İTÜ | FACULTY OF MARITIME

International Maritime Lecturers Association

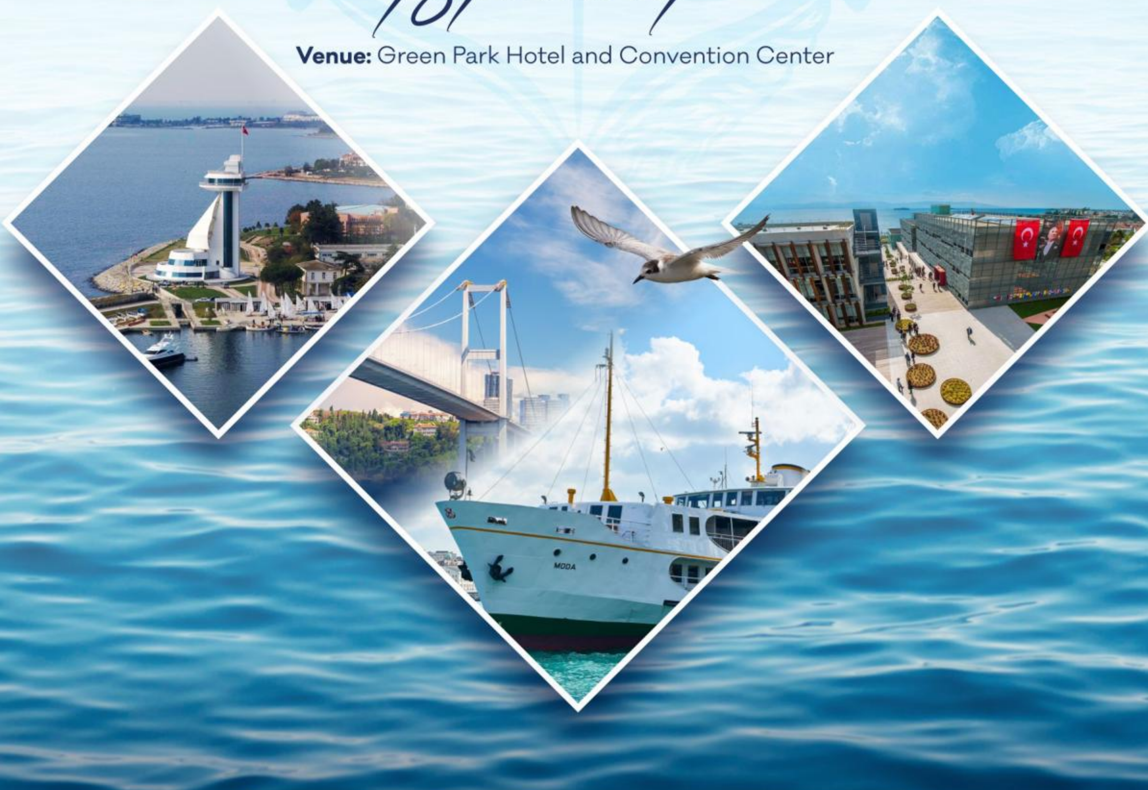
Proceedings of THE 29th INTERNATIONAL MARITIME LECTURERS ASSOCIATION (IMLA) CONFERENCE

September 25-28, 2024

ITU Maritime Faculty & Piri Reis University

Istanbul

Venue: Green Park Hotel and Convention Center



TÜRK LOYDU VAKFI

www.imla29.org

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INVITATION

On behalf of Istanbul Technical University Maritime Faculty (ITU MF) and Piri Reis University (PRU), it is our great pleasure to invite you to participate in the 29th International Maritime Lecturers Association (IMLA29) Conference. This prestigious event will take place in the vibrant city of Istanbul from September 25 to September 28, 2024.

IMLA's mission is to "promote contact and cooperation between maritime lecturers of all disciplines and to develop a body of professional expertise." In line with this mission, the IMLA29 Conference aims to bring together maritime educators, researchers, industry professionals, and policymakers to discuss the latest trends, challenges, and innovations in maritime education and training.

This year's conference will feature a rich program of engaging sessions, workshops, and panel discussions, offering an excellent opportunity for professional development, networking, and collaboration. We are also pleased to announce that IMLA29 will host three specialized subcommittees:

- International Navigation Simulator Lecturers Conference (INSLC22)
- International Conference on Engine Room Simulators (ICERS16)
- International Maritime English Conference (IMEC34)

Each subcommittee will focus on distinct aspects of maritime education and training, enabling in-depth discussions and targeted networking opportunities.

The conference will feature renowned keynote speakers and cover a wide range of topics, including but not limited to:

- Marine/navigation simulator-based maritime education and training
- Maritime safety and security
- Environmental sustainability
- Technological advancements
- Best practices in maritime education and training

Participants will also have the opportunity to engage in cultural and social activities, experiencing the rich history and beauty of Istanbul.

All accepted and presented full papers will be published in the conference proceedings book, with selected papers evaluated for publication in prestigious academic journals. Best presentation awards will be given for each subcommittee theme.

We would be honored to welcome you as a participant at this event. Your expertise and insights would be a valuable addition to our discussions and would greatly contribute to the success of the conference.

Please find enclosed the preliminary program, registration details, and accommodation options. Should you have any questions or require further information, please do not hesitate to contact us.

We look forward to welcoming you to Istanbul for what promises to be a fruitful and memorable event.

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SCIENTIFIC PROGRAM

WEDNESDAY, SEPTEMBER 25

08:00 - 09:15 REGISTRATION

09:15 - 09:25 WELCOME SPEECH - CONFERENCE CHAIRS | MAIN HALL

Prof. Dr Özcan Arslan, Dean, Istanbul Technical University, Maritime Faculty
Prof. Dr. Nafiz Arıca, Rector, Piri Reis University

09:30 - 10:00 OPENING CEREMONY | MAIN HALL

IMLA Honorary Chair **Prof. Dr. Alison Noble**
Honorary Secretary **Prof. Xin Shi**
Chamber of Shipping
Istanbul Technical University Rector **Prof. Dr. Hasan Mandal**

10:00 - 10:40 KEYNOTE SPEAKERS | MAIN HALL

Prof. Dr. Jin Yongxing
Challenges and opportunities of maritime education and training in the context of maritime digitalization and decarbonization

Prof. Dr. Hercules Haralambides
Maritime Corridors: A New Definition of Distance in Seaborne Trade

10:40 - 11:00 COFFEE BREAK

11:00 - 12:00 KEYNOTE SPEAKERS | MAIN HALL

Dr. Özkan Poyraz
In maritime education, the only constant is change itself

Dr. Christos Kontovas
GHG Emissions from Shipping: Where We Are and Where We're Going

Prof. Dr. Dong Wook Song
Maritime Lecturers as Researchers

12:00 - 12:10 GROUP PHOTO

12:10 - 13:30 LUNCH

13:30 - 14:45 • PARALLEL SESSION | A HALL

CHAIR: Prof. Dr. Xin Shi

DECARBONIZATION & ENERGY MANAGEMENT in MARITIME

- Effects of Limitations on Decarbonization in Maritime Industry: A Review Study in Terms of Energy Efficiency - **Aslı Öztoprak, Tanzer Satır**
- Assessment of Emission pollution from container ships for The Traditional International Route - **M. Ziya Sogut, Funda Yercan**
- Decarbonizing Philippines' domestic shipping: Rapid assessment and roadmap development towards zero carbon in 2050 - **Mao Tze Bayotas**
- Engine exhaust heat-driven cooling system in a maritime education campus: A case study of Piri Reis University - **Cüneyt Ezgi**
- Application of Operational Energy Efficiency Techniques for Reducing CO2 Emissions and an Investigation of the Economic Impact for Tanker Vessels - **Atil Talay, Anthony Nigro**

13:30 - 14:45 • PARALLEL SESSION | B HALL

CHAIR: Dr. Takeshi Nakazawa

ENGINE ROOM SIMULATOR

- How next generation can develop skills to meet the green shift - **Tormod Nordeng**
- An Optimized Ship Engine Room Simulator Configuration for an Effective Engine Room Resource Management Training - **Ismail Cicek, Burak Cavusoglu**
- Methodology For Assessing Exercises On A Ship'S Engine Room Simulator in The Education Process At The Faculty of Marine Engineering of The Maritime University of Szczecin, Poland - **Jan Drzewieniecki, Przemysław Kowalak, Jaroslaw Myskow**
- A Study on the Design of a Multi-purpose, Effective Ship Engine Room Simulator - **Tolunay Kayaarası**
- Simulators and the Human Element - **Quentin Cox**

14:45 - 15:00 COFFEE BREAK

15:00-16:00 • PARALLEL SESSION | A HALL

CHAIR: Prof. Dr. Özcan Arslan

MARITIME EDUCATION & TRAINING (MET)

- The Importance of Interdisciplinary Education in the Design of Floating Structures: Naval Architecture and Marine Engineering and Architecture Coorperation - **Yasemin Arıkan Özden, İbrahim Başak Dağgülü**
- Challenges and opportunities of maritime education and training (MET) in the context of maritime digitalization and decarbonization - **Yongxing Jin, Yuli Chen, Yang Sun**
- Implementation of Mechatronic Systems Teaching in Undergraduate (Bachelor) and Master's Degree Programs - **Maia Tugushi, Mikheil Lezhava, Zaza Shubladze, Tamila Mikeladze**
- Charting a Course for Comprehensive Education of Future Seafarers through Enhanced Academic Proficiency - **Anca Sirbu, Simona Elena Dinu, Sabina Zagan, Irina Stanciu, Florenta Memet, Vlad Augustin Vulcu**

15:00-16:00 • PARALLEL SESSION | B HALL

CHAIR: Prof. Dr. Funda Yercan

MARITIME HUMAN RESOURCES

- The innovation culture as a factor for sustainable development of the maritime sector - **Kamelia Narleva, Yana Gancheva**
- Employee Responses to Organizational Commitment, Job Satisfaction, and Work Involvement in Ship Agency Companies - **Retno Sawitri Wulandari, Vidya Selasdini**
- The Global Maritime Citizenship Program: Integration of the GCED Framework to the BoK-STCW-TRB Learning Outcome Matrix for BS Marine Engineering Program - **Mao Tze Bayotas**
- Challenges of Maritime Eco Port and its Human Resources in indonesia : Overview of Current and Future Action - **Vidya Selasdini, A A Priadi, Retno Sawitri Wulandari**

16:00 - 16:15 COFFEE BREAK

16:15-17:15 • PARALLEL SESSION | A HALL

CHAIR: Prof. Dr. Jin Yongxing

MARITIME ENGLISH & COMMUNICATION

- Sometimes Chat GPT is as confused as I am: a preliminary examination of the role of AI in Maritime English education - **Alison Noble, Pieter Decancq**
- Exploring cadet's engagement and cadet's response in using marlins synchronous model in an Indonesian Maritime higher education - **Sunarlia Limbong**
- Evaluation of English Maritime Document Translation Accuracy into Japanese by ChatGPT, Google Translate and DeepL - **Naoyuki Takagi, Kimihiko Kimura**
- Soft Skills for Maritime English Students: Possibility versus Necessity - **Valentyna Kudryavtseva, Svitlana Barsuk, Olena Frolova**

16:15-17:15 • PARALLEL SESSION | B HALL

CHAIR: Alain Brillault

MARITIME EDUCATION & TRAINING (MET)

- Learner Viewpoint on Maritime A.I. and Autonomous Ships - **Herbert Angeles, Edlynne Fabian-Perona**
- Users' Evaluation On The Effectiveness of The Innovative Learning Resource Online Platform In A Developing Country - **Abcede Bangalisan II**
- Reshaping Maritime Education and Training with a Circular Economy Perspective - **Pınar Özdemir, Taner Albayrak**
- Maritime Education: A critical approach to build capacity for maritime decarbonization - **Xin Shi, Yingming Wang, Jian Zheng**

17:15 - 17:30 COFFEE BREAK

17:30-18:45 • PARALLEL SESSION | A HALL

CHAIR: Prof. Dr. Alison Noble

MARITIME EDUCATION & TRAINING (MET)

- Technical Progress in the Maritime Industry and the Challenges of the Vocational Education - **Maia Tugushi, Gocha Gogitidze, Firuza Varshanidze, Svetlana Rodinadze, Luiza Sikharulidze**
- Developing Marine Engineering Technology Curriculum to Meet Future Workforce Needs - **Alok Verma, Vanicha McQueen, Paul Potier, Irfan Khan, Andrew Moore**
- Integrating 21st Century skills into STCW competences: Implications for Maritime Education and Training - **Anne Pazaver, Momoko Kitada**
- A Study on Sustainable Maritime Education and Training Infrastructure - **Tolunay Kayaarası**
- Web-based route planning training practices - **Haiyan Yu, Lennart Cederberg, Qinyou Hu**

17:30-18:45 • PARALLEL SESSION | B HALL

CHAIR: Prof. Dr. Alison Noble

MARITIME POLICY & STRATEGY

- System Dynamics Modeling for Addressing Port Congestion in Global Trade - **Umut Taç, Pelin Bolat, Funda Yercan**
- Risk Assessment of the Turkish Straits for Service Providers Using the FCM - **Arda Akyüz, Muhittin Orhan, Furkan Gümüş, Özcan Arslan**
- Ecological Monitoring of Ajara Coastline Using Drone - **Mzia Diasamidze, Ana Shotadze**
- Considerations on the United Nations Convention on the International Effects of Judicial Sales of Ships - **Oana Adascalitei**
- A Systematic Literature Review on Technological Trends in the Maritime Industry - **Muhammed Fatih Gülen, Özcan Arslan**

19:30 GALA DINNER | The Green Park Convention – İzmir Hall

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WEDNESDAY, SEPTEMBER 25

THURSDAY, SEPTEMBER 26

09:00 - 10:30 WORKSHOP: MARITIME INDUSTRY MEETING | MAIN HALL

MODERATOR: **İbrahim Kontaytekin**, Turkish Shipowners' Association Deputy Chair, ARKAS Shipping Deputy Chair

- **Takeshi Nakazawa**, IMLA Committee Member
- **İsmail Şahin**, Ship Brokers Association Chair
- **Özgür Alemdağ**, Maritime Trainer
- **Altan Yavaş**, SimBT
- **Emre Ersoy**, ErsoyBilgehan Lawyers & Consultants
- **Tunç Taner**, Havelsan

10:30 - 10:50 COFFEE BREAK

10:50-11:50 • PARALLEL SESSION | A HALL

CHAIR: Prof. Dr. Michael Baldauf

NAVIGATION SIMULATORS

- Determining the Basic Procedures to Benefit from Simulators in Training the Watchkeeping officer Candidates on COLREG Rules - **Murat Saka**
- New generation navigation simulator - **Nikolay Bedzhev**
- Research on the operation simulator for wind turbine installation vessel and its training scheme - **Jinbiao Chen, Xin Ran, Shijun Ying, Keping Guan**
- Simulating mixed traffic scenarios for training of operators in shore-based ROC and VTS - **Michael Baldauf, Daniel Rostek, Gianiti Claresta**

10:50-11:50 • PARALLEL SESSION | B HALL

CHAIR: Dr. Christos Kontovas

MARITIME EDUCATION & TRAINING (MET)

- MAAP MET Digital Green Transition: The Green Skills Academy - **Michael Amon, Eduardo Ma. Santos, Gerardo Ramon Galang, Jeppe Carstensen, Mikkel Hansen**
- Solving the Difficulties Encountered in Finding a Ship for Sea Training - **Ergün Demirel**
- AutoMareEduNet Project and pedagologigal choices for MET relating to autonomous shipping - **Peter Sandell**
- MARLSD Project: Incorporating Learning Station Desing for Maritime Education and Training - **Emre Düzenli, Gizem Kayisoglu, Pelin Bolat, Ozcan Arslan, Teona**

10:50-11:50 • PARALLEL SESSION | C HALL

Assoc. Prof. Alcino Ferreira

WORKSHOP

- Threat on board! A maritime Escape Game for learning - **Assoc. Prof. Alcino Ferreira**

11:50 - 13:00 LUNCH

13:00-14:00 • PARALLEL SESSION | A HALL

CHAIR: Quentin Cox

NAVIGATION SIMULATORS

13:00-14:00 • PARALLEL SESSION | B HALL

CHAIR: Prof. Dr. Naoyuki Takagi

MARITIME ENGLISH & COMMUNICATION

13:00-14:00 • PARALLEL SESSION | C HALL

CHAIR: Prof. Alok Verma

MARITIME EDUCATION & TRAINING (MET)

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THURSDAY, SEPTEMBER 26

A Novel Energy Efficiency Management Simulator: Development And Application - **Xiangming Zeng, Xin Shi, Chunchang Zhang, Liu Yang, Xian Wang**

Ship Communication With Bridge Simulator: A Maritime English Integrated Skills Approach - **Ahmad Fauzi**

Remote Operations Simulation: The ROC Simulator and the Future of Simulator Training in Maritime Education and Training - **Gerardo Ramon Galang**

Complex maritime traffic, complex maritime simulation - Connecting full-mission Ship-handling and full mission VTS-Simulation - **Michael Baldauf, Xiaoning Shi, Elif Bal Besikci**

Intercultural Awareness and Intercultural Development of Cadets - **Müjgan Özenir, Maria Kristina B. Javellana**

Research Topics and Development of Green Shipping Based on LDA Topic Model - **Xian Wang, Xiangming Zen, Yuli Chen**

Qualitative Case Study of Lecturer's Adaptive Skills towards Future Maritime Specialists - **Zofia Edelman-Łubian, Aleksandra Mańkowska**

Empowering EFL Learners through digital Storytelling (based on the BSMA experimental study) - **Natia Vasadze, Tamari Dolidze, Sopiko Dumbadze**

Development and Assessment of the Soft Skills in Maritime Education and Training - **Ergün Demirel**

Gender Equality Promotion For Effective Global Maritime Education Concept - **Zurab Bezhanovi, Tamila Mikeladze, Svetlana Rodinadze, Kristine Zarbazoia, Medea Abashidze, Kristine Iakobadze**

Preparing Maritime Cadets for Applying Artificial Intelligence in Maritime Education - **Qi Chen**

Implementation of a Lightboard Studio in MET – A case study at Jade University of Applied Sciences - **Laurentiu Chiotoroiu, Georgios Athanassiou, Jan Wegener, Lina van Elten**

14:00 - 14:20 COFFEE BREAK

14:20-15.20 • PARALLEL SESSION | A HALL

CHAIR: Michael Amon

MARITIME ENGLISH & COMMUNICATION

The Wording of IMO Model Courses – Similarities and Differences - **Zorica Đurović**

Deliberate pragmatic omissions in maritime VHF communications - **Jana Kegalj**

Exploring the Role of English in Constructing Professional Identity of Indonesian Seafarers on Multicultural Ships: Challenges and Strategies - **Purnama NF Lumban Batu, Wida Cahyaningrum, Peter Björkroth**

DigiMar Project Presentation: Compiling Authentic Routine VHF Maritime Communication Database - **Sandra Tominac Coslovich, Jana Kegalj**

14:20-15.20 • PARALLEL SESSION | B HALL

CHAIR: Anna Pavazer

MARITIME ENGLISH & COMMUNICATION

Characteristics of Filipino Cadets' English: The Inter-language variation among Filipino languages - **Kimihiko Kimura**

Immersing Culturally and Embracing Diversity for a Better Me: The Intercultural Experiences of Selected Maritime Cadets - **Caroline Dacwag-Balila**

Teaching Maritime English (ESP) as an interdisciplinary principle: are instructors actually becoming learners before they effectively teach their learners? - **Sofia Koutsogianni**

Software Development For Vocabulary Training in The Esp Course: Telegram Chat-Bot For Maritime English - **Viacheslav Lanin, Svetlana Strinyuk**

14:20-15.20 • PARALLEL SESSION | C HALL

CHAIR : Assoc. Prof. Dr. George Gabedava

MARITIME EDUCATION & TRAINING (MET)

Philippine Maritime Education and Training Standards on Examination and Assessment - **Rodolfo Paiso, Shermiruz Paiso**

Ship Electronics Training and Design of Automatic Ship Control Systems with Python: Changing Trends and Future Perspectives - **Zuhal Er**

Are You Simulator Literate? A Study of Maritime Communication Competence In The Full Mission Bridge Simulator - **Trude Amundsen, Alison Noble**

Maritime Psychology - an integrated training approach - **Postolache Octavian**

5

THURSDAY, SEPTEMBER 26

15.20 - 16.15 IMLA AGA MEETING | MAIN HALL

16:15 - 19:00 BUS TRANSPORTATION TO YACHT DINNER

19:00 YACHT DINNER
Media Competition Awards

FRIDAY, SEPTEMBER 27

08:30-09:00 BUS TRANSPORTATION FROM HOTEL TO UNIVERSITIES

09:00-10:30 ITU MARITIME FACULTY

10:30-12:20 PİRİ REİS UNIVERSITY

12:20-12:40 BUS TRANSPORTATION FROM UNIVERSITIES TO HOTEL

12:40 - 13:40 LUNCH

13:40-14:40 • PARALLEL SESSION | A HALL

CHAIR: Dr. Yuli Chen

MARITIME RULES & REGULATIONS

Comparative Analysis of International and Turkish National Regulations on Marine Pollution Incident Response and Cooperation - **Cihat Aşan**

The Impact of Carbon Emission Reduction Regulations on Shipping in Maritime Trade Contracts - **Hakan Muran**

Evaluation of Seafarers' Annual Paid Leave Rights Within The Scope of Maritime Labour Law No. 854 And Maritime Labour Convention (Mlc-2006) - **Ugur Tulu**

Quantitative Analysis of Oil Record Book Deficiencies: Insights from the Paris MOU Database via the Analytic Hierarchy Process - **Umut Taç, Pelin Bolat, Fırat Bolat**

13:40-14:40 • PARALLEL SESSION | B HALL

CHAIR: Prof. Dr. Levent Kırval

MARITIME STUDIES: SAFETY & SECURITY

Jurisdiction of Coastal States in Marine Accidents/Incidents Occurring in International Maritime Areas - **Burak Yolyapan, Levent Kırval**

Navigating Clear Waters: Understanding Language Challenges and Improving Maritime Safety through Linguistic Insights - **George Gabedava, Yanming Hu**

A Comparative Evaluation of AIS-Data Driven Seq2Seq LSTM with Luong Attentions for Ship Trajectory Prediction - **Füsun Er, Yıldıray Yalman**

Modelling cavitation in a Venturi nozzle of different sizes: A Study in the Context of Ship Ballast Water Treatment - **Cvetelina Velkova, Radoslav Momchilov, Ilian Kurtev**

Ship Collision Avoidance Using AI Approaches - **Prasheet Mishra, Sunil Kumar Mohapatra, Vik Patra, Pritam Pattanaik, Funda Yercan**

13:40-14:40 • PARALLEL SESSION | C HALL

CHAIR: Prof. Dr. Pınar Özdemir

MARITIME POLICY & STRATEGY

Formation of Human Resources within the Framework of the Gender Policy of the Maritime Industry - **Olena Sienko, Maryna Chesnokova, Maryna Chesnokova**

Turkey's Maritime Policies: Horn of Africa (Somalia) Example - **Muhsin Kadioglu**

Time budget for watch handover - preliminary results of senior officers' survey - **Kamil Formela, Krzysztof Wróbel, Paweł Kołakowski, Mateusz Gil**

The Current Crucial Maritime Conflicts and Their Impacts on The Maritime Areas - **Begum Muftuoglu**

System Dynamics Modelling of Maritime Ghg Emission Measures Impact Assessment - **Selen Uygur, Pelin Bolat**

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FRIDAY, SEPTEMBER 27

14:40 - 15:00 COFFEE BREAK

15:00-16:15 • PARALLEL SESSION | A HALL

CHAIR: Prof. Dr. Mehmet Ziya Söğüt

DECARBONIZATION & ENERGY MANAGEMENT in MARITIME

Greenport Alliances: Reducing the GHG Emissions in Seaports - **Kenan Tata, Tutku Eker İşçioğlu, Hüseyin Gençer, M. Taner Albayrak**

Re-emergence of Nuclear Power for Merchant Ships and Potential Reflections on Marine Engineering Education - **Deniz Ünsalan, Volkan Varışlı**

Towards Green Shipping: A Dynamic Approach for Operational Efficiency Improvement Using Historical AIS Data and Adaptive Particle Swarm Optimization - **Ashwarya Kumar, Hari Sundar Mahadevan**

A Research on Improving Global Energy Consumption with Pure Clean Energy Cycle - **Tolunay Kayaarası**

Improving Ecological end Economical Results of Marine Transport by Using Different Additives on Fuel - **Romanoz Topuria, Zaza Shubladze, Gia Purtskhvanidze, Mikheil Lezhava**

15:00-16:15 • PARALLEL SESSION | B HALL

CHAIR: Assoc. Dr. Elif Bal Beşikçi

HUMAN ELEMENT

Classification Analysis of Bullying Expressions in Maritime - **Aslı Öztoprak, Seyithan Kaçmaz, Leyla Tavacıoğlu, Bayram Barış Kızılsaç**

Navigating the waves: Understanding human response aboard marine craft through biomechanics - **Pahansen de Alwis, Karl Garme, Jens Westergren, Björn Äng**

Analyzing the Effect of Psychological Violence on Seafarers' Working Time at Sea - **Gökhan Ayaz, Leyla Tavacıoğlu**

Determination of new technologies and future skills of seafarers towards smart shipping - **Çağlar Karatuğ**

Empowering Maritime Professionals: The CrewinEdu Online Training and E-Learning Platform - **Süleyman Emre Ayvacı, Onur Sabri Durak, Onur Kılıç, Sinan Ayvacı, Oğuzhan Korkmaz**

15:00-16:15 • PARALLEL SESSION | C HALL

CHAIR: Asst. Prof. Dr. Umut Taç

MARITIME EDUCATION & TRAINING (MET)

A Study on Seafarer Education through the Experience of both Seafarer and Teacher - **Hiroyuki Kimura**

Professional Competence of a Maritime University Lecturer: Concept and Structure in Modern Conditions - **Svetlana Strinyuk, Irina Shcherbakova**

Innovative Approaches to Training and Assessment in Emerging Technologies using Maritime Simulation Techniques - **Daniel Zhang, Engr. Gerardo Ramon S. Galang**

Advancing Maritime Education: The Impact of Simulator Training on Cadets at the Italian Shipping Academy - **Reza Karimpour, Vittorio Sava**

Ensuring Academic Integrity: Best Practices of Philippine Universities in Drafting Effective Policies - **Ma Celeste Orbe**

16:15 - 16:30 COFFEE BREAK

16:30 - 17:30 **CLOSING CEREMONY** | MAIN HALL
BEST PRESENTATION AWARDS
WRAP UP - Prof. Dr. Funda Yercan, Vice Rector, Piri Reis University
IMLA 30 CONFERENCE ANNOUNCEMENT

17:30 - 18:30 CLOSING COCTAIL

SATURDAY, SEPTEMBER 28

09:00 **SOCIAL PROGRAM** (Optional with Registration)

7

ORAL PRESENTATIONS

EFFECTS OF LIMITATIONS ON DECARBONIZATION IN MARITIME INDUSTRY: A REVIEW STUDY IN TERMS OF ENERGY EFFICIENCY

Aslı Öztoprak[1], Tanzer Satır[1]
[1] *İstanbul Technical University, Maritime Faculty, Turkey*

Abstract: Although maritime transportation is known as the most environmentally friendly among all logistics methods worldwide, when the damages inflicted on the environment by ships are examined, especially the carbon emissions caused by the fossil fuels used in ships, including the greenhouse gas effect (GHG), have many adverse effects on the environment and human health. The International Maritime Organization (IMO) aims to reduce ship-sourced carbon emissions up to 50% by 2050. Environmental regulations and emissions standards are being implemented globally to reduce pollution from ships. In the maritime industry, energy efficiency plays a significant role in reducing carbon emissions as it focuses on reducing fuel consumption. Therefore, regulations to reduce carbon emissions from ships have generally focused on energy efficiency, alternative fuels, and renewable energy sources. However, steep costs, technological advancements, infrastructure inadequacies, and other factors can slow down the decarbonization process in maritime. This study presents an overview of factors that slow down and constrain processes aimed at reducing carbon emissions and achieving zero-carbon goals set by IMO from the perspective of energy efficiency through a literature review. Our study aims to provide a guidance to eliminate challenges in decarbonization for future research by highlighting the combination of factors that hinder the maritime industry from achieving large-scale transformations rapidly.

Keywords: Decarbonization, Energy efficiency, IMO regulations

1. Introduction

Considering that most of the world trade is carried out through maritime transportation, academic studies in the field of global warming, which is rapidly increasing due to the effect of greenhouse gases, focus on carbon dioxide emissions from ships. To cut carbon emissions, the International Maritime Organization (IMO) has made a number of measures. The IMO's 2018 plan, in particular, established precise goals and deadlines for decarbonizing the marine industry. Advances in energy efficiency on board ships contribute to a reduction in fuel consumption and therefore to a reduction in greenhouse gas emissions. Within this framework, Member States of the International Maritime Organization (IMO) have developed a strategy to have the majority of energy used in the maritime sector come from zero-emission fuels by 2040. This plan outlines a precise plan for a significant industry shift, indicating a dedication to cutting carbon emissions. Energy efficiency is crucial in the maritime sector for cutting carbon emissions, primarily by lowering fuel consumption. Consequently, regulations aimed at reducing ship emissions often prioritize energy efficiency, alternative fuels, and renewable energy sources. Nevertheless, challenges such as high costs, technological progress, infrastructure limitations, and other factors may impede the decarbonization efforts in maritime operations.

Firstly, the economic obstacles to decarbonizing maritime operations involve the substantial costs associated with renewable fuels such as biofuels and renewable LNG, necessitating substantial carbon taxation to effectively offset the cost disparity. In this purpose, some recent research has focused on cost comparison of renewable carbon fuels [1]. Another factor slowing down maritime decarbonization is the high initial cost of electrification. Uncertainties in infrastructure upgrading and investment are also cited as slowing down physical work in this area [2]. International maritime and environmental organizations cite the environmental impact of carbon emissions and call for urgent measures and strict regulations in this area, but the maritime sector in general has been slow to comply with decarbonization procedures. IMO has endorsed the Energy Efficiency Design Index (EEDI) and Energy Efficiency Operational Index (EEOI) indicators through MARPOL for decarbonization. On the other hand, four important Emission Control Areas (ECAs) in shipping have been identified and regulations have been introduced to reduce emissions such as Sulphur dioxide, Nitrogen oxides and Carbon dioxide.

Table 1. IMO GHG targets by the years**.**

2030	2040	2050
40% improvement in energy efficiency 25% zero-emission fuels	45% improvement in energy efficiency 72% zero-emission fuels	100% zero-emission fuels

In order to meet the milestone targets, set for 2030 and 2040, it is estimated that approximately 25% and 72% of the fuels utilized in international shipping, respectively, must consist of zero-emission fuels. This requires the acquisition of methanol and ammonia, among others, especially those sourced from green hydrogen, at a volume that aligns with present production capacities across various sectors by 2030, and exceeds these capacities by 2040. To attain this objective, constructing new zero-emission vessels and retrofitting existing ones are imperative. The next target is to launch new zero-emission ships as the main method over a 10-year period by 2040. Most importantly, the targets now include greenhouse gas emissions from production to combustion, taking into account the entire lifecycle of fuel use. This comprehensive approach ensures that all aspects of the fuel's environmental impact are considered, leading to more accurate assessments and effective reduction strategies. By considering lifecycle emissions, stakeholders can better understand the true environmental impact of different fuels and make informed decisions to reduce their carbon footprint. Methanol and ammonia derived from green hydrogen should be preferred in the decarbonization process. Today, marine methanol and ammonia are mainly produced from natural gas. This can lead to higher greenhouse gas emissions in the long term during their production and lifecycle use. They are therefore not eligible for zero emission targets [3].

Additionally, Ship Energy Efficiency Management Plan (SEEMP) is a mandatory requirement under the International Maritime Organization (IMO)'s regulations (specifically MARPOL Annex VI). It aims to improve the energy efficiency of ships and reduce their greenhouse gas emissions. SEEMP provides a framework for ship operators to establish procedures and measures to monitor and improve the energy efficiency of their vessels. It includes guidelines on voyage planning, speed optimization, trim optimization, hull and propeller maintenance, and other operational practices that can contribute to fuel efficiency and emission reduction. Enhancing energy efficiency and reducing emissions are usually the main goals of SEEMP; however, it does not have a clear framework for focusing on specific decarbonization goals or pinpointing strategies that directly contribute to these goals. Besides, SEEMP is designed primarily to enhance the energy efficiency of individual ships and typically lacks integration into broader national or international policy contexts. This gap may hinder alignment with the policies and regulations necessary to achieve larger-scale decarbonization goals. Furthermore, without alignment with broader policies, the impact of SEEMP may be limited to individual ships rather than contributing to significant reductions in greenhouse gas emissions across the maritime sector as a whole. Therefore, there is a need for greater coordination and integration of SEEMP with overarching decarbonization strategies at higher levels of governance. Regulation changes and the high cost of producing green fuels are some of the obstacles it must overcome [4].

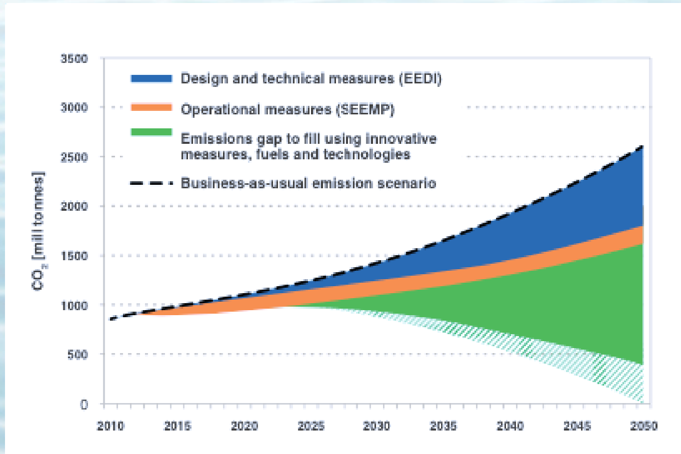

Figure 1. IMO's GHG reduction pathway [5].

Another method developed by IMO to measure and report carbon emissions resulting from ship operations is the Energy Efficiency Operational Indicator (EEOI). It is the ratio of the amount of CO2 emitted by a ship over a specific distance to the amount of cargo carried. Energy Efficiency Design Index (EEDI): EEDI is a mandatory regulation adopted by IMO that requires new ships to meet a minimum energy efficiency standard. It measures the amount of CO2 emitted per unit of cargo carried by a ship. Energy Efficiency Existing Ship Index (EEXI): EEXI is a new regulation adopted by IMO that requires existing ships to meet a minimum energy efficiency standard. Similar to EEDI, EEXI measures the amount of CO2 emitted per unit of cargo carried by a ship [6]. A recent study indicates a number of factors can be considered to be disadvantageous when considering EEDI calculations for ships. EEDI/EEXI employs a single operating profile, namely the design speed of the ship. This may not be the case for all types of ship. For instance, a cruise ship typically operates at a slower speed and is involved in a greater degree of manoeuvring. In the case of bulk carriers, the operational speed is typically below the design service speed [7].

The Carbon Intensity Indicator (CII) in the maritime industry serves as a metric designed to evaluate the average carbon dioxide (CO2) emissions per unit of transport work carried out by a ship. This indicator was established through amendments to MARPOL Annex VI by the International Maritime Organization (IMO). The comprehensive environmental impact assessment provided by CII is limited because it mainly takes into account CO2 emissions and might not fully capture other greenhouse gases or pollutants emitted by ships. Ship operators run the risk of streamlining their operations to improve their CII rankings without necessarily cutting emissions in absolute terms. One such method would be cargo management techniques as opposed to advancements in technology or operational efficiency. Implementing cargo management techniques involves optimizing the use of space on a vessel, reducing empty trips, and maximizing load capacity. By focusing on these strategies, ship operators can potentially reduce emissions while still improving their CII rankings. These difficulties highlight the need for appropriate laws and regulations in order to successfully meet goals for cutting greenhouse gas emissions [8].

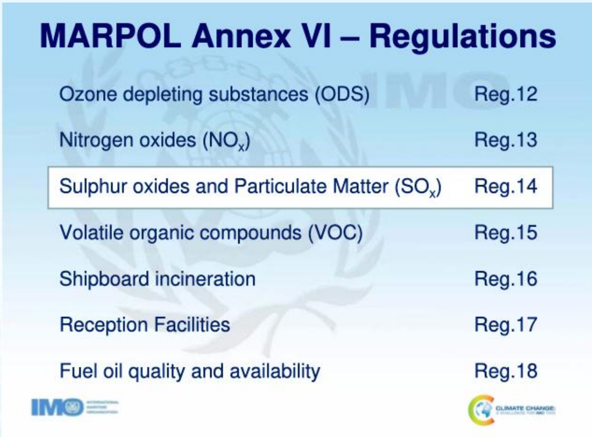

Figure 2. Marpol Annex VI regulations [9].

2. Method

Insufficient research into updated standards, expenses, and regulatory frameworks necessary for effective shipping decarbonization impedes the uptake of clean fuels and technologies.

This review employs a three-step approach to examine factors influencing energy efficiency, particularly in the context of decarbonization efforts. In this paper, a review of environmental, economic and technological limitation affects which hinder decarbonization processes in maritime industry is presented; covering the last 5 years by searching four databases (Google Scholar, Web of Science, Scientific Research, IMarEST Library). The findings highlight the importance of addressing these limitations to achieve sustainable energy practices in the maritime industry.

By analysing recent research, this review provides valuable insights for policymakers and industry stakeholders seeking to enhance energy efficiency and reduce carbon emissions in maritime operations. Among the articles found, phrases such as 'environmental, economic and technological barriers' were used to focus the research with the aim of outlining the factors slowing down decarbonisation. The analysis revealed that a lack of government policies, insufficient funding, and resistance from established industries were key obstacles hindering progress towards decarbonisation. Furthermore, the research highlighted the importance of collaboration between governments, industries, and stakeholders to overcome these barriers and accelerate the transition to a low-carbon economy. Additionally, it emphasized the need for innovative solutions and investments in renewable energy technologies to drive decarbonisation efforts forward [10].

(Google Scholar, Web of Science, Scientific Research, IMarEST Library)

Decarbonization

Limitations in decarbonization

Environmental Technological Political

Figure 2. Flow of the review method.

This study aims to demonstrate the usefulness of alternative fuels for reducing carbon emissions from ship operations as well as their application in the entire fuel life cycle, from production to storage. The research will also explore the economic feasibility and scalability of implementing alternative fuels in the maritime industry, providing valuable insights for policymakers and industry stakeholders. The study will assess the environmental impact of alternative fuels compared to traditional fossil fuels, highlighting potential benefits for sustainability.

In the process of decarbonizing the maritime industry, electric ships are crucial. Research emphasises the necessity of taking safety measures while using hydrogen, ammonia, and battery systems on electric ships in order to minimise potential risks and guarantee adherence to decarbonisation laws. Furthermore, advancements in technology are continuously improving the efficiency and safety of electric ships, making them a viable option for sustainable transportation. Implementing proper training programs for crew members and developing robust emergency response plans are also essential components in ensuring the successful transition to decarbonized maritime operations [11]. Another issue addressed in the study is the effectiveness of nuclear energy applications in decarbonisation processes. While nuclear propulsion presents opportunities for clean energy in maritime trade, it also presents difficulties because there aren't enough international regulatory frameworks in place to adequately address environmental risks. The international regulatory framework for nuclear-powered merchant ships is inadequate and does not adequately address environmental risks, which is one of the current policies hindering the decarbonisation of the maritime sector. Stronger regulations and guidelines are needed to ensure the safe operation of nuclear-powered merchant ships and mitigate potential environmental impacts. Without updated policies, the transition to cleaner energy sources in the maritime sector may be hampered [12,13]. The paper also discusses the risks nuclear-powered ships have to the environment. The investigation will also look for any weaknesses in the current laws and make suggestions for improving global governance frameworks to guarantee the safe operation and decommissioning of nuclear-powered ships. This paper looks at the relationship between marine security and environmental protection in an effort to add to the ongoing conversations about sustainable shipping operations in a world that is changing quickly.

3. Conclusion

This study has reviewed some hindering challenges to reducing emissions in the maritime industry, including environmental, technological, and political factors that must be addressed in order to achieve significant progress. The findings suggest that a multi-faceted approach involving collaboration between industry stakeholders, policymakers, and researchers is essential to overcoming these obstacles and transitioning towards a more sustainable maritime sector. By utilizing a combination of renewable energy sources such as wind, solar, and hydrogen fuel cells, ships can significantly reduce their environmental impact. Incorporating energy-efficient technologies and practices can further enhance the overall sustainability of the industry. There is great potential for cutting carbon emissions and improving sustainability in the maritime sector when alternative fuels are paired with hybrid power systems. The utilization of renewable energy sources expands constantly, in conjunction with the rapid development of technological applications. Reducing greenhouse gas emissions by means of the use of fuel-efficient ships powered by renewable energy presents an essential chance for the maritime industry. However, obstacles such limited lifespans during transition from commercial to electrical ships must be handled by feasible and rapid remedies. Innovations in battery technology and infrastructure development are crucial in overcoming these obstacles. Collaboration between governments, industries, and researchers is essential to ensure a smooth transition towards sustainable maritime transportation.

The research discussed in this article demonstrates the significance of developing appropriate regulations in combination with technological and green initiatives for decarbonizing maritime transportation. Reducing carbon emissions can be expedited by emphasizing on modern technology that agree with environmentally friendly policies. The worldwide carbon footprint can be substantially decreased as a consequence of international collaboration. The promotion of renewable energy sources and biofuels with the use of heavy fuels has been one of the primary latest attempts to accomplish the IMO's zero-carbon emission goals. This objective necessitates cooperative efforts within a broad sector network, from energy generation to ship design. The implementation of carbon capture and storage technologies in conjunction with renewable energy sources can further reduce emissions from the shipping industry.

With the use of metrics such as the EEDI, EEXI, and CII, the International Maritime Organization (IMO) seeks to generate actionable data for decarbonization programs by measuring and disclosing the fuel consumption and carbon emissions of active ships. However, these metrics do not compensate for variables like cargo, route, and speed which have an impact on the actual emission results in terms of the accuracy of prediction. Besides, adopting new technologies or retrofitting existing ones in order to implement measures to meet these metrics can be logistically challenging and expensive.

Though studies indicate that certain deficiencies could be addressed, the Ship Energy Efficiency Management Plan (SEEMP) plays a significant part on decarbonization in the maritime industry. Its implementation throughout the industry may differ due to its voluntary nature. It also emphasizes energy efficiency, instead of focusing on direct emissions which is the main target.

Significant technological advancements and infrastructure development are required for the switch to low-carbon technologies, such as hydrogen fuel cells or ammonia-powered engines, which can be expensive and time-consuming. Furthermore, implementing new technologies and complying with stricter environmental regulations can be prohibitively expensive for some shipowners and operators, especially given fluctuating fuel prices and economic pressures. On the other hand, international regulations are evolving to support decarbonization objectives, creating a framework for consistent standards and incentives for shipping companies to invest in cleaner technologies.

Alternative fuels are the most significant factor in the decarbonization of the marine industry. There isn't yet a single technique that can cut carbon emissions that much and compete with petroleum-based fuels in terms of price. It would be beneficial to carry out long-term research in this area. The IMO's sanctions are significant in this regard, although cooperation between all parties is required.

Liquefied natural gases (LNG) are incompatible with long-term decarbonization policies due to their unique storage and transportation requirements, as well as the fact that they are derived from fossil fuels. According to some studies, methanol made from natural gas contributes to global warming. Alternative fuels also present environmental risks to the marine environment, which call for their discussion within the framework of international law. It is important to consider the full lifecycle emissions of alternative fuels, including their production and transportation. Implementing regulations and guidelines can contribute to mitigate the potential environmental impacts of these fuels in decarbonization in maritime industry. Since hydrogen-based fuels don't release carbon dioxide during production, they are considered as alternative fuels in maritime decarbonization plans.

Decarbonization efforts will be viable with the combined use of suggested methods in order to meet the IMO's 2030 and 2050 targets. Aiming to achieve the IMO's goals, stakeholders supporting the marine sector must behave accordingly. It is important to remember that decarbonization is essential for all climate-related initiatives, not only the maritime industry.

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ASSESSMENT OF EMISSION POLLUTION FROM CONTAINER SHIPS FOR THE TRADITIONAL INTERNATIONAL ROUTE

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Abstract: Today, container shipping, where the total maritime transportation supply has grown by 11.5% in the last two years, can be seen as the main component of total emission pollution with its sectoral potential. In this context, the inefficiency caused by the irreversibility of these ships, which are the pioneers of fossil fuel consumption for traditional routes, has the potential to produce high entropy. In this study, the entropy production and environmental impact potentials caused by 11 container ships reaching 230 000 DWT were examined with thermodynamic approaches, taking into account the consumption data. In the study, it was observed that consumption inefficiency represents a value of 0.23 kg/kW for a fuel consumption of 0.30 kg/kW against the unit power demand. For this potential, the fuel-related environmental pollution rate in ships represents a potential of 74.84%. According to analyses, existing ships produced between 2.53 and 3..24 times greater pollution with a reversible process aspect. At the end of the study, energy efficiency recommendations for the transition to decarbonization for ships were emphasized.

Keywords: Container Ships, Sueze, Efficiency, Decarbonization

1. Introduction

While maritime transport plays a critical role in ensuring the continuity of supply to global economies, it is also a major player in global change. Today, industry in particular is a major contributor to greenhouse gas emissions, with shipping accounting for around 3% of global emissions. In contrast, there is a growing emphasis on adopting greener practices, such as switching to low-emission fuels, increasing ship efficiency through technological innovation, minimizing fuel consumption, and better route management. In addition, the International Maritime Organisation (IMO) is conducting studies that include a number of regulations to reduce emissions and promote sustainable maritime practices to 2030 and beyond. Initiatives such as using wind-assisted propulsion and research into hydrogen and ammonia as alternative fuels are gaining momentum, while the framework for long-term decarbonization strategies is being developed(IMO, 2018a). While increasing scrutiny of shipping's environmental impact is encouraging industry stakeholders to invest in sustainable technologies, work is intensifying on new frameworks to meet growing demand. A shipping industry that prioritises sustainability is becoming increasingly important as it seeks to transform itself into a structure that not only reduces its environmental footprint, but also increases its durability and efficiency in the face of climate change.

Today, the world's maritime transport is organised along various routes, and this transport has facilitated the exchange of goods and culture as well as global trade. One of the most famous routes was the Silk Road, which connected Asia with Europe and the Middle East, allowing the trade of luxury goods such as silk, spices, and precious metals. The transatlantic trade route also played an important role during the colonial period, linking Europe and the Americas, where goods such as sugar, tobacco and cotton were traded. In addition, the Cape of Good Hope route was vital for trade between Europe and Asia, especially before the opening of the Suez Canal in 1869, which allowed ships to travel directly between the Mediterranean and the Red Sea, greatly reducing travel time(Tsiamis et al., 2022). Other important routes include the transpacific route, which links Asia with North America, and the Panama Canal, which revolutionised shipping by linking the Atlantic and Pacific Oceans. These traditional shipping routes laid the foundations for today's complex global trade networks and have continued to evolve to meet the demands of an interconnected world.

The Suez route is of critical importance in world maritime transport and is an important route with intensive use, with approximately 50,000 ships passing annually. This strategic waterway provides a direct link between Europe and Asia, allowing ships to travel more quickly and economically without having to go around the southern tip of Africa. The use of the canal is an important factor affecting approximately 10% of global trade, which promotes international trade by reducing transport costs. The density on the Suez route is increasing with the increase in commercial cargo, which brings with it some difficulties; These challenges include issues such as environmental impact, ship traffic management and sustainability of the canal's infrastructure. Therefore, effective and sustainable management of the Suez route is of great importance for the future of both maritime transport and global trade. However, while this intensive use affects emissions from maritime transportation, it represents one of the points that require evaluation for the sectoral structure. Greenhouse gas emissions from ship engines have become a significant problem, especially in connection with the use of fossil fuels. Considering the ship traffic on the Suez route, the manageability of this route gains value for environmental sustainability. In recent years, in line with goals to reduce emissions, ship operators have begun to adopt more efficient navigation techniques and innovative technologies. This process contributes to both reducing environmental impacts and preserving the importance of the Suez route in international trade.

In response to the aforementioned situation, the IMO (International Maritime Organization) has developed a series of measures aimed at reducing the carbon footprint of the maritime industry. To illustrate, in 2018 the IMO established targets to reduce greenhouse gas (GHG) emissions by a minimum of 50% from 2008 levels by 2050 (IMO, 2018a). In 2023, the targets were revised and more ambitious targets were set, aiming for a reduction of at least 70% from 2008 levels by 2040 (IMO, 2021). In order to achieve these targets, the IMO has focused on the implementation of regulations pertaining to energy efficiency. In this regard, the organization has developed a series of tools, including the Energy Efficiency Index for Design (EEDI), the Ship Energy Efficiency Management Plan (SEEMP), the Energy Efficiency Operational Indicator (EEOI), the Energy Efficiency Existing Ship Index (EEXI) and the Carbon Intensity Indicator (CII) (IMO2021; IMO 2023a). Nevertheless, despite the implementation of these regulations, CO_2 emissions from international shipping increased by 5.6% between 2012 and 2018. This demonstrates that energy efficiency regulations are not a sufficient means of achieving the reduction targets set out by the IMO (Xinping et al., 2023). Consequently, more advanced measures are required to achieve these reduction targets.

Notwithstanding the implementation of sectoral measures in the maritime transport sector, the global emission impact continues to demonstrate an upward trajectory. Indeed, the probability of an increasing trend in sectoral predictions for 2050 indicates an anticipated increase of approximately 130% (IMO, 2021). The difficulties encountered in implementing sectoral measures have made it challenging to effectively manage emissions in the maritime transport sector (Bilgili, 2023). Nevertheless, a multitude of sectoral measures are still being implemented under the guidance of the IMO. In particular, it would be beneficial to discuss the existing criteria for the management of energy in this context. Indeed, it would be prudent to consider the prediction of parameters directly related to energy and the environment as a criterion. In this study, which serves as a reference in this context, the Suez routes of the referenced container ships were examined, and the potential environmental impacts of their energy, exergy efficiencies, and fossil fuel-based performances were evaluated using an entropy-based approach with a holistic perspective. The study evaluated the potential for energy efficiency in ships based on two basic environmental indicators.

2. Traditional route of the shipping

The global economy has a significant impact on traditional shipping routes, shaping trade patterns, demand for goods, and the overall dynamics of maritime transport. As economies grow and develop, the flow of goods along these routes often changes to accommodate evolving markets and changing consumer preferences. For example, the rise of Asia as a manufacturing center has changed traditional trade patterns, leading to increased shipping on routes connecting Asia to Europe and North America. In addition, economic downturns or geopolitical tensions can disrupt established shipping routes, causing delays and increased costs. The emergence of e-commerce has changed the landscape, increasing demand for faster and more efficient shipping options. This change has forced shipping companies to adapt their strategies, optimize logistics, and invest in infrastructure to meet new demands while remaining competitive. Overall, the interaction between the global economy and traditional shipping routes has highlighted the importance of agility and innovation in the shipping industry as it navigates an increasingly complex and interconnected world.

While traditional shipping routes have long dominated global trade, they are also increasing their environmental footprint as demand grows. As the world increasingly prioritizes sustainability despite the impact of global competition, the need to decarbonize the maritime industry has become critical. Maritime transport, which accounts for around 3% of global greenhouse gas emissions, cannot avoid its emissions production potential due to its dependence on heavy fuel oil. To meet this challenge, stakeholders are now implementing various strategies, including the introduction of cleaner fuels such as LNG, hydrogen and biofuels. We are also seeing innovative technologies such as wind-assisted propulsion and energy-saving hull designs aimed at increasing ship performance and reducing fuel consumption. Indeed, regulatory frameworks such as the International Maritime Organisation's (IMO) targets to reduce emissions by at least 50% by 2050 are driving the industry towards more sustainable practices.

The Suez Canal is a vital artery in the global economy, serving as a key conduit for international trade by connecting the Mediterranean Sea to the Red Sea. This strategic waterway significantly reduces the travel time for ships, allowing them to avoid lengthy voyages around the southern tip of Africa, making the transport of goods faster and more cost-effective. Around 12% of world trade passes through the Suez Canal, including critical commodities such as oil, natural gas, and manufactured goods. Its importance has been underlined by events such as the blockade of the container ship Ever Given in 2021, which highlighted the canal's role in maintaining supply chain stability. Disruptions to the Suez Canal can lead to significant delays and increased shipping costs, affecting markets around the world. As global trade continues to expand, the efficiency and capacity of the Suez Canal will remain critical to supporting economic growth, ensuring the timely delivery of goods, and enhancing international connectivity.

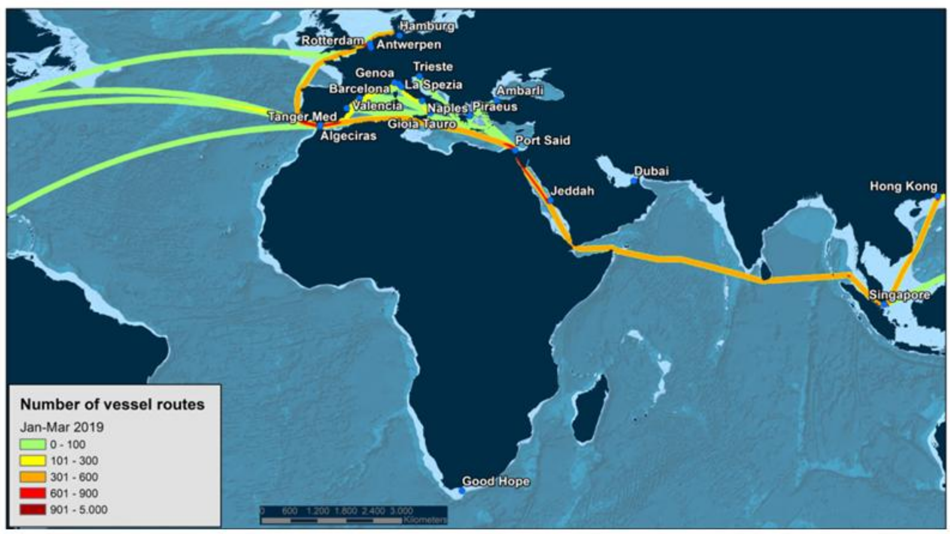

Figure 1. Suez route (Alexbank, 2021)

2.1. Container shipping and decarbonization

Container shipping plays a pivotal role in global trade, enabling the seamless transportation of goods across vast distances. However, this particular sector of maritime transport is a significant contributor to the overall emissions of greenhouse gases within the industry and is therefore an area of increasing concern in light of the growing demand for its services. The challenges to decarbonizing container shipping are evolving in response to new opportunities for driving change. The decarbonization of container shipping is a complex but indispensable undertaking that necessitates the involvement of multiple stakeholders, investment in pioneering technologies, and a dedication to sustainable practices. By embracing alternative fuels, improving energy efficiency, and adhering to regulatory frameworks, the sector can make a substantial contribution to global efforts to combat climate change by significantly reducing its carbon footprint. As the green transition progresses, the maritime sector must evolve the process of shifting from traditional structures to a more sustainable future with carbon-free technologies (Man, 2023). The three key focus areas for decarbonization can be carbon-free fuels, digitalization, and sustainable energy management. Container ships represent the most comprehensive system structure in shipping. As can be seen in Figure 2, many technological frameworks based on green transition have started to be used in container ships today.

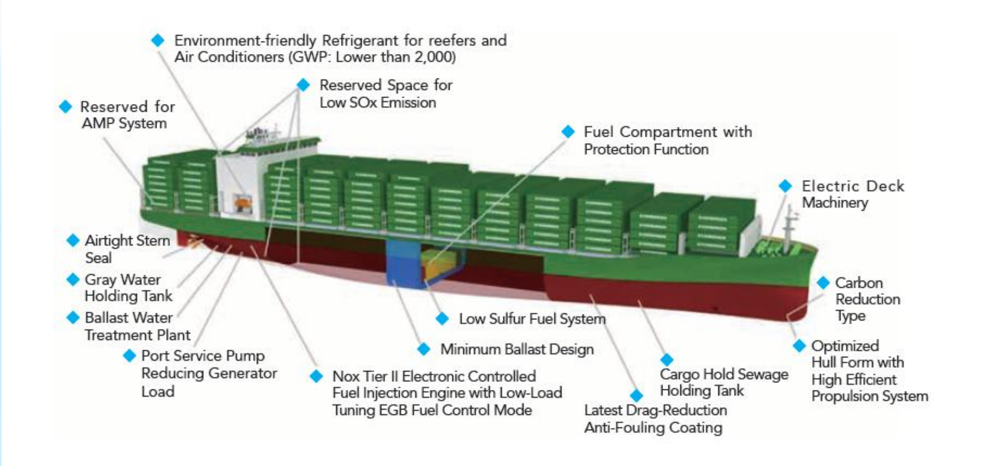

Figure 2. Green container shipping (The generalist, 2020)

Direct energy efficiency measures are of value in ensuring the efficient use and management of energy on these ships. The pursuit of energy efficiency represents a foundational aspect of the transition to a decarbonized future.

2.2. Energy efficiency in decarbonization

The decarbonization of the shipping industry is of critical importance in the fight against climate change. It provides a framework for stakeholders in the sector to enhance environmental sustainability and achieve a significant reduction in greenhouse gas emissions. Despite its status as a significant contributor to global trade, the shipping industry is one of the sectors with the highest carbon footprints. In this context, the sector persists in its decarbonization efforts, integrating renewable energy sources, utilizing alternative fuels, and implementing energy efficiency applications. The implementation of energy efficiency measures in the context of decarbonization ensures the more efficient utilization of energy resources, whilst simultaneously minimising any adverse environmental impacts. This directly supports the development of sustainable environments for energy-using structures, mostly based on fossil fuels, as well as the reduction of energy costs. For many sectoral structures, it supports energy efficiency applications, while encouraging the integration of low or zero-carbon technologies and the use of energy-efficient systems. Energy efficiency is a critical strategy for achieving decarbonization targets, while also producing outputs that support environmental sustainability and, consequently, economic growth.

In the context of the rapidly evolving global maritime responsibility sector, the energy efficiency of ships represents a crucial managerial approach that will significantly contribute to the long-term sustainability of the maritime transport sector in terms of energy and the environment. Energy efficiency represents a principal avenue for reducing greenhouse gas emissions in the maritime sector, functioning as a sectoral indicator in this regard. Indeed, in terms of sectoral stakeholders, aerodynamic and hydrodynamic improvements are being made in ship design with the objective of increasing energy efficiency. Consequently, solutions are being developed with the aim of reducing the resistance of ships on the water and reducing energy demand. Furthermore, the utilisation of sophisticated engine technologies and sophisticated energy management systems in contemporary maritime vessels serves to optimise fuel consumption, diminish operational costs and mitigate environmental impact. Furthermore, the integration of renewable energy sources, such as solar panels and wind-assisted systems, is also developing as a significant strategic action that enhances energy efficiency on ships. In the present era, initiatives such as the elevation of personnel awareness and the continuous observation of ship operations, with an understanding that corporate energy management frameworks such as ISO 50001 prioritise these aspects, can be regarded as pivotal focal points that facilitate the enhancement of energy efficiency.

4. Results and discussion

This study is based on an analysis of 11 container ships on the Suez route, with a particular focus on their route energy performance and the environmental impacts caused by the ships. A comprehensive analysis is conducted using 75% of the engine power of the vessels under consideration, with the engine and fuel consumption of the ships traversing the Suez route serving as the basis for this evaluation. In the course of the analyses, the consumption of the engines is discussed in relation to their instantaneous performance under steady-state conditions. The engine powers and distributions of the ships that serve as the basis for the study are presented in Figure 3.

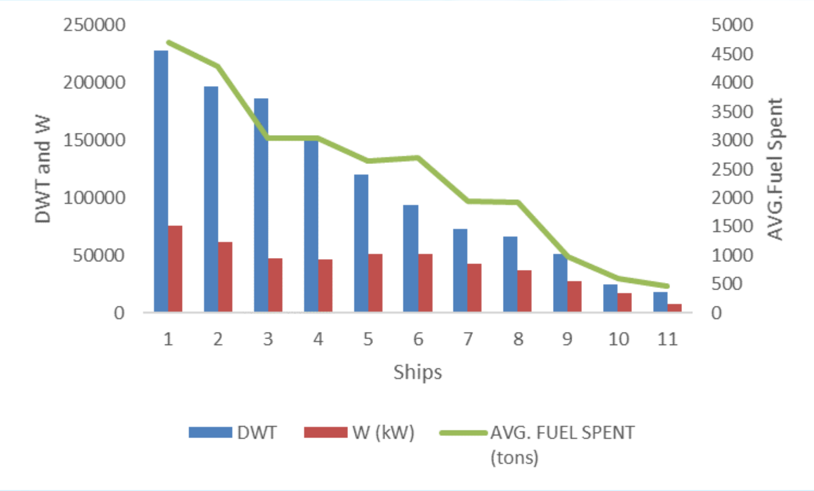

Figure 3. Power and Avg. fuel consumption of the ships

The mean fuel consumption of the ships is 0.023 tons per DWT. However, there is considerable variation in fuel consumption depending on the power, with figures ranging from 0.047 tons/kW to 0.092 tons/kW. While the lowest power-based consumption is observed in the 10th ship, when DWT is considered, the third ship exhibits the lowest unit consumption. This situation provides a compelling illustration of the potential for energy management. In this context, the distributions of the ship's power and energy performance are illustrated in Figure 4.

Figure 4. Energy consumption and thermal efficiency performances of the ships

The examination of container ships revealed that the consumption efficiency of ships numbered 9 and 10 exhibited an advantage of approximately 40% in comparison to other ships. Conversely, the consumption based on unit power production was found to be 1.98 kWin/kWw for ship numbered 9, while this value was determined to be 1.94 kWin/kWw for ship numbered 10. The efficiency change in the ships was determined to be approximately 49%. The consumption performance of the ships was examined with regard to the exergy efficiency in relation to the exergy factor. The resulting performance distributions are presented in Figure 5, with data grouped according to DWT and engine power.

Figure 5. Efficiencies impact of the ship's power.

The ship engine power was found to depend on the exergy factor, with the lowest value for unit exergy consumption observed in the ninth ship (2.79 kWein/kWw) and a similar value (2.74 kWein/kWw) in the tenth ship. The exergy efficiency of the ships was determined to be 35.81% and 36.46%, respectively. When the DWT potentials of the ships are taken into consideration, different results emerge. It is notable that a considerable number of ships have a power of less than 2 kWein. The second ship, with a DWT of 196,878, has a consumption of 1.26 kWein. In light of these findings, it can be concluded that an optimization approach is required with regard to both exergy consumption and exergy efficiency. The environmental impact of ships is contingent upon their exergetic performance. The exergy performance distributions are illustrated in Figure 6.

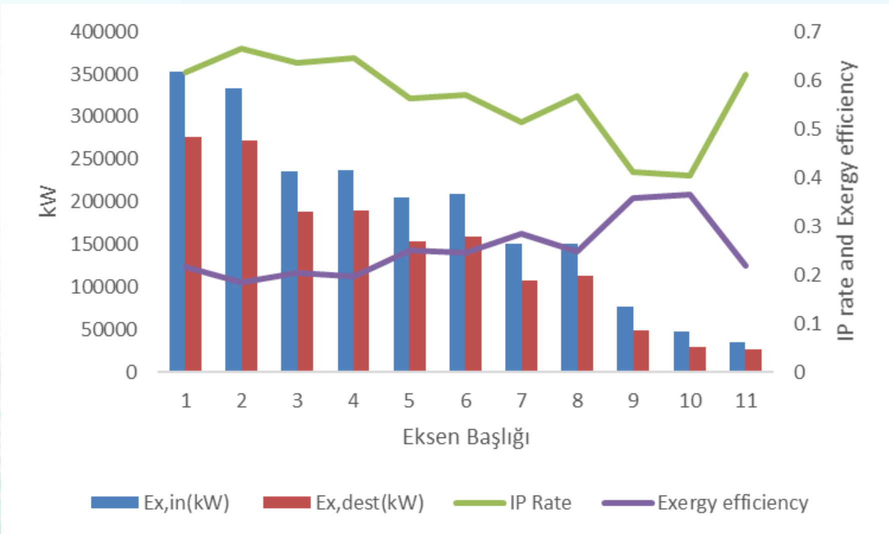

Figure 6. Exergetic parameters of the ships

The effect of fuel consumption of ships is directly related to their engine performance and exergetic performance depending on the environmental conditions they are in. The referenced exergy factor is directly valid for 1 Atm pressure and 25 °C temperature. In this structure, exergy destruction is valuable in terms of unit power management. While exergy destruction indicates a unit power consumption of 1.70 kWein/kWw to 4.40 kWein/kWw according to engine power demand, IP ratio shows a value between 1.11 kWein/kWw and 3.59 kWein/kWw in this load distribution.

The basic component of exergy destruction is the entropy load for the environmental conditions it is in. Exergy load varies between 91.10 kW/K and 928 kW/K according to the environmental conditions of the ships. On the other hand, for all ships, it was found between 28.95 kW/K and 293.74 kW/K for reversible conditions. In this respect, it also determines the potential of environmental pollution caused by entropy production. In fact, while the SI (Sustainability Index) indicator for the Suez route was found to be 25.09, this value was found to be between 0.635 and 0.815 for ships for EPI (Environmental Potential Indicator). These values show that the environmental pollution potential is 2.53 to 3.24 times higher when a reversible structure is taken as a basis. In the light of these studies, EER (Energy Efficiency rate) values for ships were taken into consideration and evaluated for 11 reference ships. According to the current fuel consumption, this rate was found to be 15.49% to 37.45%.

4. Conclusion

In this study, firstly, a method is proposed regarding the applicability of an entropy-based approach that will support the environmental sustainability of ships. For this purpose, a sampling was made for eleven ships with different DWTs in container transportation of the Suez route, which is the most used route in the world. Accordingly, the average thermal efficiency of the ships for these routes is 26.67%, while the exergy efficiency shows an average potential of 25.16%. When the exergy destruction potentials are taken into account, the average IP ratio shows a potential of 56.35. According to these consumption behaviors, it shows that the environmental pollution potential caused by the ships can be 3.24 times higher than the reversible conditions. The energy efficiency ratio of the ships for this consumption behavior has an average value of 28.53%. The entropy-based approach proposed in the study seems to provide effective results when environmental pollution and energy management of the ships are taken into account. Effective results can be seen for evaluating the performance effect for environmental conditions and evaluating possible improvement potentials with this approach. Evaluation of this study together with life cycle analyses and technoeconomic analyses can provide useful results for decarbonization.

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THE ROLE OF SIMULATOR TRAINING IN EQUIPPING THE NEXT GENERATION FOR THE GREEN SHIFT IN SHIPPING

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Abstract: As we rapidly approach the milestone years of 2030 and 2050, crucial for the maritime industry to meet the United Nations' sustainability goals, significant developments are underway in emissions reduction and fuel efficiency within shipping. Kongsberg Digital is at the forefront of this progress, developing advanced simulators that facilitate learning and research on environmentally friendly and cost-effective propulsion solutions. By building on previous advancements such as scrubbers, dual-fuel engines, and LNG operations, Kongsberg Digital's new models provide unique insights and training opportunities for operating various energy carriers. From research and development to planning and operation, products, processes, and training are increasingly taking shape in the virtual world, thanks to the growing power of simulation technologies. This paper discusses how simulator training is essential in equipping the next generation with the skills needed to achieve the green shift in shipping.

Keywords: simulator training, green shift, shipping industry, emissions reduction, LNG, methanol, hybrid power systems, digital solutions, Kongsberg Digital

Introduction

The maritime industry faces a critical challenge in reducing emissions to meet international targets by 2050. The next generation of maritime professionals must be adept at operating, understanding, and innovating solutions to achieve these stringent environmental goals. Currently, there is an unprecedented level of interest and engagement from stakeholders in this field, making the integration of advanced training methodologies more crucial than ever.

The Need for Advanced Training

Extensive research and debate focus on future energy carriers and methods to reduce the maritime sector's environmental footprint. Achieving significant reductions will require technological advancements and comprehensive training programs that align with new regulatory standards. Simulator training emerges as a critical component in this transition, ensuring both seafaring and land-based personnel are proficient in the latest sustainable practices.

Innovative Simulator Models

Kongsberg Digital has developed several new simulator models to meet the modern training needs of the shipping industry:

1. **L22 ME-GI Model**: This model is based on the machinery configuration of a next-generation LNG Carrier propelled by two MAN ME-GI low-speed engines, capable of operating on LNG, MGO, and HFO. The L22 MAN ME GI model is designed to meet new safety and sustainability requirements, enabling students to gain expertise in operating two-stroke LNG-fueled engines with a focus on safety and environmental protection. The model also complies with the Ballast Water Management Convention and includes a combined electrolysis and filter system to meet IMO and USCG requirements.
2. **DEDF42 Cruise Ferry Model**: This model supports IGF code training in LNG bunkering procedures. Handling LNG fuel and other low-flashpoint fuels on ships became part of maritime training standards in 2017, following IMO's addition of aspects of the International Code of Safety for Ships using Gases

or other Low-flashpoint Fuels (IGF Code), including LNG fuel handling and bunkering, to Standards of Training, Certification, and Watchkeeping (STCW).

3. **DEDF42-CPV-Hybrid Model**: Representing a next-generation hybrid-driven passenger coastal vessel, this dual-fuel simulator uses methanol and batteries. It features four dual-fuel generators and a 7500-kWh battery pack, enabling a zero-emission range of four hours at 8-10 knots. This model focuses on operating hybrid power systems, methanol bunkering, and methanol-fueled engines.

Digitalization and Optimization

The growing interest in digital solutions is driven by the need for emission reductions and cost savings. Simulation and digitalization enable optimization based on real ship parameters. Kongsberg Digital, in collaboration with Höegh Autoliners, is developing a PCTC (Pure Car & Truck Carrier) Simulator Model with Hybrid Fuel Technology. This engine simulator integrates hybrid fuel systems for LNG and Marine Gas Oil, with future updates to include ammonia. It provides comprehensive training on the operational intricacies and optimization of hybrid engines, essential for reducing carbon footprints.

Neptune Instructor Tool

The Neptune Instructor tool enhances the training experience by allowing users to recreate scenarios, adjust values, monitor simulations, create exercises, perform assessments, and document simulations. This tool is vital for practicing and researching green technology using simulator models.

Conclusion

Simulator training is essential for the green shift in shipping, providing the necessary knowledge and skills to operate and innovate with sustainable technologies. By using advanced simulator models, maritime professionals can gain practical experience and understanding, driving the industry towards achieving its zero-emission goals. This paper highlights the importance of integrating simulator training into the maritime sector's strategy for a sustainable future.

Figure 1. VR view from Engine Room

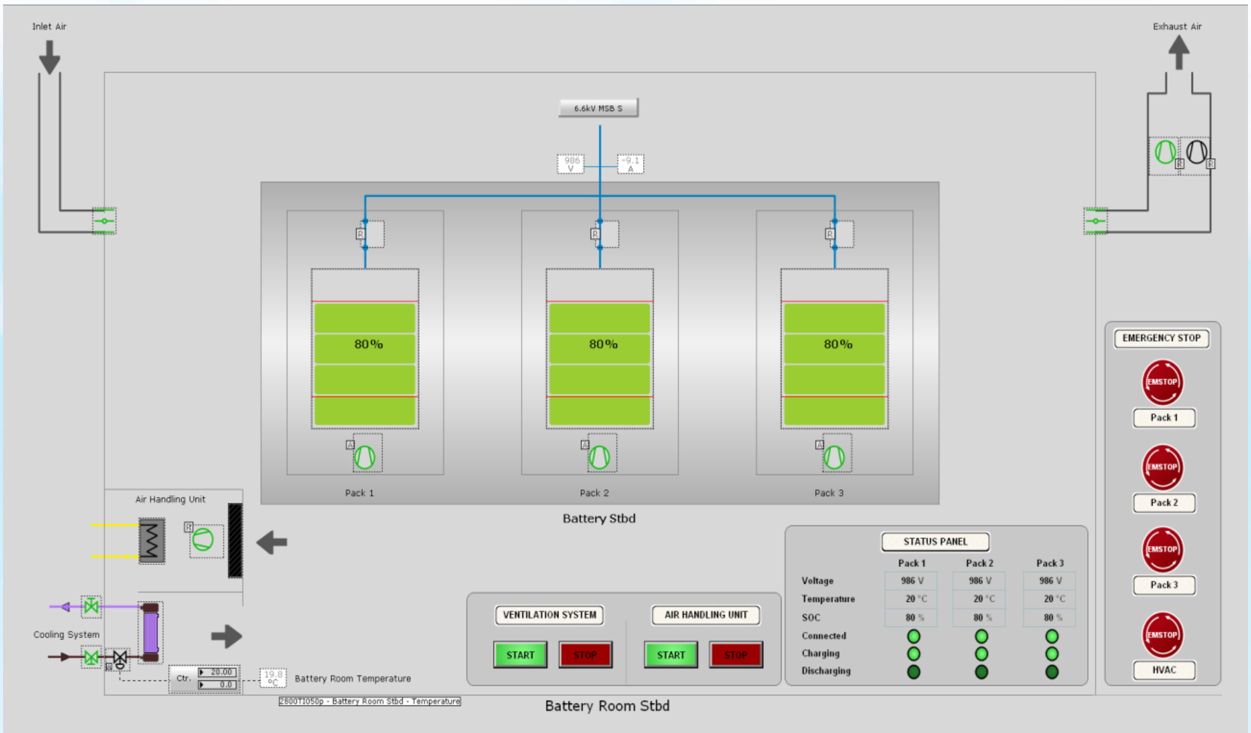

Figure 2. Battery Room

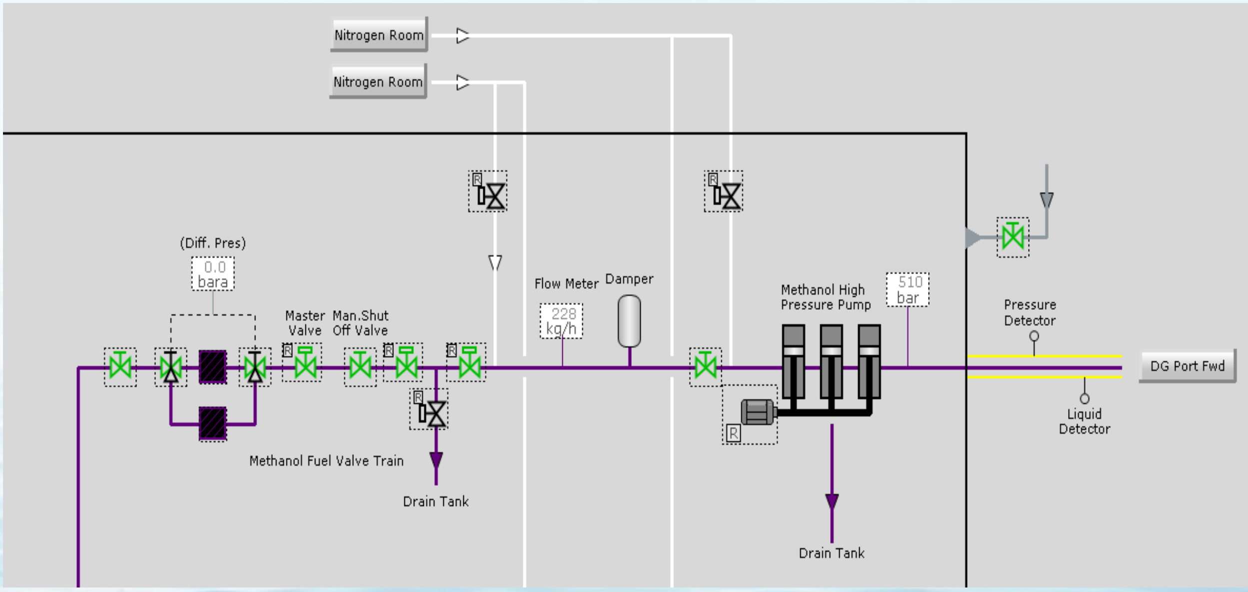

Figure 3. Section from Methanol Supply System

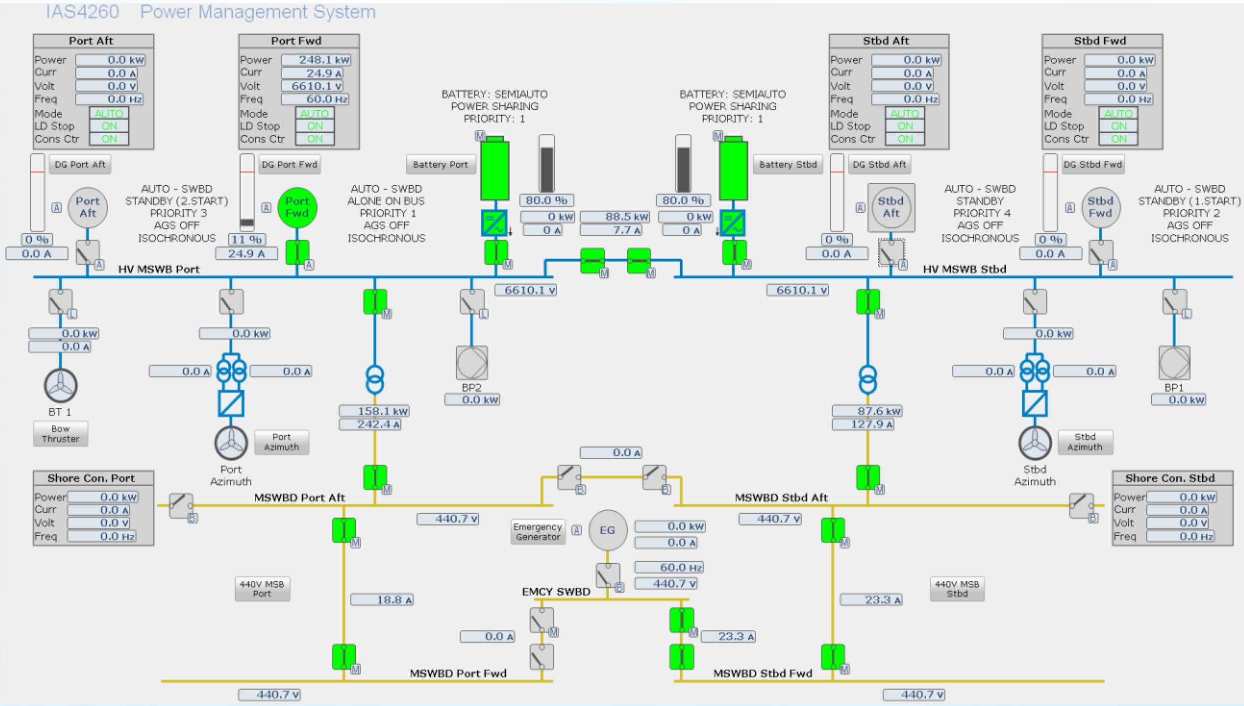

Figure 4. IAS – Power Management System

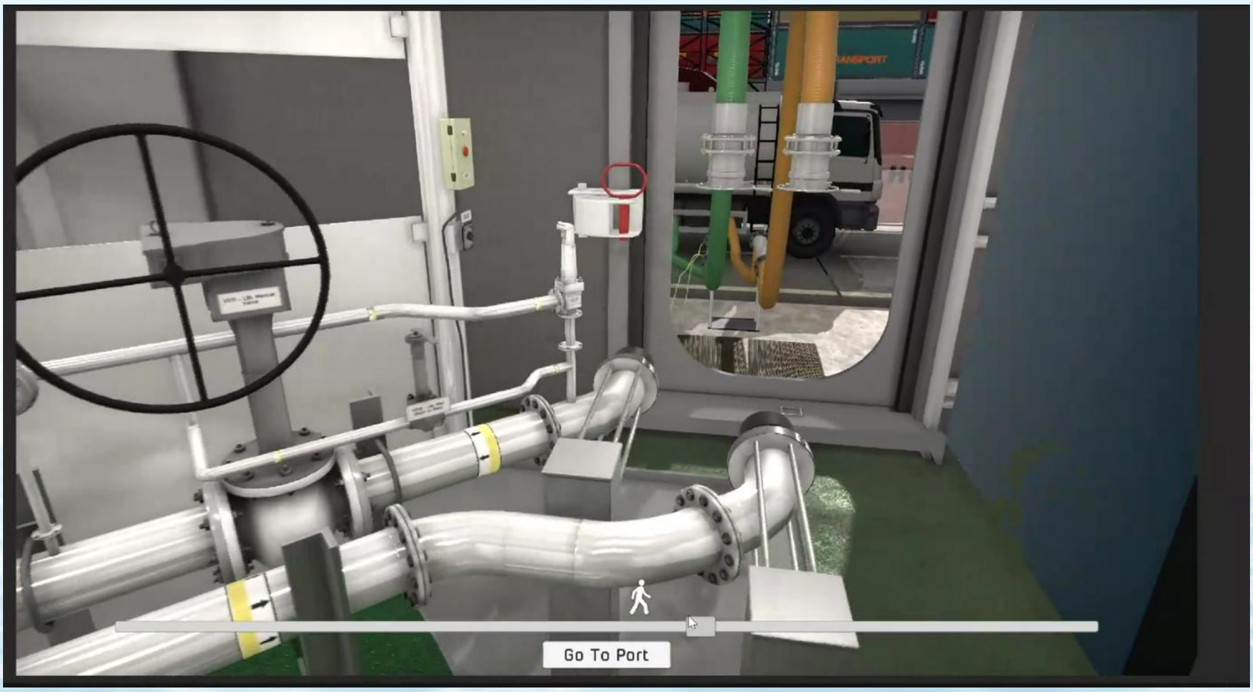

Figure 5. VR view from Methanol Bunker Station

AN OPTIMIZED SHIP ENGINE ROOM SIMULATOR CONFIGURATION FOR AN EFFECTIVE ENGINE ROOM RESOURCE MANAGEMENT TRAINING

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Abstract: Effective teamwork is crucial for safety and operational success in shipping operations. However, the absence of a unified model course in Engine Room Resource Management (ERM) training leads to a variety of instructional approaches. While Maritime Education and Training (MET) institutions typically achieve the objectives of ERM training through a combination of multiple courses within their curricula, institutions dedicated to ERM training need guidance on integrating these model courses into a concise and effective training regimen using an engine room simulator (ERS).

This study presents a proposed optimized system configuration for an effective ERM training program. The proposed ERS model integrates the IMO Model Course 2.07 and the competencies outlined in the Standards of Training, Certification, and Watchkeeping (STCW). By leveraging ERS, the model optimizes training hours while maintaining instructional efficacy. The optimized system configuration ensures compliance with STCW 2010 requirements by emphasizing collaborative teamwork, leadership, and communication skills. It facilitates the creation of practical scenarios replicating real-world challenges, enhancing decision-making capabilities. The study details the development and application of this optimized configuration through diverse training scenarios demonstrated with ERS and pilot studies with various setups. Importantly, the model is designed to be adaptable for implementation by different institutions, thereby broadening its potential impact. This research contributes to advancing ERM training, aligning with regulatory standards, and fostering a culture of effective teamwork.

Keywords: Engine Room Simulators, Maritime Education and Training, Teamwork, Collaborative Teamwork, Configuration Optimization

1. Introduction

A vessel's safe and efficient operation hinges on its crew's coordinated efforts, particularly within the engine room. Engine room personnel face a dynamic environment where effective teamwork is paramount for handling complex machinery, troubleshooting malfunctions, and responding to emergencies. Clear communication, strong leadership, and collaborative decision-making are crucial for ensuring smooth engine room operations and mitigating potential risks [1].

Engine Room Resource Management (ERM) training equips maritime professionals with the necessary skills to navigate these challenges [2]. International Maritime Organization (IMO) regulations, specifically the Standards of Training, Certification, and Watchkeeping (STCW) convention, mandate ERM training for all engine room officers. However, no standardized model course within the IMO framework is dedicated solely to ERM.

This lack of a standardized approach leads to a varied landscape of ERM training programs offered by Maritime Education and Training (MET) institutions. Institutions often integrate elements from IMO Model Course 2.07, which provides a general framework for ERM training, into various courses spread across the curriculum. This fragmented approach can lead to inefficiencies in training delivery and may not adequately address all the critical STCW competencies required for effective engine room operations.

Practical ERM training is essential for ensuring safety, efficiency, and environmental responsibility in maritime operations. However, challenges in ERM training implementation need to be addressed to optimize its effectiveness. These challenges include the lack of standardization in ERM training courses, the integration of ERM principles across various courses within MET curricula, concerns regarding training efficiency, and the need for practical skill development for real-world engine room scenarios [2].

The absence of a standardized International Maritime Organization (IMO) model course for ERM training leads to diverse approaches by MET institutions, potentially resulting in fragmented training programs that may not comprehensively cover all essential skills required for effective engine room operations. Moreover, the dispersion of ERM elements across multiple courses within the MET curriculum can hinder students' understanding of the interconnectedness of ERM principles, impeding the development of a holistic comprehension of ERM [3]. The current fragmented approach to ERM training may also raise concerns about training redundancy and extended training durations, affecting the overall efficiency of training programs [4].

Furthermore, traditional lecture-based training methods may not adequately equip trainees with the practical skills for effective teamwork and decision-making in real-world engine room scenarios, highlighting the need for more hands-on and scenario-based training approaches. Addressing these challenges is crucial to enhance the effectiveness of ERM training and better prepare future maritime professionals for the complexities of engine room operations.

The challenges in ERM training implementation are vital for ensuring a well-functioning, safe, and environmentally responsible engine room operation. By addressing issues related to standardization, curriculum integration, training efficiency, and practical skill development, the maritime industry can enhance the impact of ERM training on operational safety and efficiency. The references cited provide insights into enterprise risk management practices, challenges, and strategies for success, offering valuable perspectives on addressing obstacles in ERM implementation across various industries.

2. Literature Review

2.1 Overview of Engine Room Resource Management Training

ERM training plays a vital role in equipping maritime professionals with the necessary skills to navigate the complexities of the engine room environment. ERM training emphasizes non-technical skills such as communication, teamwork, decision-making, situational awareness, and leadership, which are crucial for ensuring safe, efficient, and environmentally responsible engine room operations [2]. The IMO mandates ERM training for all engine room officers through the STCW convention. IMO Model Course 2.07 provides a general ERM training framework outlining the required core competencies [1]. However, no standardized model course is dedicated solely to ERM within the IMO framework.

This lack of standardization has led to a diverse landscape of ERM training programs offered by MET institutions. Institutions often adopt a fragmented approach, integrating elements from IMO Model Course 2.07 into various courses spread throughout the curriculum [3]. This approach can lead to inefficiencies and may not effectively cover all the critical STCW competencies required for engine room operations [4]. Effective teamwork, including engine room resource management, ensures maritime operations' safety, efficiency, and success. This subsection explores the critical significance of teamwork and collaborative training in the maritime industry:

Enhanced Situational Awareness: Teamwork fosters a shared understanding of the operational environment and situational awareness among crew members. By collaboratively monitoring vessel systems, communicating observations, and exchanging critical information, crew members can collectively identify potential risks, anticipate challenges, and respond proactively to emergent situations in real time [2].

Improved Decision-Making: Collaborative training promotes collective decision-making processes, enhancing multiple perspectives and expertise to arrive at informed and effective decisions. By engaging in open dialogue, soliciting input from diverse team members, and considering alternative courses of action, maritime professionals can make more robust decisions under uncertainty and time constraints, mitigating risks and optimizing operational outcomes [7].

Effective Communication: Clear and effective communication is the cornerstone of successful teamwork in maritime operations. Collaborative training programs emphasize developing communication skills, including active listening, concise articulation, and assertive expression, to facilitate seamless information exchange and coordination among crew members. By fostering a culture of open communication and mutual respect, collaborative training enhances crew coordination, task allocation, and error detection in high-stakes environments [8].

Resilience to Challenges and Emergencies: Teamwork equips maritime professionals with the resilience and adaptability to navigate unforeseen challenges and emergencies effectively. Through collaborative training exercises, such as scenario-based simulations and tabletop drills, crew members can practice coordinated responses to various contingencies, including equipment failures, adverse weather conditions, and onboard emergencies. By rehearsing roles, responsibilities, and communication protocols in a controlled setting, teams can enhance their preparedness and confidence in handling real-world crises [9].

Cultivation of Team Cohesion and Trust: Collaborative training fosters the development of team cohesion, trust, and mutual reliance among crew members. By engaging in shared experiences, overcoming challenges together, and celebrating successes as a team, maritime professionals build strong interpersonal relationships and a sense of camaraderie that underpins effective teamwork. This cohesion enhances crew morale, motivation, and performance, ultimately contributing to a positive safety culture and operational excellence [10].

Research by [11] highlights the concerns regarding the effectiveness of current ERM training practices, which are:

- Lack of standardization in training content and delivery methods.
- Fragmented integration of ERM principles across the curriculum.
- Limited focus on practical skill development for real-world scenarios.
- Inefficiencies in training delivery, potentially leading to extended training durations.

These limitations in ERM training hinder its ability to fully prepare future maritime professionals for the challenges of the engine room. The following section will delve deeper into specific challenges and gaps in ERM training identified within the literature.

The current landscape of ERM training reflects the absence of a single standardized model course within the IMO framework. This section explores the various existing models and approaches MET institutions use.

2.2 Existing ERM Training Models and Approaches

IMO Model Course 2.07 can be integrated in a fragmented manner. A common approach involves integrating IMO Model Course 2.07 elements into existing MET curriculum courses [3]. This approach offers flexibility but can lead to fragmentation, as ERM principles are dispersed across various subjects. This fragmentation may hinder students' ability to develop a holistic understanding of ERM and its interconnectedness [11]. Our research indicates that existing ERM training methods are realized in the following training types:

Standalone ERM Courses: Some institutions offer dedicated ERM courses that aim to comprehensively cover the STCW competencies outlined in Model Course 2.07 [2]. However, these standalone courses can be time-consuming and may lead to curriculum overload, impacting the overall efficiency of training programs [4].

Traditional Lecture-Based Training: ERM programs often use Traditional lecture-based training methods. While these methods can effectively convey theoretical knowledge, they may fail to equip trainees with the practical skills required for real-world engine room scenarios. Effective teamwork and decision-making often rely on applying theoretical knowledge in dynamic and time-sensitive situations [10].

Limitation of Existing Approaches: ERM training models and approaches face several limitations. The fragmented integration of Model Course 2.07 can lead to knowledge gaps and hinder a holistic understanding of ERM. Standalone courses can be time-consuming, while traditional lecture-based methods may lack a focus on practical skill development. These limitations highlight the need for innovative approaches that address the identified gaps and enhance the effectiveness of ERM training for future maritime professionals [12].

2.3 Critique of Current ERM Training Methods

While aiming to equip maritime professionals with essential skills, the current landscape of ERM training faces limitations that hinder its effectiveness. Here's a closer look at the critical areas for critique:

<u>Fragmented Approach:</u>

Knowledge Gaps and Incoherent Understanding: Fragmenting ERM principles across various courses can lead to knowledge gaps and hinder students' ability to develop a holistic understanding of ERM. The interconnectedness of ERM concepts may not be readily apparent, limiting the ability to apply them effectively in real-world scenarios [11].

Difficulty Connecting Theory to Practice: Disseminating ERM knowledge through various subjects might make it challenging for students to connect theoretical concepts with practical applications in the engine room. This disconnect can hinder the development of essential skills for real-world problem-solving [3].

Standalone Courses:

Time Constraints and Curriculum Overload: While comprehensive, standalone ERM courses can be time-consuming to complete. This can lead to curriculum overload, potentially impacting the efficiency of training programs and student engagement [4]. Finding a balance between comprehensiveness and time constraints remains a challenge.

Cost-Effectiveness for Institutions: Developing and delivering standalone ERM courses may require additional resources for MET institutions. The cost-effectiveness of such programs needs to be carefully considered, especially for institutions with limited resources.

Instructor-Based Training:

Limited Focus on Practical Skills: Traditional lecture-based training methods focus on theoretical knowledge transfer. This approach may not adequately equip trainees with the practical skills required for effective teamwork and decision-making in dynamic engine room environments [10].

Inefficiency in Preparing for Real-World Scenarios: Lecture-based methods might not effectively prepare trainees for the time-sensitive and complex situations encountered in real-world engine room operations. Applying knowledge and making quick decisions under pressure is crucial, and current methods may not fully address this need.

Figure 1. Students are in training using student workstations

The limitations of the fragmented approach, standalone courses, and lecture-based training methods collectively hinder the effectiveness of current ERM training. These methods often fail to provide a comprehensive and efficient training experience. The lack of standardization, fragmented curriculum integration, and limited focus on practical skills hinder the ability of ERM training to fully prepare future maritime professionals for the complexities of the engine room.

3. Methodology

3.1. Conceptual Framework

This section introduces the proposed Distributed Engine Room Simulator (ERS) Model designed to address the limitations identified in current ERM training methods. This model leverages a collaborative teamwork training approach facilitated by a distributed ERS system with multiple touch panels. The proposed ERS model incorporates the following critical aspects of training technologies and methodology:

Use of Distributed Architecture: The ERS model is designed with a distributed architecture, allowing for seamless integration of multiple simulation panels and interactive displays. Each panel, measuring 65 inches in size, is a dedicated workstation for specific engine room roles, including Chief Engineer, Second Engineer, Third Engineer, and Electro-Technical Officer (ETO). This distributed setup enables cadets to assume different engine room positions and collaborate effectively in a simulated environment.

Touchscreen Interface: The ERS model incorporates intuitive touchscreen interfaces on each panel, facilitating user interaction and control of engine room systems and equipment. Cadets can access essential functions, monitor system parameters, and execute commands using touch-based controls, mimicking the interface of actual engine room control systems. This user-friendly interface enhances cadets' familiarity with modern maritime technology and promotes hands-on learning.

Realistic Simulation Scenarios: The ERS model offers various realistic simulation scenarios, replicating various engine room situations, challenges, and emergencies in actual maritime operations. From routine maintenance tasks to complex machinery malfunctions, cadets are immersed in dynamic scenarios that require critical thinking, problem-solving, and collaborative decision-making. By experiencing these scenarios firsthand, cadets develop practical skills and confidence in handling engine room operations effectively.

Role-Based Training: The ERS model supports role-based training, allowing cadets to assume different engine room positions and responsibilities within simulated scenarios. Cadets can rotate between roles, experiencing firsthand each position's unique challenges and responsibilities, including monitoring equipment performance, troubleshooting faults, and coordinating team activities. This experiential learning approach enhances cadets' understanding of engine room dynamics and fosters teamwork and collaboration.

Performance Monitoring and Assessment: The ERS model includes built-in performance monitoring and assessment features, allowing instructors to track cadets' progress and develop competency in real time. Performance metrics, such as response times, decision-making effectiveness, and communication skills, are recorded and analyzed to provide constructive feedback and tailor training interventions. This data-driven approach enables personalized learning pathways and ensures cadets meet the required engine room resource management proficiency standards.

The proposed Distributed ERS model is designed to address the limitations of current ERM training methods by effectively integrating the essential competencies outlined in IMO Model Course 2.07 and aligning them with the STCW convention. This section explores how this integration is achieved within the ERS framework.

3.2. Competency Mapping and Scenario Design

A competency matrix is developed to map the specific learning objectives of IMO Model Course 2.07 to the STCW regulations and the corresponding skills assessed within the ERS scenarios. This ensures comprehensive coverage of all critical competencies required for effective engine room operations. The ERS scenario library will be designed to encompass a variety of situations that directly target the mapped competencies. These scenarios can include:

- Emergency Situations: Engine room fire, machinery malfunctions, loss of propulsion, etc.
- Routine Operations: Starting and stopping engines, switching fuel sources, performing routine maintenance, etc.
- Decision-Making Scenarios: Prioritizing tasks during emergencies, allocating resources, responding to alarms, etc.

By incorporating these mapped competencies into the scenario design, the ERS model allows trainees to apply their theoretical knowledge and develop the practical skills required by STCW regulations.

3.3. Assessment and Feedback Mechanisms

The ERS model integrates features for performance assessment and feedback to ensure effective learning and competency development:

Scenario-Based Assessment: Trainee performance within each scenario will be evaluated based on predefined criteria aligned with the targeted competencies. This could include communication effectiveness, teamwork skills, decision-making accuracy, and adherence to emergency procedures.

Instructor Monitoring and Feedback: Instructors can monitor trainee performance in real time through the ERS system and provide targeted feedback during and after each scenario. This allows for immediate course correction and reinforcement of key learning points.

Debriefing Sessions: Post-scenario debriefing sessions facilitate group discussions and self-reflection. Trainees can analyze their performance, identify areas for improvement, and learn from each other's experiences.

These assessment and feedback mechanisms allow for continuous evaluation of trainee progress and ensure the effectiveness of the ERS model in achieving the desired learning outcomes aligned with STCW and IMO Model Course 2.07. The training institutions usually utilize several configurations of the ERS in training the engineering cadets, in example stages, shown in Table 1.

Table 1. Training Stages and Methods of Simulator Use

Training Stage	Method of Simulator Use	Training Objectives and Assessment
1	Classroom. Learning by practices guided by the instructor, including briefings and de-briefings	Group activities. Familiarization. No assessment.
2	Laboratory. Full mission using software environment in student workstations. Individual practices of all objectives.	Individual practices for promoting the understanding of the responsibilities of each role. Individual assessment
3	Designated spaces. A full mission team environment with distributed actual hardware, touch panels, mimics, visual and audible alarms, and environmental effects.	Collaborative teamwork practices. Assessment within a team.

Figure 2 shows a typical individual assessment methodology using ERS. The objective assessment is essential for adequately evaluating the trainee's learning level.

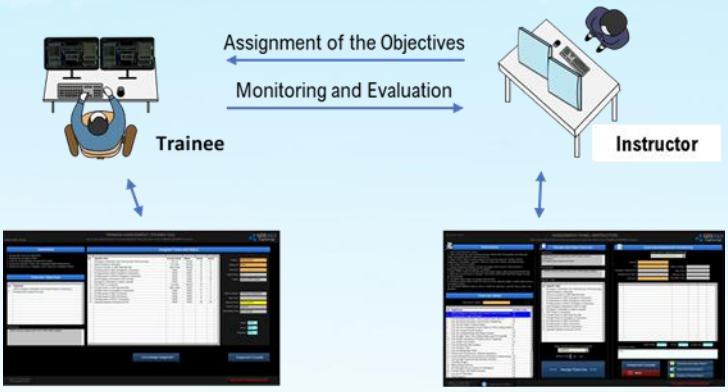

Figure 2. Individual Objective Assessment

3.4. Collaborative Teamwork

The proposed Distributed ERS model strongly emphasizes collaborative teamwork training, recognizing its critical role in effective ERM. This section explores how the ERS fosters this essential skill and addresses the limitations identified in current ERM training methods:

Enhanced Situational Awareness: Collaborative teamwork promotes shared situational awareness among engine room personnel, enabling them to collectively monitor vessel systems, assess operational conditions, and anticipate potential risks or challenges. Team members understand the operational environment comprehensively by exchanging real-time information, observations, and insights, facilitating proactive decision-making and risk mitigation strategies [6].

Improved Communication and Information Sharing: Effective communication is essential for successful teamwork in the engine room. Collaborative ERM training emphasizes developing communication skills, such as active listening, clear articulation, and assertive expression, to facilitate seamless information exchange and coordination among team members. By practicing communication protocols and strategies in simulated scenarios, engine room personnel learn to convey critical information accurately and efficiently, minimizing the risk of miscommunication and errors [8].

Optimized Resource Allocation and Task Management: Effective teamwork enables optimal resource allocation and task management in the engine room, ensuring that personnel and equipment are utilized efficiently to achieve operational objectives. Collaborative ERM training allows engine room personnel to coordinate activities, prioritize tasks, and allocate resources effectively within a simulated environment. By working together to address competing demands and constraints, team members develop the skills and strategies to optimize performance and productivity in real-world engine room operations [12].

Facilitated Decision-Making under Pressure: Engine room operations often involve high-pressure situations that require quick and effective decision-making. Collaborative ERM training prepares engine room personnel to make informed decisions under stress by simulating realistic scenarios and emergencies. Team members learn to assess options, weigh risks, and reach consensus in time-critical situations through collaborative problem-solving exercises and role-playing simulations. By practicing decision-making as a team, engine room personnel build confidence, resilience, and adaptability in the face of uncertainty [13].

Cultivation of Team Cohesion and Trust: Collaborative ERM training fosters the development of team cohesion, trust, and mutual reliance among engine room personnel. Team members build strong interpersonal relationships and camaraderie by working together to overcome challenges, resolve conflicts, and achieve common goals. This cohesion enhances crew morale, motivation, and job satisfaction, contributing to a positive safety culture and operational excellence in the engine room [7].

These collaborative teamwork skills are crucial for safe and efficient engine room operations. The ERS model equips future maritime professionals to work effectively as a team, ensuring smooth operation and rapid response to any challenges that may arise in the real world. The ERS model facilitates role-based training, assigning trainees specific roles within the simulated engine room environment. These roles can include:

- Chief Engineer: Takes overall command of the simulated engine room. Manages resources (personnel, equipment) and prioritizes tasks during emergencies and routine operations. Ensures efficient engine room operation, balancing fuel consumption, performance, and maintenance requirements. Implements safety protocols and ensures adherence to safety regulations.
- Second Engineer: Oversees the daily operations of the main engine and auxiliary equipment. Monitors engine performance parameters (temperature, pressure, RPM) and identifies potential issues. Troubleshoots minor engine malfunctions and performs routine maintenance tasks. Report engine status and any concerns to the Chief Engineer.
- Third Engineer: Focuses on auxiliary equipment operation and maintenance, including separators and fuel systems. Monitors separator performance and ensures proper fuel quality and cleanliness. Performs routine maintenance on auxiliary equipment and reports any abnormalities to senior engineers. Assists the Second Engineer with engine room tasks as needed.
- Electro-technical officer: Manages the engine room's electrical power generation, distribution, and control systems. Monitors electrical parameters (voltage, current) and identifies potential electrical faults. Responds to electrical emergencies and implement corrective actions to ensure safe operation. Communicates with other engineers regarding the status of the electrical system and any concerns.

By assuming these designated roles, cadets gain practical experience in communication, teamwork, and decision-making specific to each engine room position. This role-based approach mirrors real-world scenarios and prepares them for future careers at sea. There may be various applications of collaborative teamwork studies. Remembering the ERS as a tool for learning, these configurations may span from simple ones to the ones that are costly distributed environmental simulations.

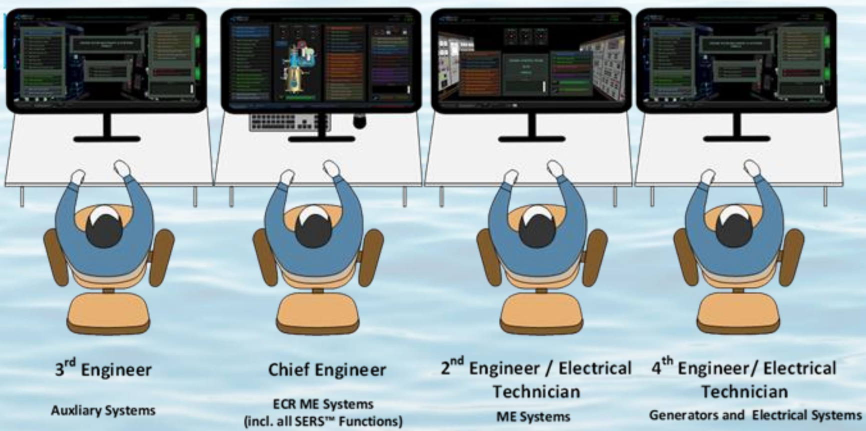

Figure 3. A basic workstation with distributed tasks to the students for effective teamwork

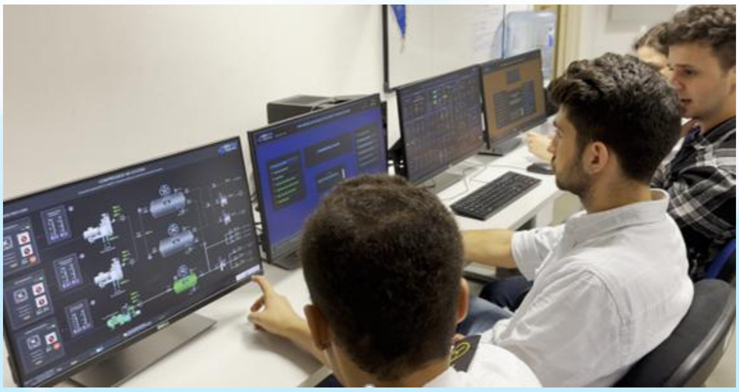

Figure 4. Four trainees are implementing the ERS exercises collaboratively

Another version of team training can be implemented in a Full Mission. We need to note that the Full Mission configuration. The full Mission term here refers to implementing the training using environmental simulations to increase realism. There may be many configurations. Figure 5 shows a typical Full Mission training environment with the engine room, instructor room, and engine control room (ECR) separated. The simulator usually includes alarm systems, sounds, and communication systems. Maritime institutions accept this configuration well; however, the authors know that many institutions cannot afford the cost and use only workstation configurations.

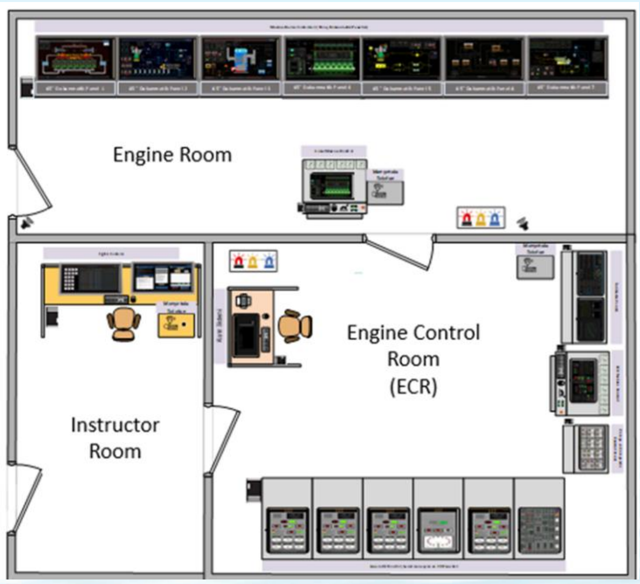

Figure 5. A typical Full Mission engine room simulator environment.

The authors have spent several years and completed funded projects to test several versions of the teamwork systems. Upon these studies, the authors proposed an optimized Full Mission simulator, which is cost-effective yet practical for teamwork with objective training methodologies. In this configuration, shown in Figure 6, 5 students are assigned different roles and responsibilities, based on IMO Model Course 7.02 and 7.04, and Imo Mode Course 2.07 contents are exercises with team study. The system shown in Figure 6 is currently installed at the Istanbul Technical University Maritime Faculty's Simulator Center. The simulator demonstration will be held during the IMLA Conference. Developed by GDS Engineering R&D, Inc. and called the Ship Engine Room Simulator for Team (SERS™4TEAM), the simulator has a modular architecture, meaning that additional hardware, consoles, alarm systems, and communication systems are all available by the manufacturer for selection based on the budget. SERS™4TEAM also allows for future upgrades with additional items to existing simulators. In this configuration, the instructors can assign students five roles: Chief, Second, Third, and Fourth Engineers and an Electrotechnical Officer (ETO). The relevant engine room systems are grouped as graphical user interface panels (GUI Panels) into different touch panels. The manufacturer provides more than 60 GU panels, and a configuration file allows the systems to be grouped into different touch panels. With this approach, the details of the systems are presented to the students interactively.

Figure 5. Optimized Team Working System with Consoles

3.5. Application Methodology

The proposed Distributed ERS model promotes a pre-existing, commercially available simulation software to create a realistic and interactive training environment. This section details the key components of the ERS setup, incorporating the adoption of the SERS™ (Ship Engine Room Simulator) software developed by GDS Engineering R&D and certified by Class NK as a Full Mission Engine Room Simulator.

Hardware Components:

Distributed Touch-Panel System: The core of the ERS is a network of four high-resolution, 65-inch touch panels. These panels will be strategically positioned to represent designated engine room workstations:

- o Main Engine Control Systems – Chief Engineer
- o Main Engine Systems – Second Engineer
- o Auxiliary Systems – Third Engineer
- o Diesel Generators and Electrical Systems – Electro-Technical Officer

Central Processing Unit (CPU): A high-performance CPU will run the ERS simulation software, manage communication between touch panels, and process user input.

Network Infrastructure: A secure network will connect all touch panels and the CPU, ensuring smooth data transmission and real-time interaction within the simulated environment.

Additional Hardware (Optional): Depending on the specific functionalities of the ERS, additional hardware components might be integrated. These could include:

- o Joystick controllers for simulating engine maneuvering
- o Sound systems for replicating engine noise and alarms
- o Gauges, buttons, indicators, etc.

Software Components:

SERS™ (Ship Engine Room Simulator) Software: The core software application driving the ERS will be the commercially available SERS™ software. Given its certification as a Full Mission Engine Room Simulator by Class NK, SERS™ is assumed to offer comprehensive functionalities, including:

o Realistic engine room interfaces on each touch panel, mimicking actual control panels and instrumentation.

o Simulation of engine and auxiliary equipment behavior based on user input and pre-programmed scenarios.

o Generation of realistic engine data (temperature, pressure, alarms) for trainees to monitor and analyze.

o Communication features like voice chat and a shared information dashboard (subject to SERS™ capabilities).

Scenario Management Software (Integrated with SERS™): SERS™ likely incorporates its scenario management functionalities. Instructors can utilize these functionalities to:

o Select and launch specific scenarios for training sessions.

o Adjust scenario difficulty levels to cater to different trainee experience levels (subject to SERS™ capabilities).

o Monitor trainee performance and progress through the scenarios (subject to SERS™ capabilities).

Debriefing and Feedback Software: The ERS might integrate additional software tools to facilitate debriefing sessions and provide feedback. This could include:

o Recording and playback functionalities for scenario actions and decisions (compatibility with SERS™ recording features must be assessed).

o Annotation tools for instructors to highlight key learning points during debriefing sessions.

Integration with SERS™: The integration process between the touch-panel system, CPU, network infrastructure, and the SERS™ software will require careful consideration. The details will depend on the specific architecture and functionalities offered by SERS™. SERS™ will likely handle most of the simulation functionalities. At the same time, the custom software might focus on managing communication between workstations, facilitating the distributed environment, and potentially integrating additional debriefing or assessment tools. With the capabilities of the SERS™ software and combining it with a distributed touch-panel system, the ERS model can create a realistic and interactive training environment that fosters collaborative teamwork skills for future maritime professionals.

Proposed Configuration Advantages: The innovative configuration proposed in this study comprises one central control console and four strategically placed 65-inch touch panels. This setup facilitates a highly realistic simulation of a ship's engine room hierarchy, allowing students to assume roles such as Chief Engineer, Second Engineer, Third Engineer, Fourth Engineer, and Electrical Officer. Each student, operating from their respective touch panel, is tasked with managing and operating the systems under their designated responsibility via a unified software platform. This approach fosters collaborative decision-making, communication, and problem-solving skills for effective teamwork in a real-world maritime environment.

Cost-Effectiveness and Accessibility: The proposed configuration represents a significant advancement in providing cost-effective ERM training. The need for extensive hardware and dedicated space is minimized by consolidating multiple workstations into a single integrated system. This reduction in infrastructure requirements translates to a more accessible and affordable training solution for maritime education institutions. Furthermore, the centralized software platform streamlines training management and facilitates real-time monitoring and assessment of student performance.

4. Discussions

4.1. Evaluation of the ERS Model Effectiveness

The proposed Distributed ERS model presents a promising approach to enhancing ERM training for maritime professionals. This section explores potential methods for evaluating its effectiveness in achieving its intended learning outcomes.

Qualitative Evaluation Methods:

- **Trainee Feedback Surveys:** Conducting surveys after training sessions can gather valuable insights from trainees regarding their experience with the ERS model. Surveys can assess factors like:
  - Perceived realism and fidelity of the simulation environment.
  - Usability and ease of operation of the distributed touch-panel system.
  - Effectiveness of the role-based training approach in fostering teamwork skills.

- Overall satisfaction with the learning experience provided by the ERS model.

- **Instructor Observations:** Instructors can provide qualitative feedback based on their observations of trainee behavior during ERS simulations. This feedback can address aspects like:
  - Effective communication and collaboration within the distributed environment.
  - Problem-solving and decision-making skills demonstrated by trainees during scenarios.
  - Ability of the ERS model to challenge trainees and encourage critical thinking.

Debriefing Session Discussions: Facilitating focused discussions during debriefing sessions allows trainees to share their experiences, identify areas for improvement, and collectively analyze their performance within the ERS scenarios. These discussions can provide valuable insights into the model's effectiveness in promoting learning and teamwork skills.

Quantitative Evaluation Methods:

Scenario-Based Performance Assessment: The ERS model can be designed to track and evaluate trainee performance within pre-programmed scenarios. This could include metrics like:

- Time taken to complete a scenario.
- Number and type of errors made during decision-making.
- Efficiency and effectiveness of communication and collaboration within the team.

Pre- and Post-Training Assessments: Standardized tests or knowledge assessments can be administered before and after training using the ERS model. This allows for a quantitative comparison of trainee knowledge and understanding of ERM principles before and after using the ERS, potentially demonstrating the model's effectiveness in knowledge retention and skill development.

Longitudinal Studies: Longitudinal studies tracking the performance of graduates trained using the ERS model compared to graduates from traditional training methods could be conducted over an extended period. This can provide insights into the long-term impact of the ERS model on maritime professionals' professional competencies and teamwork skills.

By employing a combination of qualitative and quantitative evaluation methods, the effectiveness of the ERS model in achieving its learning objectives can be comprehensively assessed. Positive evaluation outcomes can validate the model's contribution to improved ERM training and its potential to enhance future maritime professionals' preparedness and teamwork skills.

4.2. Comparison with Existing ERM Training Approaches

The proposed Distributed ERS model offers several advantages over traditional ERM training methods:

Fragmented Approach: Traditional ERM training often segments knowledge across various courses, hindering the development of a holistic understanding.

Standalone Courses: Standalone ERM courses can be time-consuming and resource-intensive for MET institutions.

Lecture-Based Training: Lecture-based approaches may not adequately prepare trainees for the practical application of knowledge and teamwork skills in real-world engine room scenarios.

Integrated Learning: The ERS model integrates ERM principles into a cohesive training environment, fostering a holistic understanding of best practices.

Improved Efficiency: The distributed architecture allows for efficient training of multiple trainees simultaneously, potentially reducing training time compared to standalone courses.

Practical Skill Development: The ERS model emphasizes role-based training and scenario-based learning, providing trainees hands-on experience in communication, teamwork, and decision-making within a simulated engine room environment.

Scalability and Adaptability: The ERS model can accommodate different training needs by adjusting scenario difficulty and incorporating additional functionalities based on specific requirements.

Standardized Training: The ERS model promotes standardized training across MET institutions, ensuring consistent learning outcomes for future maritime professionals.

Assessment and Feedback: The ERS model facilitates performance assessment and feedback, allowing instructors to identify areas for improvement and personalize training strategies.

Overall, the ERS model presents a more comprehensive and practical approach to ERM training than traditional methods. Promoting teamwork skills and replicating real-world engine room challenges equips future maritime professionals with the necessary knowledge and practical abilities to excel in their careers.

4.3. Implications for Maritime Education and Training (MET) Institutions

The Distributed ERS model offers a range of potential benefits for MET institutions seeking to enhance the quality and effectiveness of their ERM training programs.

Reduced Training Time: The distributed architecture allows for simultaneous training of multiple cadets, potentially reducing overall training time compared to traditional standalone ERM courses.

Standardized Training: The ERS model promotes standardized training across different MET institutions, ensuring consistent learning outcomes for future maritime professionals.

Practical Skill Development: The ERS model emphasizes role-based training and scenario-based learning, providing cadets with hands-on experience in communication, teamwork, and decision-making within a simulated engine room environment.

Deeper Knowledge Retention: This model's interactive and engaging nature can improve knowledge retention compared to traditional lecture-based approaches.

Assessment and Personalized Learning: The ERS model facilitates performance assessment and feedback, allowing instructors to identify areas for individual improvement and personalize training strategies to address specific needs.

Cost-Effectiveness: While initial investment may be required, the ERS model's potential to reduce training time and improve training efficiency can lead to cost savings in the long run.

Scalability and Adaptability: The ERS model can accommodate different MET institutions' specific needs and resources by adjusting scenario difficulty and incorporating additional functionalities.

Enhanced Reputation: MET institutions adopting the ERS model can showcase their commitment to innovative and effective training methods, potentially attracting a wider pool of qualified maritime cadets.

4.4. Limitations and Future Directions

The Distributed ERS model offers a significant advancement in ERM training; however, some limitations must be considered for future development.

Technical Expertise: Maintaining and operating the ERS model might require technical expertise for troubleshooting and software updates.

Fidelity and Realism: While the ERS strives for a realistic environment, it may not fully replicate the complexities and stresses of an actual engine room.

Focus on Specific Scenarios: The ERS model's effectiveness relies on its comprehensiveness and variety of pre-programmed scenarios.

Integration with Advanced Technologies: Future iterations could integrate virtual reality (VR) or augmented reality (AR) for an even more immersive training experience.

Standardized Scenario Library: Developing a standardized scenario library across MET institutions can promote knowledge sharing and ensure comprehensive training coverage.

Real-Time Data Integration: Future ERS models could potentially integrate with real-time engine data from operational vessels to enhance the realism of simulated scenarios.

Advanced Assessment Tools: Developing more sophisticated assessment tools that analyze communication patterns and teamwork effectiveness within the ERS can provide even richer insights into trainee performance.

5. Conclusion

5.1. Summary of Findings

This research investigated the potential of a Distributed ERS model to address shortcomings in current ERM training for maritime professionals. The proposed ERS model tackles these limitations by:

- Integrating competencies outlined in IMO Model Course 2.07 and STCW regulations into the design of pre-programmed scenarios.
- Utilizing a distributed touch-panel system that fosters a realistic and collaborative training environment.
- Emphasizing role-based training and teamwork skills development through features like communication tools and shared information dashboards.
- Employing scenarios with varying difficulty levels to challenge trainees and encourage critical thinking.

The ERS model offers several advantages over traditional ERM training methods. These include improved training efficiency by allowing simultaneous training for multiple participants, enhanced learning outcomes through practical skill development in a simulated environment, deeper knowledge retention due to interactive and engaging scenarios, standardized training across MET institutions for consistent learning outcomes, and scalability and adaptability to cater to the specific needs of different institutions.

The ERS model significantly benefits both MET institutions and future maritime professionals. MET institutions can improve training quality and efficiency, potentially reducing costs. Future maritime professionals gain practical skills, teamwork experience, and enhanced preparedness for challenges in real-world engine room settings.

5.2. Contributions to ERM Training Practices

This research has explored the potential of a Distributed ERS model to revolutionize ERM training for maritime professionals. The proposed ERS model offers significant contributions to current ERM training practices by:

- Bridging the Gap Between Theory and Practice: Traditional ERM training often struggles to bridge the gap between theoretical knowledge and practical application in a real-world engine room environment. The ERS model addresses this by:
  - Integrating STCW Regulations and IMO Model Course Competencies: The scenario design aligns with industry standards and learning objectives, ensuring trainees develop the essential skills required onboard.
  - Role-Based Training and Scenario-Based Learning: Trainees experience the complexities of teamwork and decision-making in a simulated engine room, replicating real-world challenges and fostering practical skill development.
- Fostering Collaborative Teamwork Skills: Effective communication and teamwork are crucial for safe and efficient engine room operations. The ERS model promotes these vital skills through:
  - Distributed System and Communication Features: Trainees practice communication across workstations, replicating real-world collaboration and task delegation within the engine room team.
  - Scenario Design: Scenarios encourage collaborative problem-solving, requiring trainees to analyze situations, communicate effectively, and make collective decisions.
- Enhancing Learning Effectiveness and Engagement: The ERS model departs from traditional lecture-based methods, promoting a more engaging and interactive learning experience through:
  - Interactive Scenarios: Pre-programmed scenarios with varying difficulty levels challenge trainees, promote critical thinking, and encourage the application of theoretical knowledge.
  - Performance Assessment and Feedback: The ERS model provides immediate feedback on decisions and actions within scenarios, allowing for self-reflection and continuous learning improvement.

- Promoting Standardized Training Across Institutions: The ERS model, with its standardized scenario library and core functionalities, has the potential to:
  - Ensure Consistent Learning Outcomes: Trainees from different MET institutions receive consistent training aligned with industry standards, preparing them equally for their careers.
  - Scalability and Adaptability: The model can be adapted to accommodate the specific needs of different institutions by adjusting scenario difficulty and incorporating additional functionalities.

The proposed Distributed ERS model presents a promising approach to enhancing ERM training for maritime professionals. This section outlines recommendations for future research and implementation efforts to refine the ERS model further and realize its full potential.

5.3. Recommendations for Future Research and Implementation

Standardized Scenario Library Development: Research efforts should focus on developing a comprehensive and standardized scenario library across MET institutions. This library should encompass routine operations, emergencies, and decision-making challenges, ensuring comprehensive training coverage.

Integration with Advanced Technologies: Future research can explore the potential of integrating virtual reality (VR) or augmented reality (AR) technologies into the ERS model. This could create an even more immersive and realistic training environment for trainees.

Advanced Assessment Tools: Developing more sophisticated assessment tools that analyze communication patterns, teamwork effectiveness, and leadership behaviors within the ERS can provide even richer insights into trainee performance and areas for improvement.

Longitudinal Studies: Conducting longitudinal studies to track the performance of graduates trained using the ERS model compared to graduates from traditional methods can provide valuable insights into the long-term impact of the ERS on the professional competencies and teamwork skills of maritime professionals.

Cost-Effectiveness: Strategies for cost-effective implementation should be explored. This could involve open-source software alternatives, collaborations with MET institutions to share development costs, or potential grant funding opportunities within the maritime training sector.

Faculty Development: MET institutions adopting the ERS model may require faculty development programs to ensure instructors can effectively utilize the technology and facilitate scenario-based learning within the ERS environment.

Scalability and Adaptability: The ERS model's design should accommodate different MET institutions' training needs and resource constraints. This could involve offering modular components or customizable features.

The ERS model represents a significant step forward in ERM training. By pursuing the recommended research directions and addressing implementation considerations, it can be refined and disseminated across MET institutions. This can revolutionize ERM training, equipping future maritime professionals with the necessary skills and knowledge to ensure safe, efficient, and collaborative operations at sea.

Acknowledgments

This study used the Ship Engine Room Simulator (SERS™) developed by GDS Engineering R&D. SERS™ is certified as Full Mission (Class A) by Class NK. SERS™4TEAM is a trademark of GDS Engineering R&D, Inc.

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DECARBONIZING PHILIPPINES' DOMESTIC SHIPPING: RAPID ASSESSMENT AND ROADMAP DEVELOPMENT TOWARDS ZERO CARBON IN 2050

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Abstract: As the maritime industry is gearing towards zero carbon shipping by or around 2050, in addition to the decarbonization efforts in the international shipping sector, a huge chunk of the carbon emission that needs to be addressed comes from the domestic shipping sector. Thus, the International Maritime Organization (IMO), together with their partners such as the United Nations Development Programme (UNDP), Global Environment Facility (GEF), Global Maritime Energy Efficiency Partnerships (GloMEEP), Institute of Marine Engineering, Science, and Technology (IMarEST), and collaboration project IMO-Norway Green Voyage 2050 Project, has provided guidelines and tools for the decarbonization of the various domestic shipping fleets across member states. The primary objective of this study is to assess the current landscape of the Philippines' domestic shipping in its decarbonization efforts using the Ship Emissions Toolkit: Rapid Assessment, provide concrete strategies for the reduction of carbon emissions in order to align with the targets of IMO using the National Action Plan Framework and develop a roadmap consisting of short-term, medium-term, and long-term targets towards a zero carbon industry in 2050 utilizing the Ship Emissions Reduction Strategy Toolkit. The study employed a quantitative-qualitative mixed approach with the utilization of document analysis, theory triangulation, and gap-situation analysis. The development of the roadmap can be utilized as the National Action Plan with a huge focus on data collection and analysis systems due to the scarcity of the foundational data needed for a more comprehensive strategic action plan. The targets and strategies were divided into five main disciplines: human elements, operation, technology and innovation, policy and regulation, and economics. A roadmap was developed coupled with relevant proposed measures to supplement the achievement of the said targets. With the gap and assessment analysis performed together with the development of the action plan, it is concluded that the Philippines; domestic shipping has a huge gap in the data collection and analysis mechanism with data such as carbon emission derived from a bottom-up approach with huge gaps and high unreliability in the demographic data of the domestic fleet. Thus, it was strongly recommended that such effective and efficient mechanisms be put in place before proceeding to a comprehensive development of the national action plan so that baseline data and effective strategies specifically catered to the situation of the Philippines can be established. In addition, upgrading the different aspects, from human elements to economic, is also essential in catalyzing the goal of zero carbon domestic shipping.

Keywords: domestic shipping, maritime decarbonization, maritime energy management

1. Introduction

The Philippines is an archipelagic nation comprising 7,640 islands scattered around a geographical area of 300,000 km2, 1,830 km2 of which is covered in water (Boquet, 2017). It is a thriving maritime nation. With an average daily basic pay of around 8 USD and with airplane tickets ranging from 40-100 USD (one-way), maritime transport is the most common means of transportation across these islands (average price of 45 USD) (Philippine Statistics Authority [PSA], 2018). In addition, cargo movement via ships remains much more cost-effective, with a freight mass of 48.95 million metric tons carried by maritime modality, which is very far from the mass being transported through domestic air carriers of about 237,000 metric tons (Maritime Industry Authority [MARINA], 2024). The demographics of the Philippine domestic fleet consist of a plethora of different vessels dominated by passenger and fishing vessels by population, with an average fleet size of 487.54 gross tonnage (GRT) at an average age of 16.42 years. Out of the 12,819 registered domestic vessels, 96% are still in operation, exclusive of motorbancas (MARINA, 2024). The majority of the vessels were imported newly built vessels (35%) and locally constructed vessels (33%), with second-hand imported vessels being regulated to an age of less than 20 years but with reported anomalies in the reporting of such data (Patag, 2023). The shipbuilding and repair (SBSR) domestic landscape has room for growth, with only four class A shipyards, with 66% needing improvement for new technology and greener operations. There are no accurate records for the retired vessels, and the data presented have questionable reliability due to discrepancies and inefficiency in reporting and data collection. Despite the recently started modernization program, only 5% of the vessels are fitted with advanced hulls. On the other hand, data for the propulsion systems, energy management practices, and emissions are virtually non-existent, except approximation data coming from the bottom-up approach (Vergel et al., 2022). In terms of the maritime workforce, data for domestic seafarers are overwhelmed with that of overseas ones; however, there are significant findings when it comes to a large number of fishermen, 1.5 million workers, who are not oriented with international regulations, especially that of MARPOL Annex VI (MARINA, 2024).

The dynamics of domestic maritime transport, in a nutshell, involve a series of transshipment ports across the archipelago, with four major ports (Manila, Batangas, Iloilo, Cebu, and Davao). There are 246 shipping routes determined, with an average sailing distance of 4 km and a maximum sailing distance of 809 Nm (Manila—GenSan). The general sea condition along these routes includes light and variable winds with smooth seas, having an average tide height of 1-2 meters (relatively small) (MARINA, 2024). It is undeniable that the dominance of the cargo shipment towers over the ferry services in the operation of domestic shipping.

As shown in Figure 1, it can be inferred that the initiatives toward a decarbonized domestic shipping industry are still in their infancy stage (Boquet, 2017). It is inherent in relation to the Philippines' current situation that a national effort towards GHG reduction is yet to be implemented due to the lack of baseline setting and premature data collection and monitoring system, which was recently enforced by the Philippine Maritime Industry Authority (MARINA) in 2021 but with lingering issues regarding on-the-ground implementation (MARINA, 2024). This is also being supported by the recently published Maritime Industry Development Plan 2019-2028 (MIDP), which was the first strategic document of the administration containing a plan for initiating efforts and policies towards net zero carbon domestic shipping (MARINA, 2024).

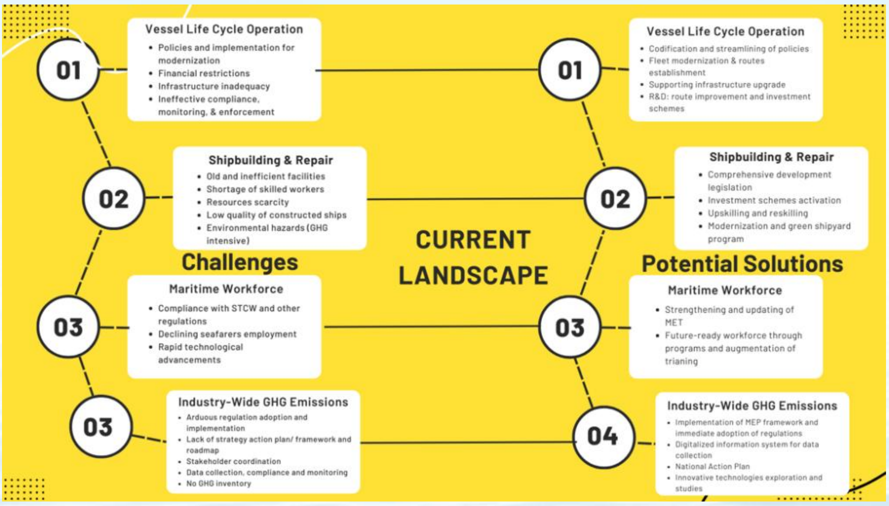

Figure 1. Overview of the current landscape of the Philippines' domestic shipping industry in lieu of carbon emission reduction (Source: MARINA*; Boquet)*

In the last Conference of Parties 28 (COP28) held in December 2023, the Philippines has upped its nationally determined contribution (NDC) to 75% carbon reduction in 2030 (Climate Analytics, 2023). This initiated a regulatory domino leading to the enforcement into law of Republic Act No. 9279- National Climate Change Action Plan, which subsequently resulted in the revision of the MIDP of MARINA, giving emphasis to carbon emission reduction strategies. The MIDP contained a particular initiative called "Marine Environment Protection Strategy Green Maritime Philippines," which is a roadmap encompassing all measures towards more environmentally friendly domestic shipping. This enveloped the plan for policy development of a National Action Plan (NAP) for carbon emission reduction, which is currently in the pipeline (MARINA, 2024). Prior to this, the Philippines, being a signatory to MARPOL Annex VI, had already issued a memorandum circular through MARINA regarding the implementation of the Data Collection System (DCS) and Ship Energy Efficiency Management Plan (SEEMP) (Memo Circular SR 2021-05) in domestic ships, which will start in 2024, with delays due to inefficient national legislation process. The current goal set by MARINA is at 15% GHG emissions reduction by the end of 2028, starting with a 5 % reduction each year from 2026, which is close to the IMO target of striving for a 30% reduction in 2030 (MARINA, 2024).

To lay the groundwork and start the initiatives toward a decarbonized domestic shipping industry, the Philippines has established a partnership with various stakeholders. Firstly, the World Bank Group (WBG), International Finance Corporation (IFC), and IMO's Integrated Technical Cooperation Program (TCP) are responsible for the capitalization of the programs with 345,250 USD starting funds. Secondly, industry experts from World Maritime University (WMU) and the University of Strathclyde, in collaboration with government agencies and national partners headed by MARINA, for the initial assessment and mapping of the strategic roadmap. This project will initially focus specifically on domestic passenger ships as they comprise 35% of the domestic fleet with 80% of the passenger volume (IMO, 2021). In addition, regional cooperation was also forged with Asia Pacific Neighbors with the support of the Korean Maritime Institute and Transport Connectivity and Logistics regarding the sharing of policies and technologies for decarbonized and sustainable maritime transport (Economic and Social Commission for Asia and the Pacific [ESCAP], 2021).

This study aims to develop a national action plan for the Philippines' domestic shipping toward a zero-carbon industry by or around 2050 by achieving the following sub-objectives:

- Assess the current landscape of the Philippines' decarbonization efforts using the Ship Emissions Toolkit: Rapid Assessment
- Develop concrete plans and strategic actions toward the reduction of emissions to align with the targets of the IMO using the Ship Emissions Reduction Strategy Toolkit
- Creating a roadmap containing short-term, medium-term, and long-term measures and targets toward a zero-carbon industry by or around 2050 utilizing the National Action Plan Framework

2. Methodology

Gap determination and initial assessment of the current landscape were done using the methodology shown in Figure 2. With such methodology, the following initial assessment and gaps were determined. First, a rapid assessment was conducted using the toolkit provided by the GEF-UNDP-IMO-GloMEEP Project and IMarEST Project (2018), with the progress of each key factor being converted into a numerical rating with a range of 1-5. 1 indicates initial steps for data collection and baseline are non-existent or underway, while 5 indicates advanced maturity in the emission strategy process undergoing review and evaluation at indicated intervals.

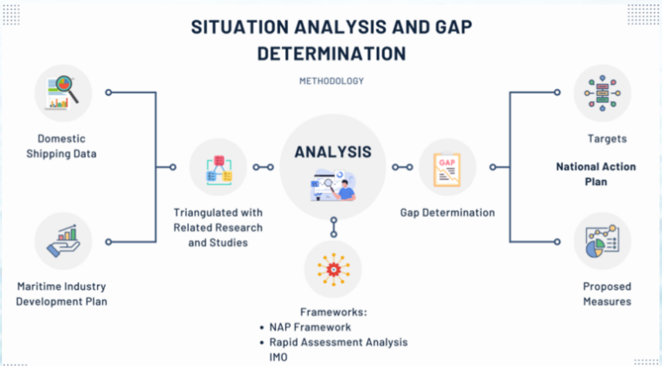

Figure 2. Methods for situation analysis and gap determination

2.1 Rationale of the Methodology

The logic behind the NAP's methodology is to ensure that proposed measures and targets are hinged on the current data collated and analyzed. The gaps in the current system and policies are also carefully analyzed to avoid developing a redundant and irrelevant action plan (GEF-UNDP-IMO-GloMEEP Project and IMarEST, 2018). This method needs to be conducted in a structured and logical manner with the help of the guidelines and frameworks provided by IMO and other industry stakeholders. Triangulation of such data with the relevant research and projects already conducted along with the partnership initiatives further eliminates overlapping data. With the combination of triangulation and document analysis methods, a gap and situation assessment can be generated for the formulation of a suitable and realistic NAP based on the country's needs and landscape. Thus, the author devised the formulation of the theoretical framework shown in figure 3.

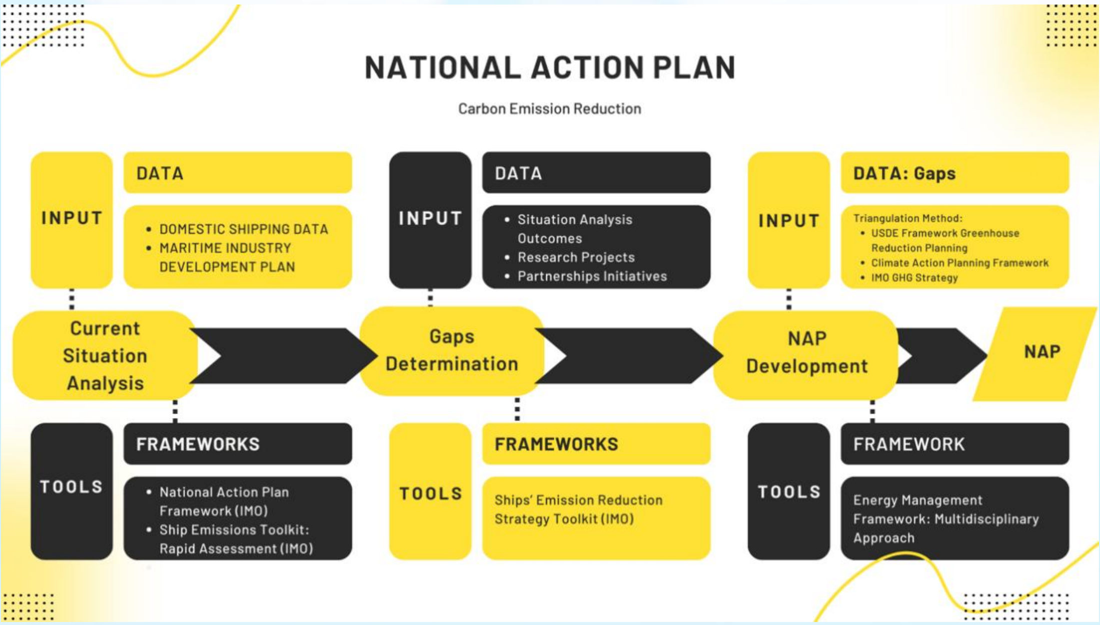

Figure 3. Theoretical framework for NAP development

3. Results and Discussion

In line with decarbonization efforts in the domestic shipping industry, there were already a number of initial studies made that explore the viability of such industry towards decarbonization actions. With the small island developing states, including archipelagic states, especially those located near the equator, being the most heavily impacted by climate change, the viability of sustainable domestic ships, which have zero cradle-cradle GHG footprint, was assessed. The limitations when it comes to the financial and technological capacities of SIDs, as well as the shipping pattern, were considered in the development of the "Greenheart Project" partnering with a Japanese NGO. The barriers to the adoption of such technologies were overcome with open-source design, focusing on smaller vessels with sustainable and affordable materials that could be able to sail across different bodies of water powered by wind and solar power sources. The move towards decarbonization could easily start with such initiatives, ensuring that barriers to entry are low in order for the industry inertia to be overcome (Teeter, 2016). Thus, with such a philosophy in mind, potential starting sites and vessels for the transformation of ferry vessels to electrification were studied using ship sizes between 3-10 gross tonnage (GRT). With a bottom-up estimation leading to 34% of national CO2 emissions coming from domestic shipping, electrification of viable 9,201 vessels can lead to a reduction of 15.65 tons/year, reducing the contribution of such sector by 22.09% (Palconit & Abundo, 2019).

However, according to Vakili & Ölçer (2023), utilizing a multi-disciplinary holistic approach with life cycle analysis and electrification of passenger vessels (i.e., lithium-ion batteries) is not adequate to be environmentally viable. It is also noteworthy to consider the nature of the energy source of the grid where the electricity is withdrawn, whether it is utilizing renewable green energy, and whether it has the capacity to supply adequate electricity without compromising other consumers. The authors recommend that shifting to an LNG-sourced grid in the short to medium term will result in a significant reduction while transitioning to a cleaner energy source (hydrogen and ammonia) in the long term. Such a conclusion was corroborated by Marfe (2020), who also did a life-cycle assessment of a fully battery-powered ferry on a particular route in Davao. Especially in the case of the Philippines, with an energy mix indicated in Figure 4, barely covering energy demand with a meager 51% energy sufficiency, with plans of increasing LNG uptake (up to 35%) by opening three new LNG terminals with an increased plan of developing other renewable sources (STATISTA, 2023).

As part of the partnership of WMU and the Philippines for energy efficiency enhanced domestic passenger ships, in addition to the case study for the viability of battery-powered ferries, a feasibility study towards greener ports in the Philippines was conducted by Vakili and Ölçer (2023). The result of the study supplemented their feasibility study with battery-powered ferries since these vessels will require support from the port side for a sustainable and efficient operation, where lack of infrastructure, as well as energy capacity coupled with the current state of energy source, posed challenges for environmental feasibility. A holistic and interdisciplinary approach must be first initiated for the emergence of an efficient and sustainable national infrastructure that can complement the shift to greener domestic shipping.

As one of the challenges in the initiation of decarbonization efforts is the lack of baseline data for the energy demands and consumption in the domestic maritime industry, according to Vergel et al. (2022), a bottom-up approach can be utilized to derive a relatively more accurate estimate of such figures. With the incomplete data provided by MARINA, data such as fuel consumption and operational information from secondary sources were gathered, leading to the final figure of 847 ktoe of final energy consumption with 506.94 ktoe of energy demand (81% HFO; 19% MDO), which is equivalent to 1,587 kton of CO2. Recommendation for a more systematic and accurate data collection mechanism of the administration was raised by the authors to set a more accurate baseline information of energy demand as shown by the huge discrepancy in the demand-consumption figures.

Lastly, with the concerns raised with the previously mentioned studies regarding the energy mix of the national grid as well as the significant amount of carbon emission from the maritime industry, the best policy scenario was explored to explore the viability of a 100% renewable energy system (Gulagi et al., 2021). This is achievable in 2050 with simulated model scenarios, considering the economic, social, and technical factors, but only with the hybridization of energy sources from wind, geothermal, battery, and alternative fuel sources. With the decreasing capitalization cost and the increasing need for sustainable and self-sufficient energy systems, SIDS and developing countries will have lower barriers to entry towards decarbonized and efficient energy systems.

3.1. Rapid Assessment Evaluation

The result of the assessment is shown in Table 1 below, in which the Philippines' status falls below the data collection stage and data analysis stage. With result obtained from the rapid assessment toolkit of 1.8125 which does not meet the minimum requirement of 3.0 before an administration can proceed to the "Development of a national ship emission reduction strategy" contained in Ship Emissions Toolkit Guide No.3. Although the Philippines as a signatory to all MARPOL Annexes and other international regulations with strong adoption in the national legislation, with loopholes in the actual implementation, already conformed with the criteria set forth in the Ship Emissions Toolkit Guide no.2, cannot formulate a national action plan strategy since the establishment of baseline data and pertinent information through a robust, efficient, and accurate data collection system is the foundation of such process. As such, triangulation with another framework, IMO-Norway Green Voyage2050 Project (2022), was performed for the determination of the specific gaps, as shown in Table 2.

Table 1. Rapid assessment evaluation results

Rapid Assessment Rating					
Subject Under Evaluation	**Rating**	**Subject Under Evaluation**	**Rating**	**Subject Under Evaluation**	**Rating**
Legislation and policies	3	Existing and planned ports	2	Maritime stakeholders	3
Relevant government ministries and other institutions	3	Bunker facilities and expansions plans	0	Fleet composition	3
Port state control practices	0	Shipbuilders and repair yards	0	Fuel consumption and emission	0
Shipping's role in economy	3	Marine equipment stakeholders	3	Possible emission scenarios	3
Uptake and implementation of technical and operational measures	0	Maritime emissions experts, technical, and training institutions	0	Relevant technical cooperation and technology transfer mechanisms	3

Financing mechanisms	3	Average	1.8125

Table 2. Gap determination checklist using the NAP framework.

Checklist Points	Compliance	Comments	Checklist Points	Compliance	Comments
NMTP development		NMTP only covers the period of 2019-2024	Climate target and climate change policies		Targets set without detailed proposed measures and with no baseline data
Cargo volume and profiling			Inclusion of domestic shipping in the NDC		Domestic shipping is included in the NDC but with no specific appropriation details
Economic contribution of domestic maritime transport			Regulate framework for domestic shipping emissions		Baseline data and information are yet to be collected starting 2024.

The red checklist points are the priority gaps that need to be addressed, while the green ones are the secondary gaps that need to be supplemented based on current progress. These findings will be critical in formulating the NAP in the succeeding section.

3.2. Five-Point Action Plan Towards a Decarbonized Philippine Domestic Fleet

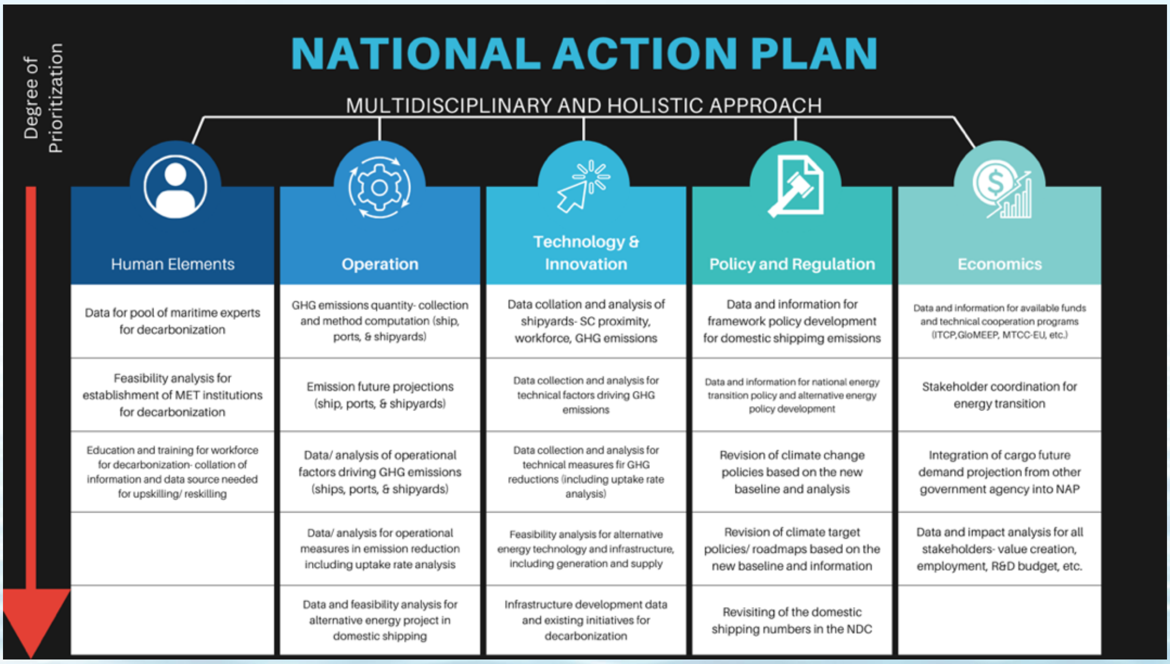

Figure 4. NAP objectives are across different perspectives with a degree of priority based on rapid assessment and gap determination.

Based on the gap and situation analysis conducted, priority gaps and secondary gaps were identified. These will be incorporated into the Energy Management Framework (Vakili, 2022), a multidisciplinary approach blended with systems thinking theory for holistic action plans. The action plan will also be triangulated with two frameworks for verification: the United States Department of Energy (USDE) Framework, Greenhouse Gas Reduction Planning, and Climate Action Planning Framework (USDE, 2023). The scope of the NAP, however, will focus on the data collection and analysis process since a National Emission Reduction Strategy cannot be formulated without the existence of foundational data (GEF-UNDP-IMO-GloMEEP Project and IMarEST, 2018). The NAP objectives across five different perspectives are shown in Figure 4. The target plan and the proposed measures in the fulfillment of the objectives mapped in Figure 4 are shown in Tables 3-5. The target timeline was adjusted so as to maintain the initial timeline indicated in the MIDP, which is close to the 30% IMO target by 2030.

Table 3. Target plan, objectives, and proposed measures covering the human element aspect (representative table).

Objective Checkpoints	**Baseline**	**2025**	**2026**	**2027**	**2028**	**2029**	**Designation**
Short Term	-						
1. Data collection for pool of maritime experts for decarbonization							
1.a. International	-	100%					MARINA
1.b. Local	-	100%					MARINA
Medium Term (2030 and beyond)							
1. Revision of NAP based on the new baseline data and short term data trends	-	-	-	-	-	-	MARINA
Long Term (2040-2050)							
1. Development of dynamic MET curriculum that is future proof and allow life-long learning of maritime workforce	-	-	-	-	-	-	MARINA, DEPED
Proposed Measures	1. With the delay in the upgrading and revision of the STCW Code for the required competencies in the handling of new technologies and fuels, benchmarking with other countries having more advance MET curriculum, as well as partnerships with other institutions in upgrading the MET to conform with the lates developments and regulations.						

Table 4. Target plan, objectives, and proposed measures covering the operation element aspect (representative table).

Objective Checkpoints	**Baseline**	**2025**	**2026**	**2027**	**2028**	**2029**	**Designation**
Short Term							
1. Collection of carbon emission quantity	-						
1.a. Ships	-	100%					MARINA. NMP
1.b. Ports	-	100%					MARINA, NMP
1.c. Shipyards	-	100%					MARINA, NMP
Medium Term (2030 and beyond)							
1. Revision of NAP based on the new baseline data and short term data trends	-	-	-	-	-	-	MARINA
Long Term (2040-2050)							
1. Development of incentivization and classification scheme for rewarding stakeholders which comply with annual quota of carbon emission from operational measures	-	-	-	-	-	-	MARINA, NEDA
Proposed Measures	1. When it comes to data collection and reporting, method A (top-down approach) can be used in the initial baseline data for a faster collation (due to the ease of access records from DOE and DTI/ PCG), however the reliability and accuracy compared to the actual consumption is not that good as compared to method B (bottom-up approach). It is therefore suggested to verify the data reported from method A with that						

	of method B. The final evolution of data collection and reporting is the method C, where AIS and other technologies are used for real time data. However, the present infrastructure and system is not yet capable of such mechanism.

Table 5. Target plan, objectives, and proposed measures covering the technology and innovation element aspect (representative table).

Objective Checkpoints	Baseline	2025	2026	2027	2028	2029	Designation
Short Term	-						
1. Data collection analysis of shipyards data	-						
1.a. Supply chain proximity	-	100%					MARINA
1.b. Workforce Skill Level	-	100%					MARINA, TESDA
1.c. Carbon emissions		100%					MARINA, DENR
Medium Term (2030 and beyond)							
1. Revision of NAP based on the new baseline data and short term data trends	-	-	-	-	-	-	MARINA
Long Term (2040-2050)							
1. Increase uptake of green technologies and alternative fuels to 100% by 2050	-	-	-	-	-	-	MARINA, DOE, NEDA, DBP
Proposed Measures	1. Information dissemination measures should be performed especially to shipyards (class B or lower) and other stakeholders involve in the calculation of EEXI and EEDI to ensure correct and reliable data are reported.						

According to the IMO-Norway GreenVoyage2050 Project (2022), the NAP comes in various templates; this NAP is patterned after a baseline setting and benchmarking template where the focus is on the collection and analysis of data for the revision and refinement of NAP. The rapid assessment toolkit mentioned earlier can be applied simultaneously with the initial drafting of the NAP. That is why such tasks are included in the short-term measures with medium-term measures for the revision of such based on the benchmarking and baseline data. This is the most applicable template in the Philippine setting due to the inadequacy of reliable data and information caused by the infancy of such measures and inadequate data collection mechanisms on almost all checkpoints necessary for carbon emission. The action plan follows the plan, do, check, act (PDCA) cycle. It is dynamic, which means that it is being implemented, evaluated for effectiveness, and revised according to the evaluation, leading to constant change depending on the factors affecting the NAP (internal and external) (IMO, n.d.).

4. Conclusion

Based on the results and discussion, it is concluded that the three instruments, namely Ship Emissions Toolkit: Rapid Assessment, Ship Emissions Reduction Strategy Toolkit, and National Action Plan Framework, are essential in the development of a nation’s roadmap towards decarbonization of the maritime domestic fleet. The Rapid Assessment toolkit is a critical tool for localizing and personalizing the roadmap according to the current situation of a particular country. Thus, it is very important to do such an assessment first before dwelling on the other processes. In the case of the Philippines, the result of the rapid assessment points out the lack of data collection and analysis mechanism that leads to the non-establishment of baselines and databases for the effective development and implementation of the action plan and strategy. It is recommended that a data collection and analysis mechanism should be put in place before proceeding to the development of a comprehensive national action plan to ensure that the adopted strategy will be based on scientific facts and methodologies. Once established, rapid assessment should once again be performed to calibrate the national action plan as well as the emission reduction strategy. In addition, continuous upgrades of all dimensions of the industry, from the human aspect to the economic aspect, are critical for catalyzing the transition towards zero carbon domestic shipping.

Acknowledgments

The author would like to extend his thanks and appreciation to his family and wife for their support and unending love. Finally, I thank AMOSUP and MAAP, headed by Chairman Conrado Oca and President VADM Eduardo Ma R Santos, for their unwavering support and mentorship.

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METHODOLOGY FOR ASSESSING EXERCISES ON A SHIP'S ENGINE ROOM SIMULATOR IN THE EDUCATION PROCESS AT THE FACULTY OF MARINE ENGINEERING OF THE MARITIME UNIVERSITY OF SZCZECIN, POLAND

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Abstract: The regulations regarding the training of personnel to work at sea relied on national and international requirements based on the STCW Convention impose on educational units to, among others: use simulators to train seafarers. In addition, the scope of training opportunities provided by the simulator and the realism of the mechanisms and representations of the installation, as well as the operation of its algorithm, should be taken into account. An important element of simulation training is the implementation of emergency scenarios that are difficult to implement as part of conventional training. This translates into an increase in the level of safety at sea and avoidance of serious incidents. Participation in simulator training allows to acquire the skills necessary for safe operation of the engine room in a real facility. Therefore, ship's power plant simulators are used not only to learn operational activities or emergency procedures, but also to check the qualifications of trainees. Typically, such tests are performed at the end of a course conducted on a simulator, and their positive results are the basis for students to pass the course or to issue an appropriate course completion confirmation or certificate. The basis for the tests carried out and the analysis of their results is the instructor's subjective assessment of the behavior of the person being assessed. This assessment has a number of disadvantages, such as uniqueness and incomparability of results obtained by different trainees, instructors and on different simulators. This resulted in, the authors have implemented and applied a computer-aided assessment of qualifications based on the Kongsberg K-SIM simulators. The methodology of designing and assessing exercises for students of   at the Faculty of Marine Engineering of the Maritime University of Szczecin, using the simulator tools was discussed. Furthermore, based on the example of the selected exercise, the procedure for preparation and starting the main propulsion engine was defined by the method of determining the didactic goal. Next, the process of creating initial conditions was described and the tasks that the student must perform were defined, taking into account various paths leading to achieve the desired effect. In addition, the principle of creating assessment blocks for completed partial tasks and the main goal using the tools of the Teacher program were presented and the method of scoring tasks and defining the rules for awarding negative points for critical errors were proposed.

Keywords: maritime education and training, machinery operation simulators, competence assessment

1. Introduction

In recent years, the continuous development of automation in industrial processes has been observed, which also does not bypass merchant vessels. This rapid implementation of monitoring and control systems has created the possibility of a significant reduction in the number of the ship's crew. Consequently, this leads to an increase in the requirements for the qualifications and trainings of crew members in operation of machinery and devices, especially in the engine department. Thanks to the modern computer techniques and the introduction of trainings on simulators, operators of complex technical facilities, which ships are, can read the construction and operation of the latest systems and have appropriate knowledge about procedures, activities and possible damage that can be found in real life, where in particular an error in assessment may threaten life, environment or property. The applicable regulations regarding the training of personnel to work at sea based on the STCW Convention impose on educational units to, among others: use simulators to train seafarers relied on national and international requirements specified by (IMO 2010, EMSA 2024, ITF 2017, Directive of the European Parliament and of the Council 2008 and the Ministry of Infrastructure and Development Journal of Laws 2018).

The STCW Convention today provides the possibility to substitute seagoing service with simulator time via Article IX through a communication to IMO and its member states. However, there is no framework governing this possibility, which leads to different interpretations and subsequently to difficulties during the process of endorsing CoC (authors are members of working groups: (3) Emerging technologies in education and training (4) Facilitation, flexibility and quality of onboard, shore-based and workshop skills training, including use of simulators and (6) Requirements for sea time or practical experience in relation to new and emerging technologies including the use of simulation, to review the Convention and Code, and to identify gaps/provisions).

Simulator training, accompanied by new training technologies and digitalization like VR, is used in a wide range of safety critical industries. Whereas simulators can be a very effective tool to train e.g. emergency situations, dense traffic situations in night time situations, collision prevention and does contribute to an increase of competencies and subsequently the level of safety, there are certain areas where seagoing service and the experience of the real life onboard cannot be replaced e.g., heavy weather, working in remoteness / isolation/ situational awareness under real-time operational pressure and, consequently, a high level of stress. However, training on simulators can compress years of experience in a few weeks and provide knowledge about dynamic and interactive processes typical of real operations in the engine room. In addition, proper training provides participants with necessary experience and confidence during the subsequent job on board. It is possible to experiment with specific problems that can be encountered in real condition and obtain answers to questions such as: "What happens if ...?" without any consequences. This effects have been widely studied (Kandemir et al. 2018, Kluj 2011, Moorhead and Pinisetty 2020, Uitterhoeve and Leunen 2021)

2. Description of the simulator and Instructor Tool

This article applies to one of Marine Power Plant Simulators K-Sim Engine L11 MAN 6S70ME Suezmax Crude Oil Carrier located at the Maritime University of Szczecin, Poland. It is found to comply with class A, B, C, D - Standard Certification of Maritime Simulators No. DNV-ST-0033 June 2021 Valid Until 15.06.2027 (DNV 2022). It ensures:

- primary and advanced training and education of students leading to professional qualifications and higher officer qualifications,
- refreshing and periodic training for a qualified engineer,
- training of officers in the field of operation of engineers with the most important auxiliary devices,
- enabling detailed research and understanding of various processes occurring in the ship's engine room systems,
- training of officers in the location of faults and deterioration of the gym's operating status and clearly demonstrating the impact of various types of faults and deterioration of the quality of the condition on the total efficiency of the system,
- Understanding and compliance with the rules of the ship's operational economy.

It consists of the following components:

1. Instructor room,
2. Briefing room connected instructor position to simulator,
3. Operational simulator, Engine room – full mission simulator,
4. Graphic simulator – 10 stations.

In the instructor room there are two positions for two instructors and a server with software that allows classes, supervision of students along with recording students' activities during classes. During classes, the training can be done simultaneously with 15 students: 5 in the operational simulator and 10 in the graphic simulator. The room with equipment is shown in Figure 1, while the detailed data and equipment of the simulator are described in manual (Hermansen A. 2018).

The simulator is equipped with an integrated instructor system for creating group and individual exercises for students. The instructor tool allows you to design exercises according to your own scenarios: from the simplest to familiarize students with the construction and starting procedures of marine power plants to more complex scenarios covering failures and damages that may appear during normal operation. The instructor tool also allows you to control the work of students during real -time exercises: sending messages instructor - student, assessment of students' progress, sending errors messages, final assessment of individual work of students. Exercise creation is preceded by the creation of appropriate initial conditions: lying at berth/anchor, maneuvers, sea going, loading condition and weather conditions. Based on previously prepared initial conditions, you can start creating the appropriate exercise scenario.

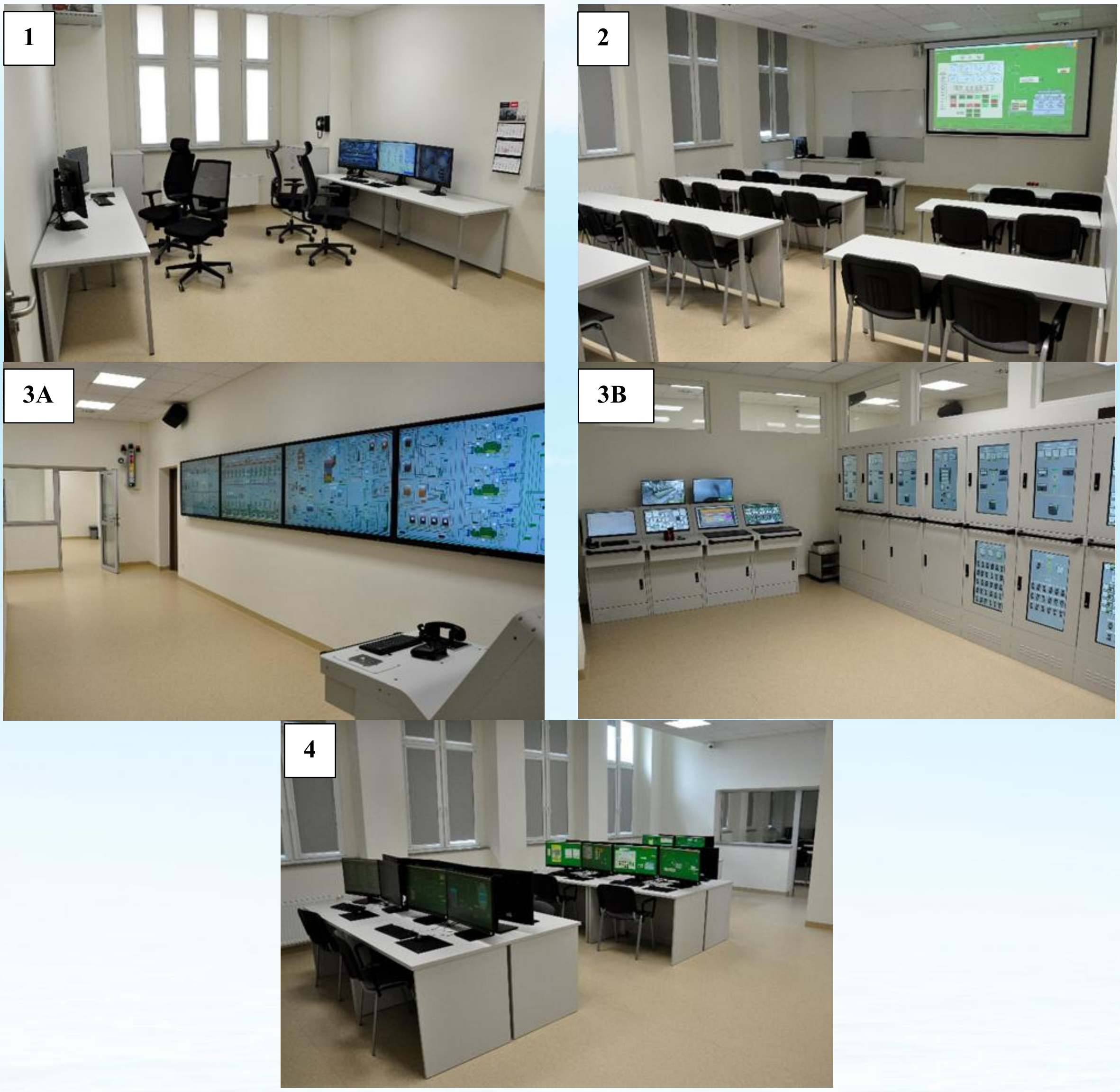

Figure 1. Engine Room Simulators – Maritime University of Szczecin, Poland:
1 - Instructor room, 2 - Briefing room, 3AB - Engine room full mission simulator, 4 - Graphic simulator.

Script creation is based on four levels:

1. Triggers are logic and mathematical expressions which can be used to start actions, e-coach messages and assessment. Triggers value can also be true (active) or false (inactive);
2. E-Coach messages are messages which can be used to give instructions, commands and feedbacks to the students.
3. Actions can be used to perform operations like introducing malfunctions, operating valves, starting pumps etc.
4. Assessments are used to evaluate the student performance.

It is possible to create any exercise scenario with assistance of available Trigger Blocks. Individual blocks are placed on the board using drag and drop tool. Each trigger should then be attributed to the own name marking the event - e.g. start exercise, start pump, open valve, etc. On the left side of the exercise card, a tree is created consisting of individual triggers. Subtree is automatically added to each trigger, always consisting of the same elements: e-coach messages, actions, assessment. E-coach messages allow the student to send the necessary information or comments. For example: you can inform the student about the start of the exercise or the desired purpose of the exercise. You can also send information about the correct/incorrect operation, exceeding the time or operation parameters of devices during actions undertaken by student. During the classes, it is also possible to ask questions to check knowledge that will also be calculated for final assessment. The actions block is procedural commands that can be used to automate the tasks of the instructor consisting in setting the defects, start operation of the devices, start a given process, etc. There are many possible settings, e.g. the time and speed of the given process, event ramp, repeatability, termination of the process. Partial (in individual trigger) and comprehensive assessment of the task set to the student during the exercise are available. At the end of the exercise, each student is individually assessed by an objective assessment system - he obtains a final result illustrating his progress during partial classes from individual issues or as a final exam in the subject of Marine Power Plant, as it is a tool recognized by maritime administration to individual ranks in the engine department.

Triggers available to create exercises are shown in Figure 2.

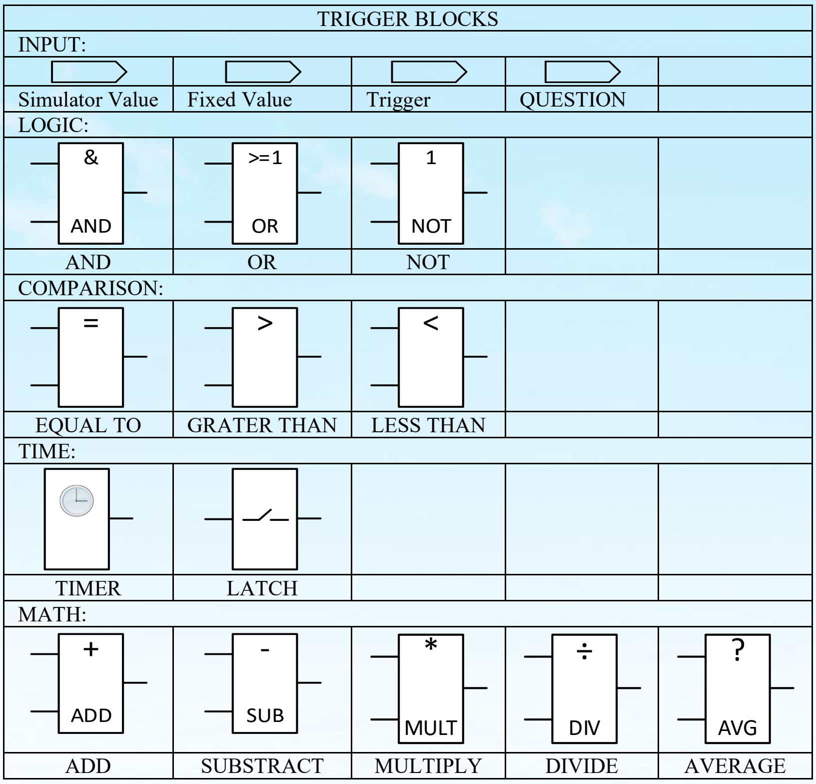

Figure 2. Available trigger blocks.

3. Characteristics of the exercise and didactic goal

The presented methodology for assessing progress in student work was prepared on the basis of the exercise entitled "Port Departure". This is an example of a typical procedure on every commercial ship, where after the announcement of the "One Hour Notice" message, the engine crew begins to prepare the engine room ER for standby and maneuvers, and in particular to start main engine ME and transfer the control to the bridge. The main didactic goal of the exercise is to prepare students of Marine Power Plant Operation Course for independent conducting of complex ship procedures, in this case the preparation of ER for standby and maneuvers. During many years of didactic work, it was observed that students cope much worse in situations that are not described in details and require them to make decisions independently. So it was decided that the partial goals should include mastering the skills of recognizing condition of ER equipment, such as power plant load or sea water temperature and adjusting the appropriate course of action based on that. In practice, this boils down to the ability to make decisions in complex and multi-stage situations that are not burdened by stress resulting from a malfunction or unexpected change in environmental conditions (such as a storm).

The exercise is prepared in two versions and preceded by an introduction in the form of a lecture, where characteristic elements of the procedure are explained. Since the procedure is quite complex and covers various aspects of ship operation, such as the power plant, ME, boilers, automation and control systems, the exercise can only be carried out with higher semester students who already have a certain range of knowledge and skills.

The first version includes a set of additional messages in the form of E-coach information, which the instructor prepares in advance and programs to appear at a precisely defined stage of the exercise including partial tasks that student should perform (Figure 3). These messages are designed to appropriately guide the student on the correct path of the task being carried out without the need for excessive involvement of the instructor. The messages usually cover the most common errors or omissions in the tasks being performed. This allows the instructor to work with a group of students efficiently, devoting time to each of them on the most important issues of the problem being solved, without the need for constant monitoring of the correctness of each action.

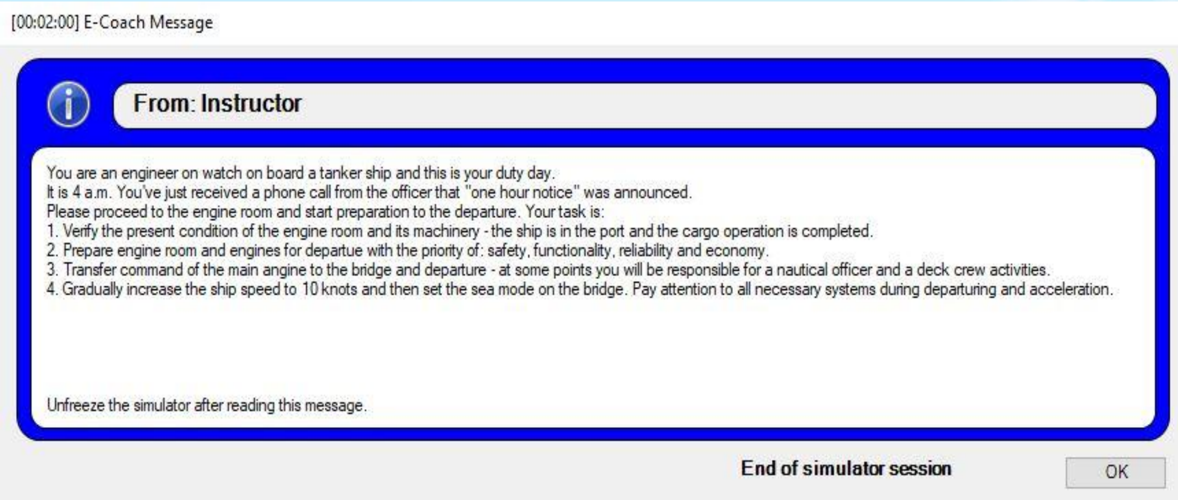

Figure 3. Instruction message from teacher.

For example, in Figure 4, a warning is presented, which is programmed to appear when the student opens the starting air valve to ME without first draining the air receivers.

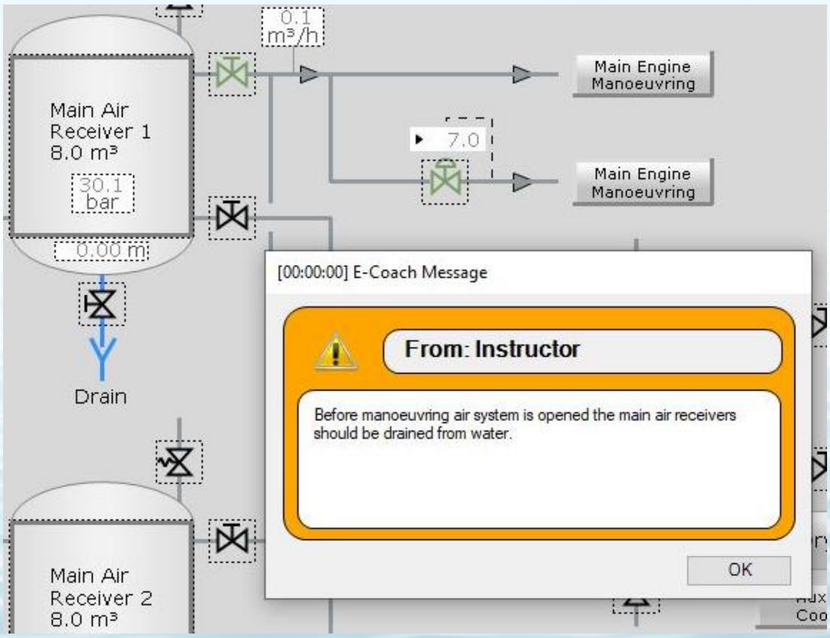

Figure 4. Example of a warning message, yellow frame.

If the student properly drains the tanks before opening the air to ME, the message will not appear. Messages are divided into three categories distinguished by colors: error message (red color), warning message (yellow color), and positive message (green color). In particular, positive messages (Figure. 5) play a significant role in reaffirming the student that they have chosen the correct solution, and additionally, it has been observed that received praise often motivates students better than negative information. The main role of the instructor at this stage of training should be skillfully guiding students to think critically and understand the exercise's concept.

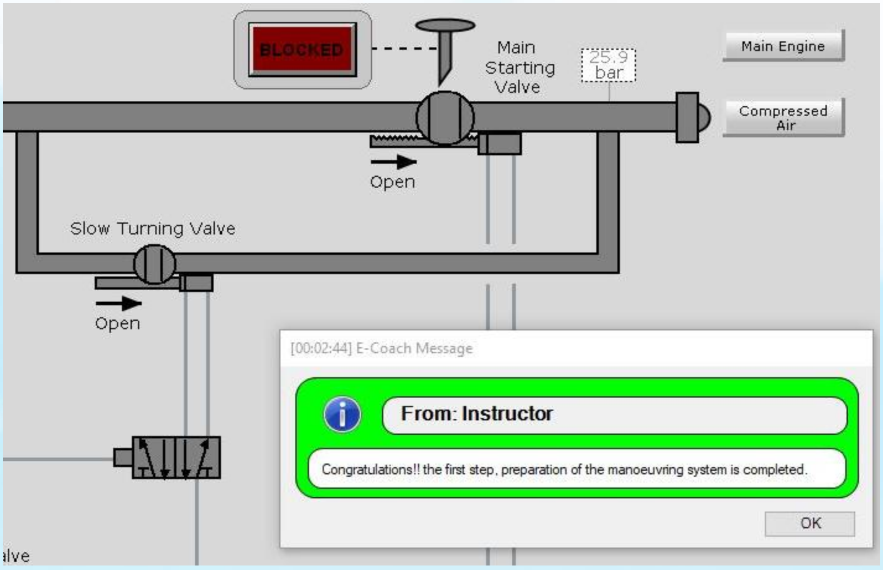

Figure 5. Example of positive message, green frame.

The second version of the exercise is the same exercise but without any messages. It includes an evaluation module, but students have at least one opportunity to do the exercise without hints and without the additional stress of expecting their work to be graded. After the exercise, typical errors are discussed, usually using an anonymous student as an example. Following this training, students are then subjected to an assessment that is done using the second version of the exercise, although external conditions are usually changed in some way. The end goal of the exercise is to have the ship sailing at a fixed speed, at least half ahead. ER should be at sea mode of operation after the maneuvers are completed. One must be aware that there is usually not just one correct way to achieve a goal, and often it depends on additional circumstances where one approach may be slightly better, while in other circumstances another may yield better results.

3. Description of task blocks and characteristics of errors validity

Due to the complexity of tasks related to functioning of marine power plant MPP, the main task was divided into sub-scenarios (task blocks). It is possible to divide according to various criteria:

- According to the procedure, e.g. air-blow the engine, engine control shifting, etc.
- According to MPP system, e.g. starting air and lubricating oil installation, etc.
- According to the machinery, e.g. diesel generator, etc.

The examples of sub-scenarios used in the exercise are presented in Figure 6. An additional advantage of the division is the ability to save them in the simulator library for use when designing other exercises.

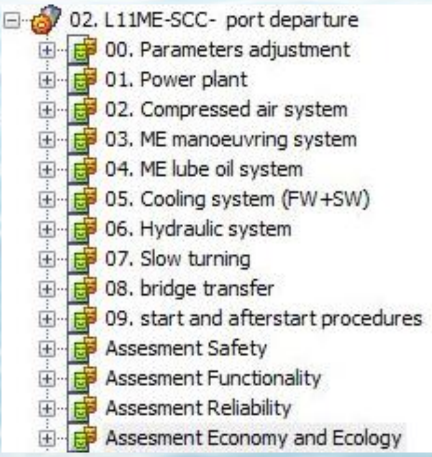

Figure 6. Exercise scenario structure divided into sub-scenarios.

With such diverse functional sub-scenarios, there's a significant issue regarding how to evaluate the exercise as a whole. Each sub-scenario consists of several to a dozen individual tasks or actions to be completed. They form a certain set, some of which are necessary to achieve the end result, without which the task won't be completed at all. An example of such an action is opening the air valves for starting ME. Some actions only ensure the required reliability in case of unforeseen situations, but their absence won't prevent the task from being carried out. There are also actions meant to ensure the safety of task execution, which are necessary even though they do not affect the success or failure of the main task execution. Additional difficulty comes from evaluating potential errors that can occur during the procedure. Typical errors include the launch of additional, unnecessary pumps or operation of heat exchangers with incorrect valve opening sequence. They should also be included in the set of activities subject to assessment as presented in Figure 7 positions 05.02N and 05.06N.

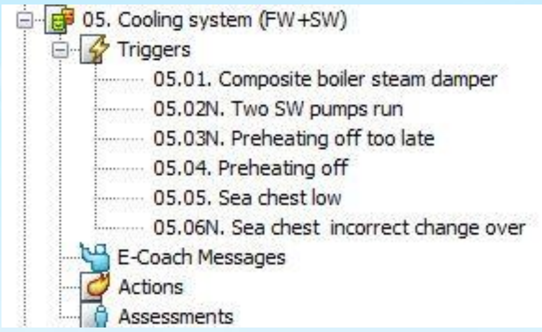

Figure 7. Exercise scenario structure divided into sub-scenarios.

So far, the methodology of assessment has been focused on evaluating the effectiveness of completing the main task with consideration of no more than critical errors, such as black-outs or a fire in ER, which would qualify the exercise for a negative assessment. However, with this approach, it was extremely difficult to make a fair assessment of whether the student performed the task correctly and thoughtfully, or simply achieved the desired end result through trial and error, posing a threat to the crew, ER and its equipment.

The new approach involves selecting a group of criteria that according to instructors and marine engineers should be taken into account when evaluating the task. The selected criteria were presented on Figure 8.

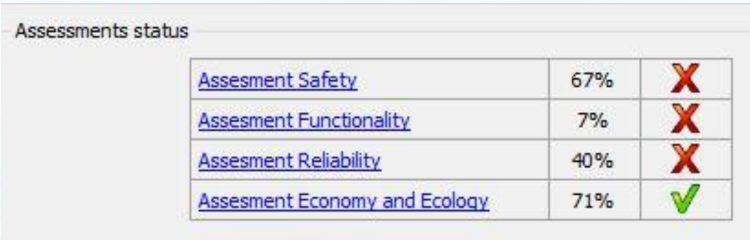

Figure 8. Report window of final exercise assessment.

SAFETY CRITERION (SC) include all those identified activities whose execution, or lack thereof, poses a threat to the broad safety of the ship, crew and its surroundings. In this perspective, a black-out occurring during ship preparation to leave the port is no longer classified as a critical error but as a state of danger, which is assigned a negative points value. Thus, the student has a chance to complete the exercise with a positive outcome, provided they manage to restore the situation after the black-out. Comparison of the safety criterion assessment elements is shown on Figure 9. It consists of six negatively and five scored items. This is due to the nature of the criterion, which essentially involves avoiding mistakes, meaning actions and events with negative scoring. For example, changing control to bridge for engine while forgetting to close indicator valves poses a real fire hazard. The relatively low negative scoring mainly stems from the fact that in real conditions, the crew would quickly identify the problem and eliminate the threat. However, certain activities must be carried out, as skipping them would endanger safety. This results in obtaining positive points. An example of such must-do actions is activating an additional generator set. Due to the high importance of this criterion, threshold of 90% of the required points has been initially assigned to achieve a positive assessment. It may seem like a very strict requirement, but it is important to note that a significant number of points are negative points, which can be avoided by following the rules of safe operation. The scoring scale with a passing threshold and the number of "points earned" at the start of the exercise is presented on Figure 9. A student starting the exercise already has a pool of 67% of the possible points to obtain.

FUNCTIONALITY CRITERION (FC) includes activities necessary to obtain the final effect of exercise. ME start from bridge and accelerating ship to a speed of 10 kN and commencing of sea passage COSP. Due to the specificity of this criterion, it consists almost exclusively of the positive scored tasks, as shown on Figure 10.

It's worth to notice that some tasks can fall into more than one category.

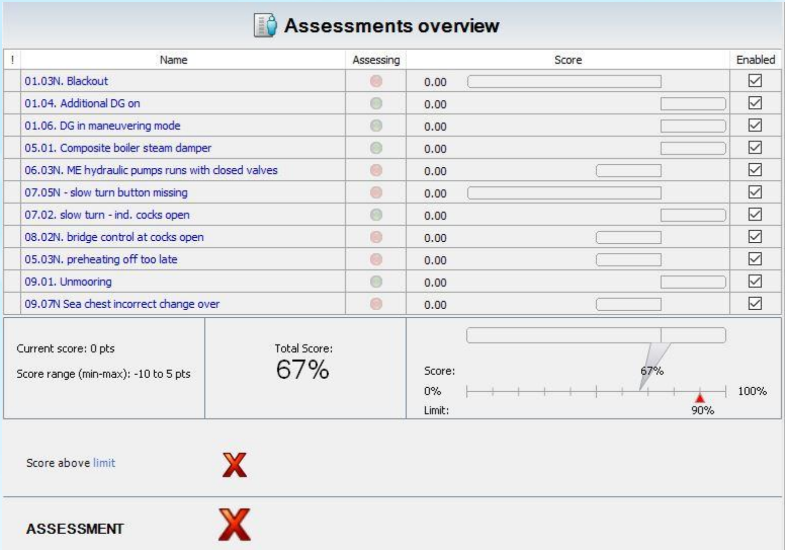

Figure 9. Examples of activities evaluated in *SAFETY CRITERION*.

Attempt to start ME while the ship is moored prevents it from gaining speed (FC) and poses a risk to the crew on board (SC). Skipping the step ME preheating off can hinder the proper functioning of the engine (FC) but also creates a risk of triggering the slowdown protection and even shutting down (SC). Usually, this task can be delayed compared to starting ME when prolonged maneuvers are anticipated, risking the engine cooling excessively while waiting for the next start-up. Hence, a separate evaluation was decided for ME preheater off (Figure 10, pos. 05.04) and preheating off too late (Figure 9, pos. 05.03N). As FC covers all the necessary tasks to achieve the final exercise outcome, practically all of them must be completed with passing threshold of 80%. This means that only minor deviations from the required settings are allowed. Additionally, it was decided to designate one of the tasks, engine start and run (Figure 10, pos. 09.03 marked with a green checkmark "✓"), as a critical task, which means that failing to complete it disqualifies the entire exercise.

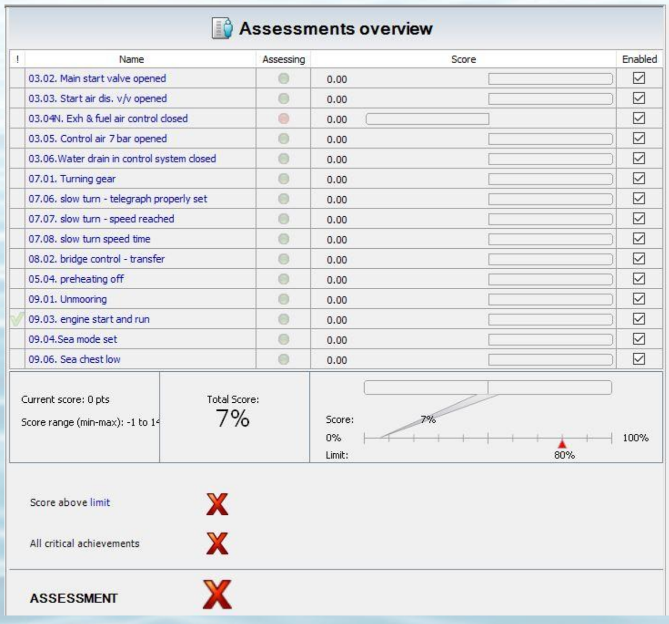

Figure 10. Examples of activities evaluated in *FUNCTIONALITY CRITERION*.

RELIABILITY CRITERION (RC) was developed to test whether a student can correctly predict potential threats and proactively counteract them. It includes activities that are typically not necessary to achieve the final exercise outcome but significantly increase the likelihood of success in the event of a malfunction or unfavorable external conditions. In the vast majority of cases, this involves preparing devices for standby mode, but it also includes activities aimed at ensuring as trouble-free operation as possible. Examples of activities classified in RC are presented in Figure 11. The scoring required to pass was initially set at 70% by fact these activities are not necessary, and they are related to experience of engineer, which students may have not own.

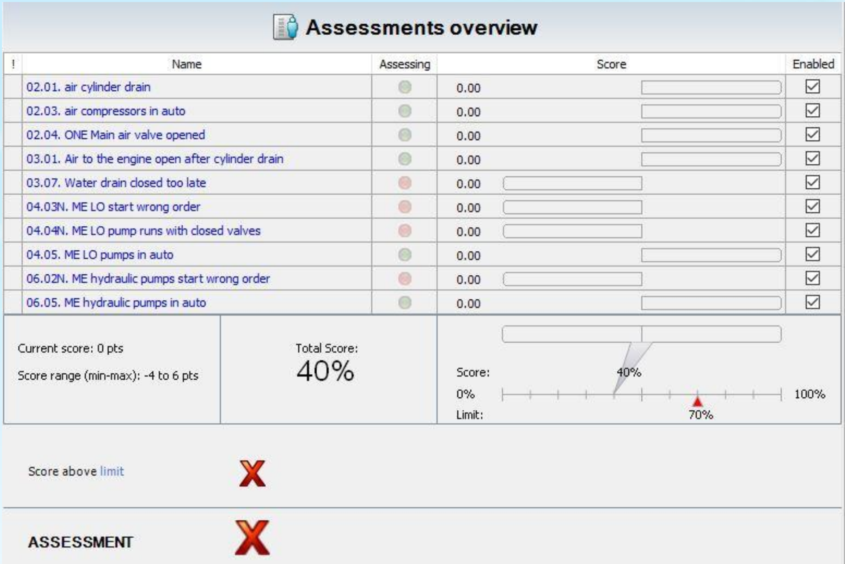

Figure 11. Examples of activities evaluated in *RELIABILITY CRITERION.*

ECONOMY CRITERION (EC) in many aspects overlaps with ECOLOGY CRITERION (EC), because both usually come down to minimizing fuel consumption. That's why they have been merged into one criterion (EEC) as presented on Figure 12, which allows to simplify the assessment procedure of students' skills.

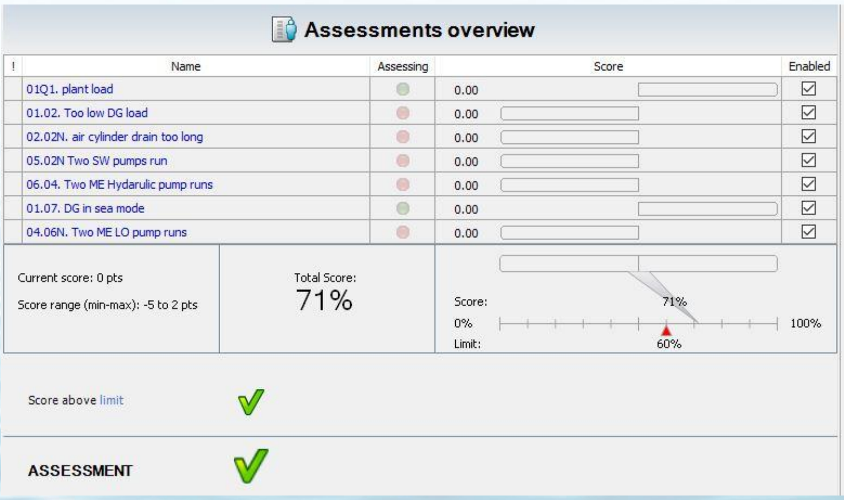

Figure 12. Examples of activities evaluated in *ECONOMY AND ECOLOGY CRITERION*

EEC is designed to develop the ability to make decisions, such as choosing the best time to attach additional devices or when they are no longer needed. EEC is contradictory to SC and FC, but only seemingly. For example, in SC, it is assessed whether an additional power unit (Figure 9 pos. 01.04.) was engaged during maneuvers, which is necessary to ensure the safety of the maneuvers. At the same time in EEC (Figure 12 pos. 01.02.), the evaluation is made on when and under what load the power unit was engaged. If at the very beginning of the power plant preparation procedure the load on the power unit with one working power unit is small, let's say below 25%, it is not justified, neither economically nor ecologically, to immediately engage the second unit as it can be done at the end of the procedure or when, the load on the power plant significantly increases. The passing threshold for EEC has been initially set at 60% of the possible points, which allows for verifying the student's skills while not being a barrier to obtaining a positive final grade. It is important to remember that this category, just like reliability, already requires some experience in the functioning of MPP.

Summary and conclusions

In the previously used assessment methodology, each of the many exercise sub-scenarios was assessed as a separate assessment block. This led to multiple assessments (as many as sub-scenarios in the exercise) resulting from the evaluation of usually a small number of actions. As shown in the example presented in Figure 7, a single sub-scenario usually contains less than 10, and often less than 5 assessed elements. This clearly poses a difficulty in accurately determining the student's skills. Furthermore, assessing a single system device or procedure, which typically constitutes a single sub-scenario, is fragmentary and non-complementary.

The new approach to evaluating student skills based on specific criteria seems like a more holistic approach. It's also fairer to the students because each criterion can include a lot more assessed items. In the case discussed, the Safety criterion has 11 elements, Functionality has 15 elements, Reliability has 10 elements, and Economy and Ecology has 7 elements. However, it's important to note that the exercise is still not in its final form and further development is expected.

Getting four grades from a larger number of elements, especially much more diverse compared to the previously used methodology, gives a better picture of the student's acquired competencies. Of course, the passing thresholds can always be adjusted to the requirements of a specific exercise. Initially set thresholds at 90%, 80%, 70%, and 60% levels may seem quite strict, but a high bar is usually a challenge for young people rather than a reason for discouragement.

The team of instructors for the simulator of onboard gym is currently planning to test a new methodology for assessing exercises on a group of volunteer students. The observations made will allow for corrections to be made and for more individually tailored assessment thresholds to be established based on the group's level. It's worth noting that preparing the exercise scenario and programming the E-coach system and assessment is very time-consuming. It's estimated that around 200 work hours were spent creating the presented exercise. However, the educational impact observed so far makes it all worth it. Students respond much better to well-prepared exercises, especially when they feel like they are training for situations that are likely to occur in their professional work. They are also more inclined to accept assessments given with the help of an automated system rather than when they are subjectively given by an instructor. This is probably due to the feeling that automated assessment is determined based on exactly the same criteria for everyone, ensuring much higher impartiality compared to subjective instructor assessment.

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ENGINE WASTE HEAT-DRIVEN COOLING SYSTEM IN A MARITIME EDUCATION CAMPUS: A CASE STUDY OF PIRI REIS UNIVERSITY

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Abstract: The universities should lead society in environmental issues and for a green, sustainable future. Waste heat-driven cooling systems, also known as thermally driven cooling systems, utilize waste heat from industrial processes or other sources to generate cooling. These systems are environmentally friendly and energy-efficient, as they harness waste heat that would otherwise be released into the environment or require additional energy for dissipation. In this study, the performance of a natural gas engine waste heat-driven cooling system is investigated on the Piri Reis University maritime education campus as a green campus. Although absorption cooling systems have a low coefficient of performance (COP), they offer several advantages, particularly in certain applications and environments: Energy efficiency, low electricity consumption, environmentally friendly, quiet operation, reliability, and reduction of emissions.

Keywords: cooling; absorption;energy; green campus

1. Introduction

A trigeneration system, also known as combined cooling, heat, and power (CCHP), is an energy-efficient technology that produces electricity, heating, and cooling simultaneously from a single fuel source. Trigeneration systems offer several advantages: By harnessing waste heat for heating and cooling purposes, trigeneration systems can achieve higher overall energy efficiency compared to separate generation of electricity, heating, and cooling. Trigeneration can lead to cost savings by reducing energy consumption and utility bills, especially in applications where there is simultaneous demand for electricity, heating, and cooling. Trigeneration systems can enhance resilience against power outages or grid failures by providing on-site generation of electricity, heating, and cooling.

(Wu and Wang 2006) reviewed combined cooling, heating and power. (Saidur et al.2012) reviewed the latest developments and technologies on waste heat recovery of exhaust gas from internal combustion engines. (Shu et al. 2013) reviewed waste heat recovery on two-stroke internal combustion engines for ships. (Ezgi 2014) designed and analyzed of an H_2O–LiBr AHP system for naval surface ship application. (Jradi and Riffat 2014) provided a comprehensive review of the latest developments in the field of combined cooling, heating and power generation. (Wang and Wu 2015) reported, for a 16 kW internal combustion engine, the cooling output could reach 34.4 kW with coefficient of performance (COP) of 0.96 and exergy efficiency of 0.186. It is conducted transient simulation of the engine waste heat powered cooling system for cargo ship application (Cao et al. 2015). They calculated that the waste heat powered cooling system showed a cooling COP of 0.6. (Du et al. 2017) developed an ammonia-water absorption refrigeration prototype for waste heat utilization of diesel engine exhaust. (Kumar and Das 2019) presented an experimental study of an ammonia-water absorption refrigeration system using the exhaust of an internal combustion engine as energy source. They obtained the maximum COP to be 0.136 for the refrigeration system. (Ezgi and Bayrak 2020) studied experimental analysis of a laboratory-scale diesel engine exhaust heat-driven absorption refrigeration system. They calculated the highest COP to be 0.3022 for the generator temperature of 160°C.

Piri Reis University is Türkiye's first and only environmentally friendly green campus with International BREEAM (Building Research Establishment Environmental Assessment Method) Accreditation on the seaside in Tuzla. BREEAM is used to specify and measure the sustainability performance of buildings. The seaside campus of Piri Reis University produces 45% of the electricity demand by itself and uses the energy released during the process to the cooling and heating of the buildings with the application of the trigeneration system working with natural gas.

In this study, it is investigated performance of gas engine waste heat-driven cooling system as one of indicators of sustainability performance at Piri Reis University seaside campus and compared to vapor compression refrigerators.

2. Absorption Chiller

An absorption chiller is a type of chiller that uses heat energy, rather than mechanical energy, to produce cooling. It's an alternative to the more common vapor-compression chillers. Instead of using a compressor to pressurize refrigerant, the absorption chiller relies on a heat source to provide the energy needed for the refrigeration cycle. This heat can come from waste of from natural gas engine. The heat input drives an absorption process where a refrigerant (lithium bromide) is absorbed into water. This absorption process occurs at low pressure. Next, the solution containing the refrigerant is heated, causing the refrigerant to be released as a vapor. This is known as desorption. The refrigerant vapor then enters a condenser where it is condensed back into liquid form by rejecting heat to a cooling water. This releases the heat absorbed during the absorption process. The high-pressure liquid refrigerant then passes through an expansion valve or throttle valve, where its pressure and temperature are reduced. The cold liquid refrigerant then enters an evaporator where it evaporates, absorbing heat from the chilled water or air passing through the evaporator coils. The low-pressure refrigerant vapor is then returned to the absorber, where the cycle begins again.

2.1 Performance of absorption refrigeration system

The COP of absorption refrigeration systems is defined as

$$COP_{absorption} = \frac{\dot{Q}_L}{\dot{Q}_{gen}+\dot{W}_{pump}} \quad (1)$$

COP of the serial absorption refrigerator is calculated from the ratio of overall heat output to the heat input from hot water:

$$COP_{absorption} = \frac{\dot{Q}_{L1}+\dot{Q}_{L2}}{\dot{Q}_{gen1}+\dot{Q}_{gen2}+\dot{W}_{pump,1}+\dot{W}_{pump,2}} \quad (2)$$

The overall COP of an absorption refrigeration system under reversible conditions becomes (Cengel 2011)

$$COP_{rev,absorption} = \frac{Q_L}{Q_{gen}} = \eta_{th,rev}.COP_{R,rev} \quad (3)$$

$$COP_{rev,absorption} = \left(1-\frac{T_0}{T_s}\right)\left(\frac{T_L}{T_0-T_L}\right) \quad (4)$$

where T_L, T_0, and T_s are the thermodynamic temperatures of the refrigerated space, the environment, and the heat source, respectively.

The second-law or exergy efficiency of the cycle is

$$\eta_{II} = \frac{COP_{absorption}}{COP_{rev,abssorrption}} \quad (5)$$

3. A case study of Piri Reis University

World maritime education attaches utmost importance to issues such as environment and marine pollution in accordance with international rules such as MARPOL / SOLAS. Since 2013, Piri Reis University has opened Türkiye's first and only environmentally friendly Green Campus and started to provide this education to students with its international accreditation. Piri Reis University seaside campus has a trigeneration system as a green campus. The heating, cooling, and electricity demands of buildings are met by a trigeneration system.

The picture of the natural gas-powered generator used in this University is given in Figure 1. The hot water obtained from the engine jacket water through the jacket water-hot water heat exchanger shown in Figure 2 is heated to a high temperature in the exhaust gas-heat water heat exchanger shown in Figure 3 and sent to the absorption cooling system. The boosted waste heat contains sufficient thermal energy to drive an absorption chiller to obtain a stream of cold fluid. As shown in Figure 4, the absorption chiller provides chilled water of 7 oC. The operation cycle diagram is given in Figure 5.

Lithium Bromide-water is used as a solution in absorption chiller, where water serves as the refrigerant. As per thermodynamic calculations, the solution mass-flow rate through the absorber and generator in each absorption chiller are 1.187 kg/s and 0.950 kg/s, respectively. The concentration of LiBr in the rich and weak solution in each absorption chiller are 0.5945 and 0.4758, respectively.

Figure 1. Natural gas-powered generator

Figure 2. Jacket water-hot water heat exchanger

Figure 3. Exhaust gas-hot water heat exchanger

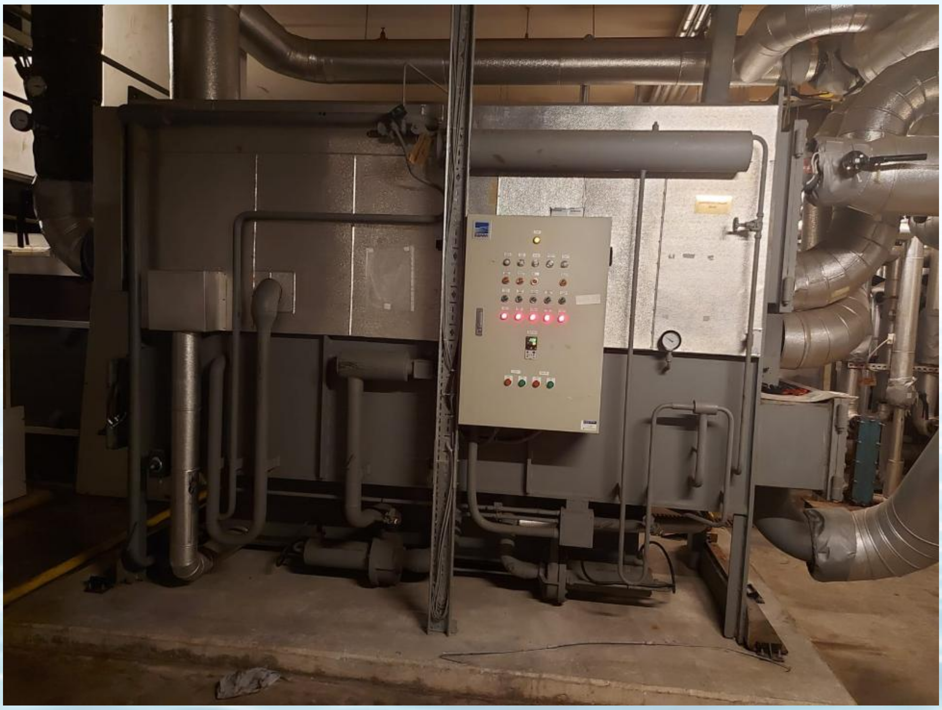

Figure 4. Picture of absorption chiller

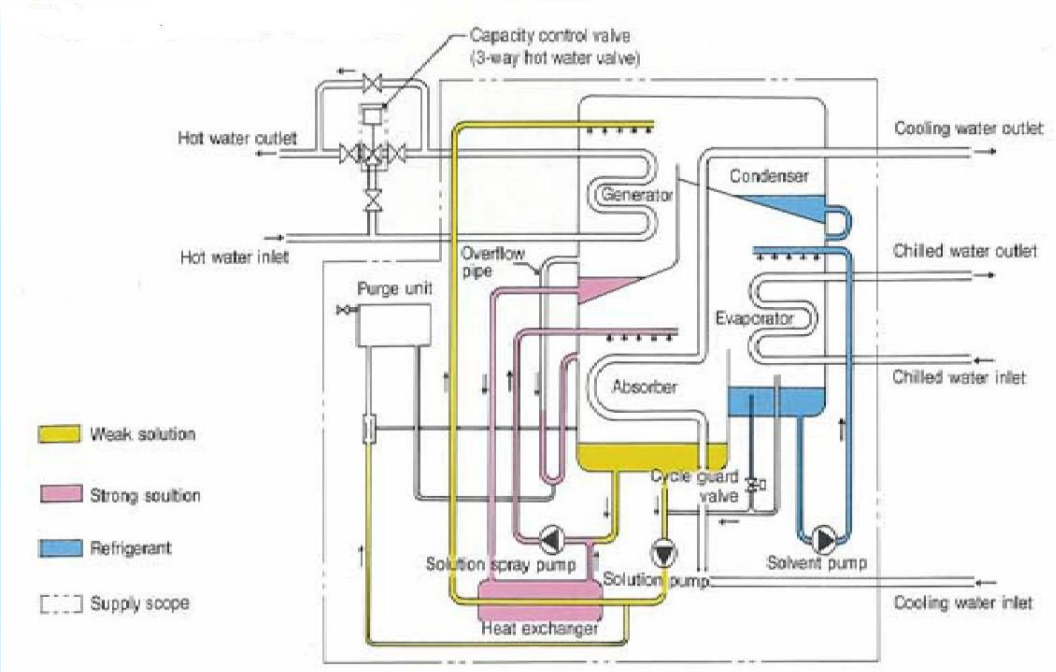

Figure 5. Operation cycle diagram

The properties of the system are given in Table 1.

Table 1. Properties of System

Type of refrigeration	Absorption refrigeration
Solution	Lithium bromide-water
Heat-type	Engine waste heat
Engine fuel	Natural gas
Energy source	Hot water

The performance data of the genset is given in Table 2.

Table 2. Performance Data of Genset

	Value	Unit
Engine output power	826	kW
Electrical output power	800	kW
Bore/Stroke	132/160	mm
Speed	1500	rpm
Thermal efficiency	45.3	%
Electrical efficiency	42.5	%

Specifications of the absorption chiller are given in Table 3.

Table 3. Specifications of Absorption Chiller

	Value	Unit
Chilled water inlet temperature	12	ºC
Chilled water outlet temperature	7	ºC
Chilled water pressure drop	15	kPa
Cooling water inlet temperature	28	ºC
Cooling water outlet temperature	33	ºC
Cooling water pressure drop	36	kPa

Each absorption unit has four pumps: Solution, solution spray, refrigerating, and vacuum pumps. The rated motor output of the absorption chiller is given in Table 4.

Table 4. Rated Motor Output of Absorption Chiller

	Value	Unit
Solution pump	1.5	kW
Solution spray pump	0.75	kW
Refrigerating pump	0.4	kW
Vacuum pump	0.4	kW

4. Results

As shown in fig. 6, the external loops of two absorption refrigerators are connected. A total of 3510 l/min chilled water is obtained, 1755 l/min in each absorption chiller. A total of 8,370 l/min cooling water is delivered, 4185 l/min in each absorption chiller. The cooling water cooled by sea water absorbs heat from the absorber and condenser in each absorption chiller.

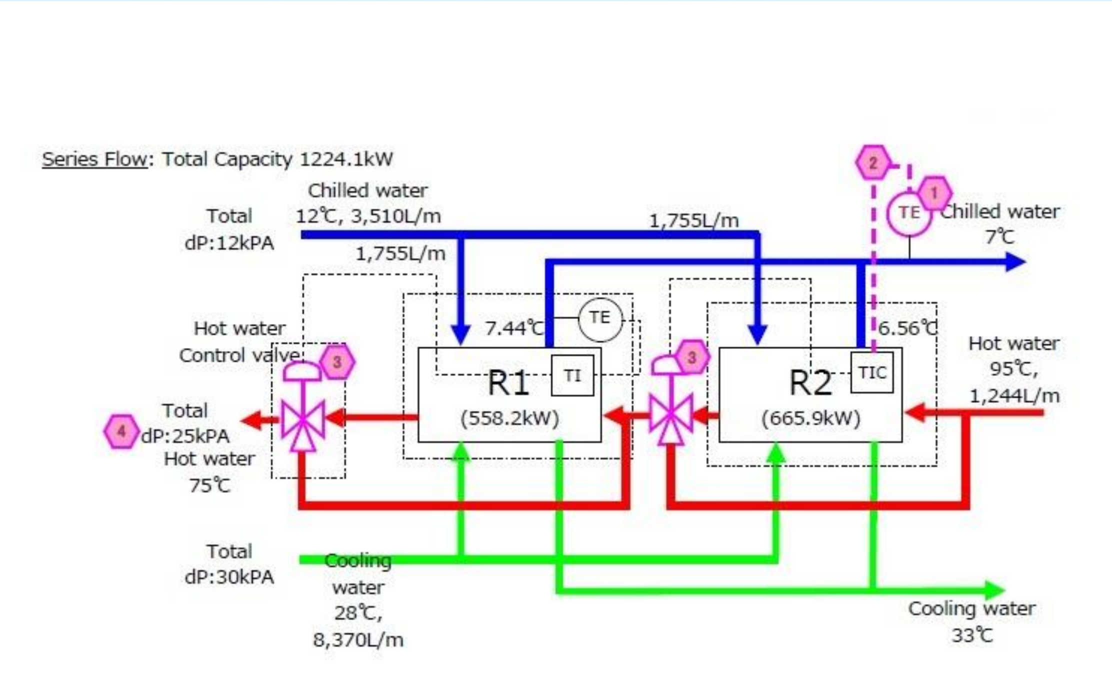

Figure 6. Serial arrangement of two absorption refrigerator

The heat input rate from two engines to two absorption chillers is as follows:

Engine exhaust to hot water:454 kWx2=908 kW

Engine jacket water to hot water: 413 kWx2=826 kW

The total rate of heat input=1734 kW

With a total removed heat rate of (558.2+665.9) kW, the total pump input power of (3,05+3.05) kW for the first and second absorption chiller, respectively, and total heat rate input of 1734 kW; the COP of the absorption chiller for series flow at full load is calculated as

$$COP = \frac{(558.2+665.9)\ kW}{(1734+3.05+3.05)\ kW} = 0,70 \tag{6}$$

The reversible COP versus environment temperature is given in Figure 7. As the environment temperature increases the reversible COP decreases. The exergy efficiency versus environment temperature is given in Figure 8. As the environment temperature increases the exergy efficiency increases.

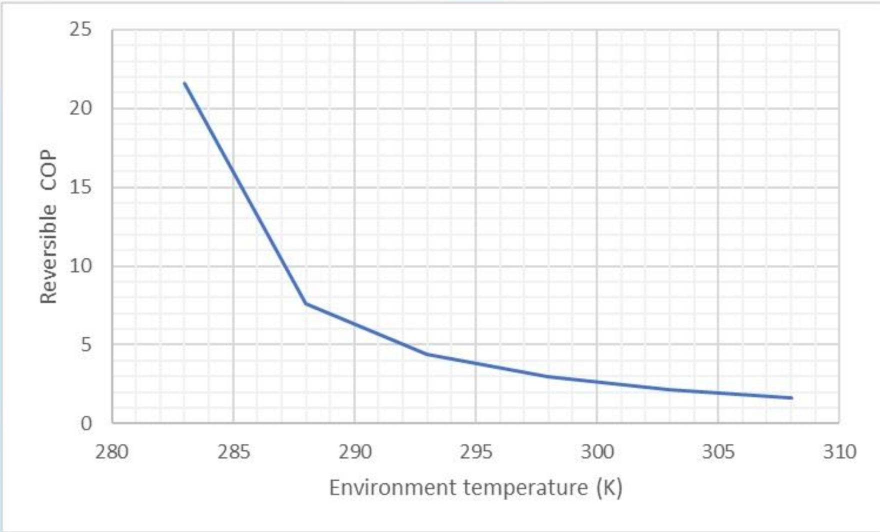

Figure 7. Reversible COP of serial flow absorption system

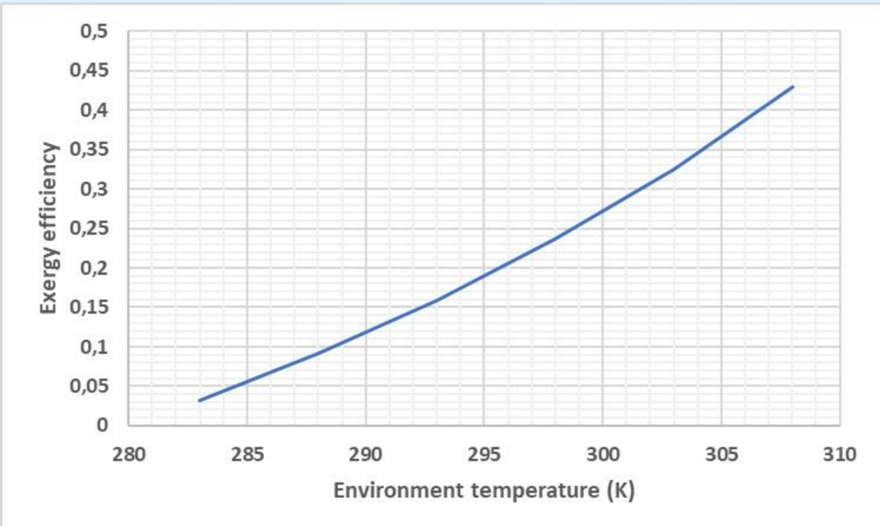

Figure 8. Exergy efficiency of serial flow absorption system

The amounts of cooling produced by the absorption chiller can be regarded to correspond to electricity savings. The saving is calculated by estimating the electricity input needed to produce the same cooling effect using the vapor-compression refrigerator. For comparison, the calculations are made with COPs of 2, 3, 4, and 5 and 1000 operating hours a year for the vapour-compression refrigerators. The energy consumptions of vapor-compression refrigerators with COP of 2-5 for cooling load of 1,224.1 kW for 1000 operating hours are illustrated in Figure 9. As seen in Figure 9, using the waste heat-driven absorption chiller can save 605,950 kWh-238,720 kWh energy compared to vapor-compression refrigerators with COP of 2-5 for 1000 operating hours in summer, respectively. In addition to energy efficiency, the gas engine waste heat-driven absorption chiller also reduces CO_2 emissions as seen in Figure 10. The gas engine waste heat-driven absorption chiller system can improve green profile of the campus because it will reduce its summer CO_2 emissions by 132–330 tons in the cooling cycle compared to the vapor-compression refrigerators for 1000 operating hours.

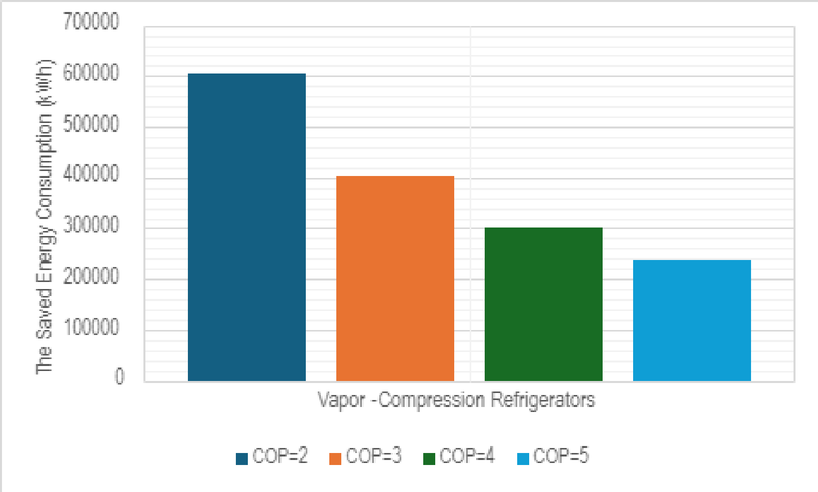

Figure 9. Saved energy consumption compared to vapor-compression refrigerators

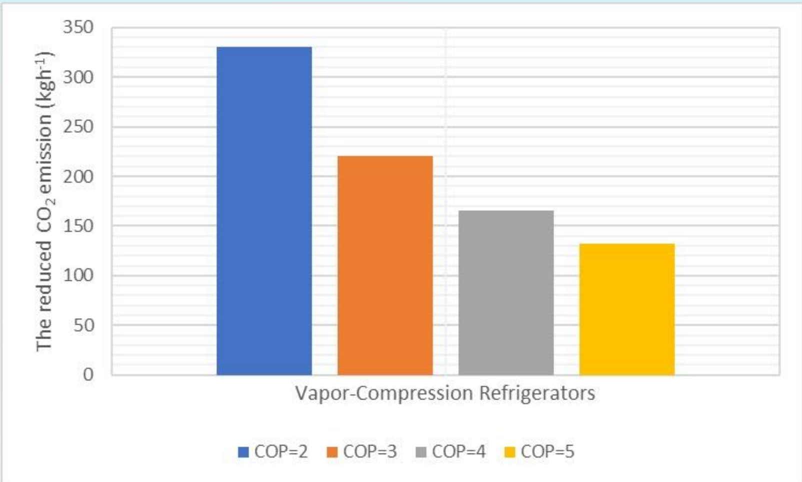

Figure 10. Reduced CO_2 emissions compared to vapor-compression refrigerators

Conclusions

Waste heat-driven absorption chillers are particularly useful in situations where waste heat is readily available, making them more energy-efficient than traditional vapor compression chillers in certain applications. They're often used in large-scale air conditioning systems for commercial buildings, industrial processes, and district cooling systems.

The reversible COP of a serial flow absorption refrigeration system is between 1.63 and 21.55 depending on the environment temperature. The exergy efficiency of a serial flow absorption refrigeration system is between 3.2% and 42.93% depending on the environment temperature. The COP of the actual serial flow absorption refrigeration system at full load is 0.7.

Although the COP of gas engine waste heat-driven absorption chiller is lower than vapor-compression refrigerators , Piri Reis University seaside campus both provides energy savings of 605,950 kWh-238,720 kWh and reduces CO_2 emissions by 330-132 tons for cooling load of 1,224.1 kW for 1000 operating hours a year compared to vapor-compression refrigerators with COPs of 2, 3, 4 and 5, respectively.

Fuel consumption and CO_2 emissions decrease to produce the same amount of cooling power given by a vapor compression refrigeration system when a waste heat-driven absorption chiller is used.

Acknowledgements

The author thanks Piri Reis University for its support.

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A STUDY ON THE DESIGN OF A MULTI-PURPOSE, EFFECTIVE SHIP ENGINE ROOM SIMULATOR

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Abstract: Practical studies on land or on board form the basis of ideal maritime training. This study was conducted on the assumption that well-designed simulators in terms of scope, relevance and user-friendliness can effectively contribute to mariners training with experienced instructors who apply the curriculum, plan and program prepared in accordance with the needs. Global, international standard simulator designs may show visual differences other than the principles. If the principles are sustainably updated by STCW according to needs and technology, simulators can enable the effective treatment of not only all kinds of managerial and operational scenarios but also maritime engineering and science curriculum subjects. Automation principles correctly applied in simulators will allow the student to make observations, analysis and comments, make the right decisions and apply them correctly. Simulators are investments that require frequent updates and have high investment and operating costs, and they must model real-life applications for effective training. For this purpose, it is important to prepare it with expert software developers, programmers, and staff with high professional knowledge and experience. Simulators are not training tools that start and stop remotely. However, observations made in different simulator training institutions show that this is the case. Under STCW principles, instead of each institution having a separate simulator for standard, effective training, the establishment of central simulator training centers will enable possible technical, administrative, financial and legal problems during training to be easily resolved. The right expert, design and instructor staff are essential for effective simulator training. In this study, the basic factors related to education, which are assumed to be effective in ensuring the safety of life and property of seafarers who change direction and shape according to rapidly developing technology and play an international role, especially on commercial ships, were examined. All global institutions providing maritime training have adopted the STCW rules as a regulatory reference. IMO is always contributing to education with updated STCW based Model Courses. Each nation implements some practices in education according to its own laws and regulations. This situation is clearly seen in the curricula of all institutions providing maritime education. It has been understood through the analysis of some statistical data that visual, practical, tangible education is much easier, understandable and fun than theory in order to keep up with the rapidly developing technology. This result shows that; maritime education institutions should focus on real systems or well-designed virtual application investments. Practical trainings, provided by nations and institutions' investments together with the internationally effective curriculum, plan and program prepared for this purpose, will make an undeniable contribution to the more reliable training of the new generation of the mariners working under rapidly developing technological and managerial conditions.

Keywords: Design, Expert, Instructor

1. Introduction

As in every field, simulators are frequently used in all trainings related to the maritime sector as mentioned in IMO, MET, STCW, EMSA, WMU and IAMU documents. As briefly mentioned in Artem Ivanov's article "DESIGN OF MULTIFUNCTION SIMULATOR FOR ENGINE ROOM PERSONNEL TRAINING", the developing digital automation method and technique allows faster, more accurate and precise measurements to be made, and faster decisions to be made with retrospective analysis and comments. In addition to the pressure to operate ship systems and machinery in an economical, continuous, efficient, safe, secure and environmentally friendly manner, the increase in operating costs and global competition have led ship owners to take advantage of this opportunity and direct the management of their ships from manned to unmanned management, as described in Mohit Kaushik paper.

In this context, although unmanned engine room management has been implemented on some ships in the last fifteen years, it is still too early to implement completely unmanned ship management sustainably on a global scale, as described in DNV documents. It is unclear when sustainable unmanned ship management will be implemented on a global scale. Therefore, it is certain that simulators will continue to be important in the maritime sector for a long time. Most of the Maritime institutes continue to deliver new age Engine Room Simulators, like Danish Training Institute, mentioned in Ocean Science Technology web site.

Although the simulators to be used in maritime areas are different, there are common features that all of them must have for effective training. Common features related to life and property safety such as ease of use, multifunctionality, analysis and interpretation capability, making suggestions, and providing advance warning for possible errors are gaining importance as basic factors affecting the suitability, application and acceptability of simulators. However, for successful and effective training, the manufacturer must first determine the simulator training needs of the maritime sector through qualitative analysis and definitely take into account the recommendations of institutions and teachers who are experts in their field in terms of visual design and training logic as pointed out in the papers "Role and importance of the simulator instructor" published by ScienceDirect.com. and "Effective Training with Simulation" published by The National Academies Press, (Figure 1).

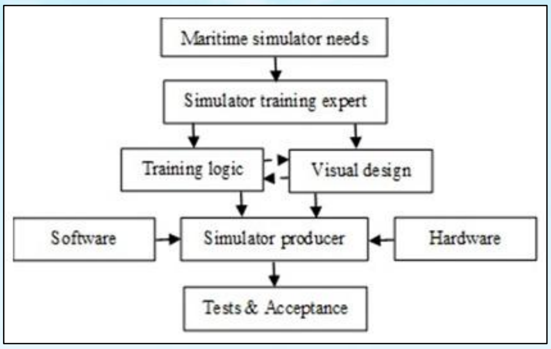


Figure 1. Common features assumed for all training simulators.

In this study the features expected from simulators, to be used in Marine Engineering education and training, was examined as a sample without specifying any brand name.

2. Research and methodology

It was predicted in this study that, the Basic Principles (P_B) cluster of any simulator absolutely covers the Easy Use (E_U), Easy Learning (E_L), Structural Design (D_S) and Functional Algorithm (A_F) concepts. (1)

$$P_B \propto [E_U, E_L]_0^n . [D_S, A_F]_0^n \quad (1)$$

Here, P_B is the set of n number of factors affecting simulator use and training, generally consisting of E_U, E_L, D_S and A_F.

2.1. Factor effecting easy use of simulators

No research on the E_U has been found in the literature. In this study, it was predicted that some factors related to command, control and system elements displayed on the screens would facilitate the use of simulators. (Table 1) (Figure 2). In the simulator visual design, drawing and preparing the command, control and system circuits and elements with the same graphic art will help the student to quickly recognize the elements and remember their functions.

Table 1. Factors facilitate the use of simulators.

1	The simulator's remote, in-place, wired, wireless, mouse, touch or voice usage method.	Selected correctly
3	All graphic works belonging to the simulator.	Simple, readable, appropriate color and 2-dimensional
4	The shape, drawing, color and placement of all remote, control and system elements.	Two-dimensional, without shadow, simple, single line framed and colored to fit the function
5	All command, control and system labels.	Readable, in appropriate size and color, technical terms comply with international terminology

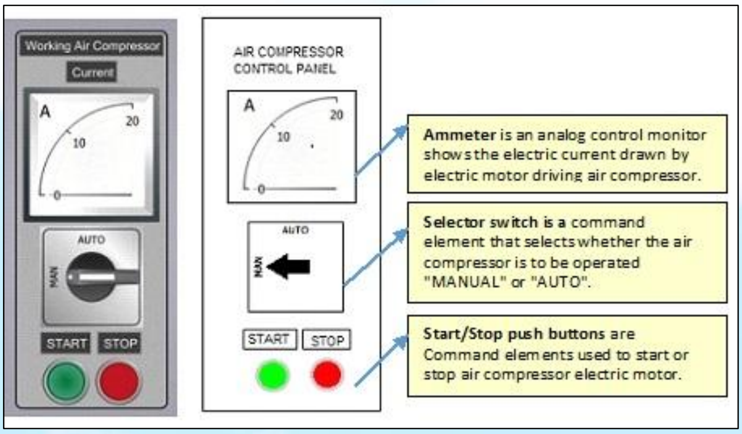


Figure 2. Refused and recommended command and control elements and pop-up text box examples.

2.2. Basic functions facilitate the learning of simulators.

No scientific surveys on this subject were found in the literature. In this study, it was predicted that the basic functions, located at the bottom of each screen, would have an impact on easy simulator learning E_L (Table 2) (Figure 3).

Table 2. Basic functions facilitate the learning of simulators

Trainings	Updatable, upgradable, selectable active lists module
Purpose	Revisable text module
Conditions	Revisable text module
Process	Revisable text module
Faults	Time base running alarms module
Corrections	Time base corrective actions module
Pausing	Instanteneous programme pausing button
Continue	Instanteneous programme continue button
Evaluation	Instanteneous training valuation module

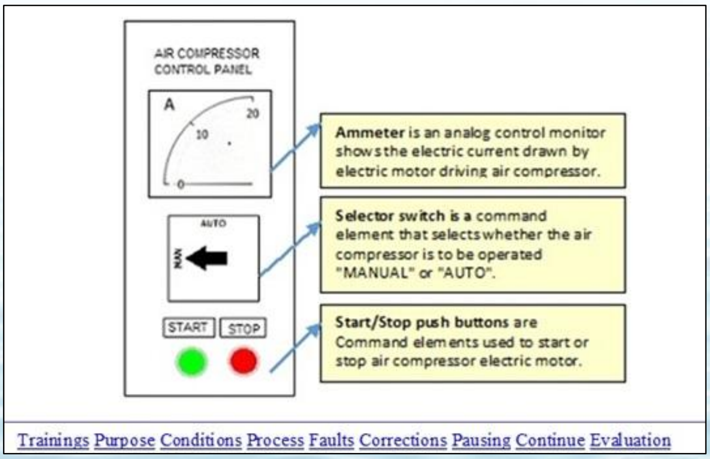


Figure 3. Graphical design of a page with basic menu.

Each function in the model envisaged in this study may have a cascade submenus that can be accessed via screen, remotely, wired, wirelessly, touch, mouse or voice, but not considered in this study. Since the screen structure will be prepared according to the same principles for the ease of education in each menu selection, the teacher and the student will not have difficulty adapting to the page structure. Graphical drawings should belong to real applications, but in some cases, explanatory drawings can also be used. The important point here is to use international technical symbols, drawings and color codes in graphical or technical drawings. The aim of this is to provide the student with the ability to draw and read technical drawings related to disciplines such as electricity, mechanics and automation, in addition to receiving simulator training.

2.3. Factors effecting the structural design of simulators.

Structural Design (D_S), assumed in this study, is the back-bone of any simulator in terms of easy teaching and learning. All systems and machinery on board ships are more-or less interconnected with each other. Preparing an overall menu for a simulator should consist of all training scenes and conditions projected for selected model ships. In the process of effective simulator training, the student's navigation between menus should be related to the main operation. While working on any device or system, navigating between very different menus causes the student to lose the main teaching topic and confuse the events. This problem is well known by teachers who have been providing simulator training for many years. While working on an integrated device or system, the student should be able to easily access the menus prepared in a meaningful order related to the topic (Figure 4).

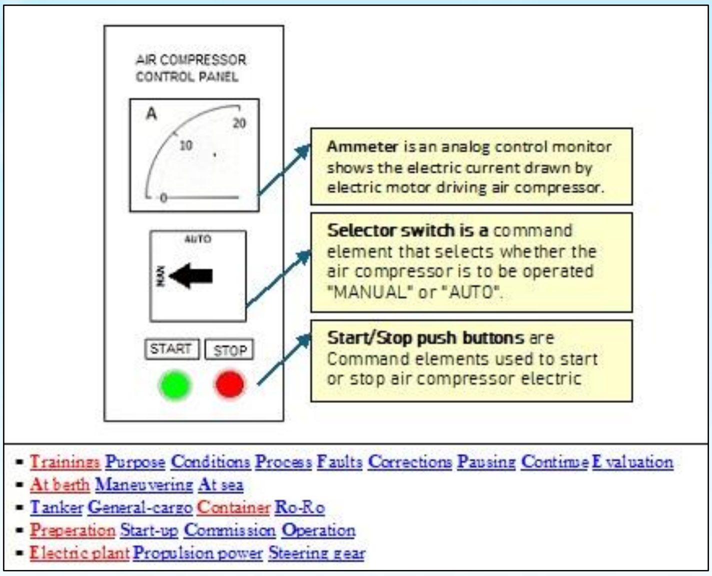


Figure 4. A sample for structural design concept of simulator.

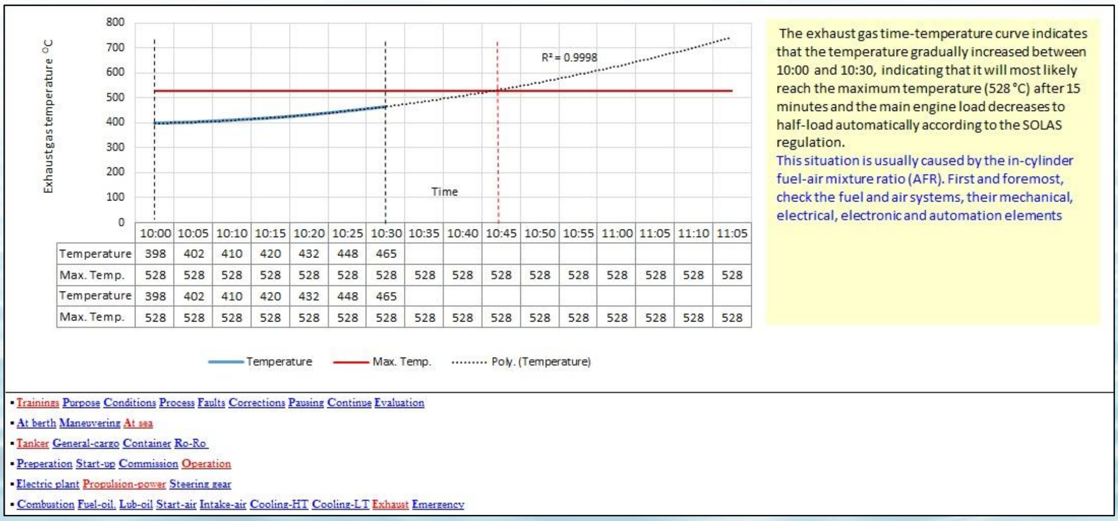
In this type of structural simulator design, the instructor and the student can easily understand which stage of the training scenario they are in. Access to the system or system elements will be accelerated by moving forward and backward between the menu options of the training scenario with triggers to be made on the links. This issue is extremely important in simulator training in terms of following which stage the event is in without breaking away from the scenario and losing the order of operations. It was predicted that this feature would only be possible with a simulator with a well-planned structure.

2.4. Factors effecting the functional algorithm concept

Functional Algorithm (AF) is the rational way to perform the operations in the training scenario planned in the simulator, in the correct order and completely, with natural or artificial events that will occur at each stage of the completed menu selections. A very simple short explanation of this phenomenon is the cylinder and exhaust gas temperature analysis. While the temperatures change depending on time in the graphics, possible error causes and solution suggestions are given in the text box that opens when desired (Figures 5 and 6). It can also be considered as a simple example of the move towards artificial intelligence. The examples given in this study can be applied in a much more advanced way to all devices and systems available on ships. The essential thing here is simulator instructors who know these systems and devices very well, know how to operate and maintain them in accordance with international laws, regulations and standards, and are familiar with ship operations.

The main point in all simulator trainings to be used in every field of the maritime sector is not to explain the machines and systems to the student for every situation, every device and every system, to teach them how to start and stop them and to evaluate their success accordingly. The task of the simulator instructor is to teach the work to be done, the working values, the situations that arise, what to do why, how and when, to make the right decision with observation, analysis and comments and to take corrective actions. Teaching the logical relationship between multi-parameter, dependent, integrated systems, their problems, how they affect each other, how to make quick analyzes to explain these situations and how to make the right decisions in the real field is real simulator training.

Figure 5. Cylinder temperature analysis.



	10:00	10:05	10:10	10:15	10:20	10:25	10:30	10:35	10:40	10:45	10:50	10:55	11:00	11:05	11:10	11:05
Temperature	398	402	410	420	432	448	465									
Max. Temp.	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528
Temperature	398	402	410	420	432	448	465									
Max. Temp.	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528

Figure 6. Exhaust gas temperature analysis.

Another important issue in simulator training is that the information on other disciplines that will form the basis of the training subject should be acquired in advance. It is impossible for people who do not have this basic information to understand the simulator training to be given. An important feature of simulator training is the need for terminology related to the training subject. Automation, electricity, first of all, science, calculus, statistics and related professional basic interests should be acquired to a certain level. The student can establish relationships between events, analyze and comment using data, make the right decisions and apply them only with simulator training that is based on solid basic training.

Today, almost everything is related to automation. Those who are responsible for operating the existing systems and devices in maritime fields economically, continuously, efficiently, safely, securely and environmentally are also responsible for their automation systems. If the command and control elements and their signals that form the basis of automation systems are well understood and used, they will be friend, otherwise a very dangerous enemy that misleads the user.

Training based on algorithmic thinking in simulators prepared with the right design, hardware and software provides significant benefits in real field applications. New generation simulators should be designed and developed completely based on these principles, away from artistic and decorative concerns. This training model should fully understood too by the authorities and the teachers (Figure 7 and 8).

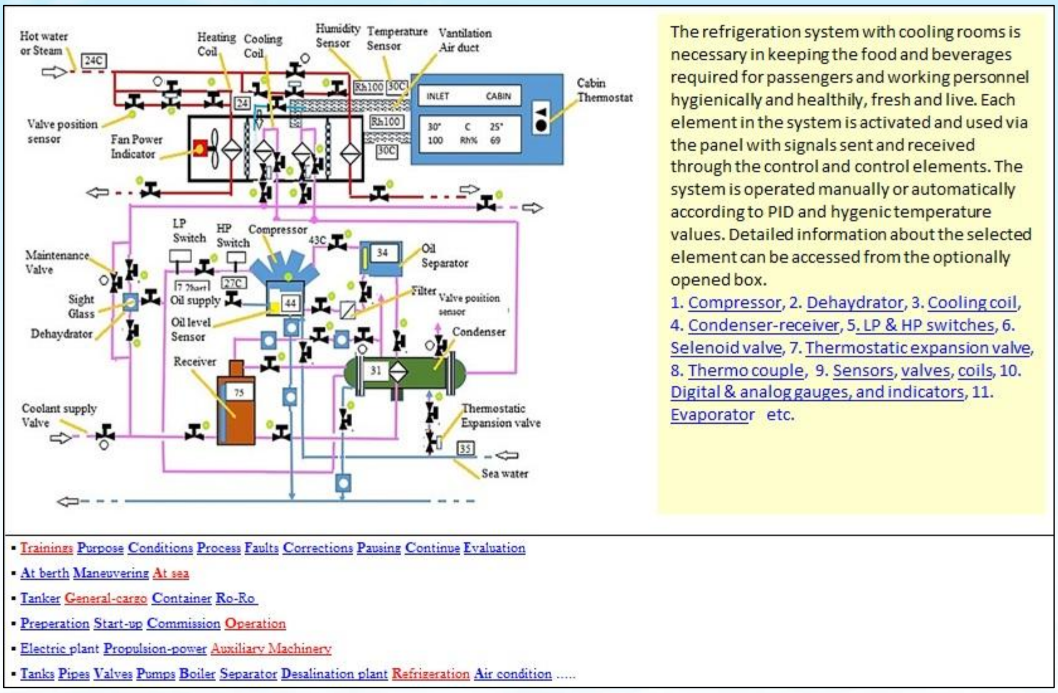


Figure 7. Refrigeration system

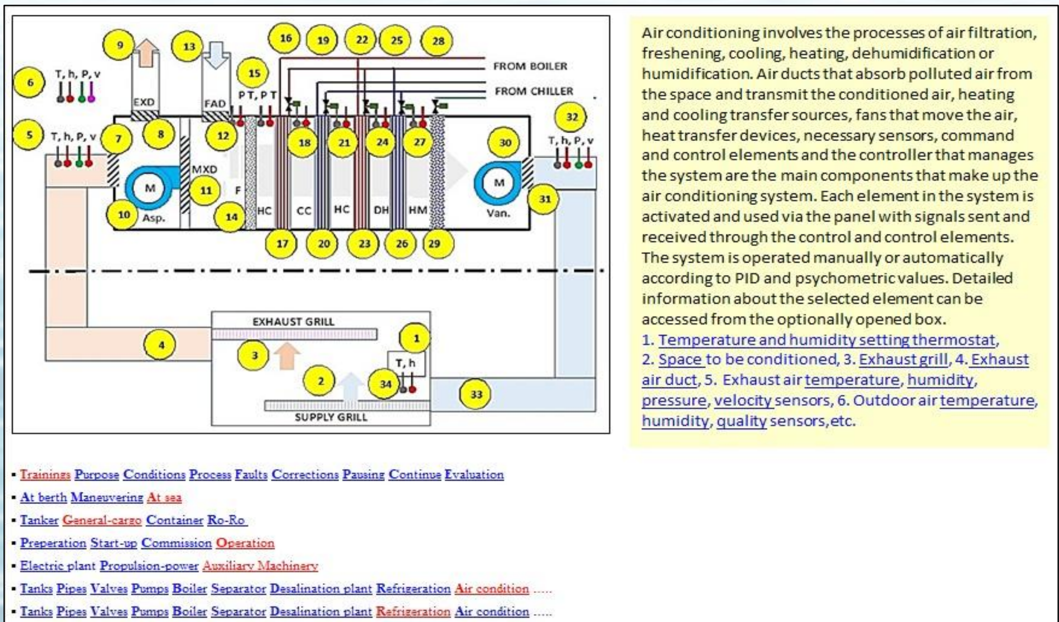


Figure 8. Air conditioning system

3. Results and discussions

The new generation simulators needed by the maritime industry definitely require Marine Engineers (MEs) with advanced up-to-date knowledge and experience about ship systems and machinery, and designers and software developers who will work in line with their needs. What is important here is that the user requests are met unconditionally by designers and software developers so that education and training can be easy, fast and effective. Only in this way can simulators produced be useful for the needy to reach their goal.

The simulator design of any machine or system should include command and control elements that can perform measurement, evaluation, analysis and interpretation operations with the desired sensitivity and accuracy. All command and control signals should be realistic and work in real time. In order to perform the necessary operations easily and quickly, administrative, financial, legal and technical main sections should be prepared under the guidance and control of expert teachers, including all submenus, and should always be visible on all screens. The simulator teacher's good knowledge of the automation algorithm will enable the student to observe and analyze the working values, establish relationships between events, make correct comments and make correct decisions. This feature will help the user to easily solve the problem through logic, especially in emergency situations.

4. Conclusion

The ever-developing digitization and automation technology enables the operations required in every discipline and field to be performed much faster, more accurately and precisely, errors to be corrected more quickly, efficiency to be increased and costs to be reduced. In order to continue these operations, personnel who have received preliminary training on the subject and have gained sufficient knowledge and experience are required. Well-designed simulators for the purpose maintain their importance as the most important tools to provide this training and experience. The desired quality operation of complex systems in every discipline and the rapid resolution of problems to be encountered are only possible with very well-designed simulators, teachers and effective training programs. For this reason, it is an inevitable fact for investors that simulator designs should definitely be prepared in accordance with the suggestions of subject-matter expert teachers. In this study, considering that it is time for manufacturers to design smart simulators, the mentioned issues were tried to be explained with a few very simple examples.

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ANALYZING OPERATIONAL ENERGY EFFICIENCY TECHNIQUES FOR REDUCING CO_2 EMISSIONS ON TANKER VESSELS

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Abstract: Air pollution and environmental effects from maritime transportation have received increasing attention during the last decades. Due to the combustion characteristics of typical main engines designed on ships and the widespread use of fossil fuels, international shipping emits significant amounts of SOx, NOx, and CO_2 particles into the atmosphere. In recent years, CO_2 pollutant has gained most attention. CO_2 emissions from ships contribute to 3.3% of all global greenhouse gas emissions. Enlarging of the world shipping fleet and building of bigger size ships, increase the amount of CO_2 emissions. CO_2 emissions from ships are expected to reach dangerous levels in the future. International Maritime Organization (IMO) has already developed some ship energy efficiency techniques and put some targets for reducing CO_2 emissions from global shipping. This study investigates operational energy efficiency techniques applied for tanker vessels based on the Energy Efficiency Design Index (EEDI). A data table was created for tanker vessels, which includes the CO_2 reduction methods and reduction rates based on available public data. As an operational technique, the impact of speed optimization for fuel consumption and CO_2 reduction for tanker vessels were analyzed. Speed reduction for tanker vessels is an option to lower fuel consumption and decrease CO_2 emissions at a relatively low cost and with little effort. In evaluation of the speed impacts on fuel consumption and reduction of CO_2 emissions, the Kongsberg Full Mission Engine Room Simulator (ERS) at USMMA (United States Merchant Marine Academy) was used in different engine modes. Fuel consumption values are evaluated in different service speeds and engine loads of the vessel. It was found that focusing on speed optimization for tanker vessels with operating ERS can be used to determine voyage times, fuel consumptions at different speeds between port A and port B. In addition, we were able to investigate the economic impact of speed optimization for tanker vessels dependent on the changes in freight rates and fuel prices.This analysis suggests that speed optimization under certain conditions is beneficial in reducing emissions, but the real effectiveness of such a scheme depends on port time, freight market rates, and fuel prices.

Keywords: CO_2 emissions; Energy efficiency; Tanker Vessels

1. Introduction

Maritime transportation is responsible for the carriage of about 90 % of all world trade. Although ship trade is the most energy efficient type of transportation, enlargement of the world fleet increases the amount of the pollutants such as; sulphur oxides (SOx), nitrogen oxides (NOx), particulate matter (PM), and carbon dioxide (CO2). The International Maritime Organization (IMO) has taken some measures to reduce SOx, NOx and CO2 emissions. Shipping, while essential for trade, contributes significantly to the emissions that cause climate change. Global shipping is responsible for 3% of worldwide greenhouse gases (GHG) [1]. The International Maritime Organization (IMO) has been applying targets for reducing CO2 emissions for future transportation since 2011. The IMO's initial strategy is to set carbon intensity goals of at least a 40% reduction in CO2 emissions per transport work by 2030, and a 70% reduction by 2050 must be met [2]. To reduce CO2 emissions, an Energy Efficiency Design Index (EEDI) was created for new ships to increase their energy efficiency and the Ship Energy Efficiency Management Plan (SEEMP) was developed for all new and existing ships to reduce fuel consumption.

However, the expansion of the international world trade and the enlargement of the world shipping fleet has also increased the amount of CO2 emissions in the maritime sector. Depending on future socioeconomic development and energy sector improvements, the study predicts that the quantity of emissions produced by shipping could rise by a range of 50% to 250% [3] In order to address this alarming concern, the IMO is planning to introduce some new regulations to reduce CO2 emissions from maritime transportation. The EEDI and SEEMP measures have been utilized in the development of techniques for reducing CO2 emissions from shipping. Application of these techniques for ships might reduce 25-75 % of CO2 gas emissions in the future [4].

Improving cost-effective operational energy efficient techniques and practices, as well as, using energy efficient technologies have high potential for reducing CO2 emissions which are normally resulting in a reduction in fuel consumption [4]. There were several studies and researches done as operational energy efficient techniques for reducing CO2 emissions. N. Rehmetulla et al investigated the implementation of technical energy efficiency and CO2 emission reduction measures in shipping. They collected data from the implementation of technical energy efficiency measures, in order to validate the different data sets with each other [5]. R.T. Poulsen et al studied how voyage planning and execution decisions affect energy efficiency and distinguishes between the commercial and nautical components of energy efficiency [6]. A. Fan et al proposed a speed-trim joint optimization method for reducing energy consumption and emissions related to ships. They estimated the propulsion power for various operating condition by numerical simulation, two-dimensional method, and ship-engine-propeller principle. Then the obtained data, consisting of ship power, draft, trim angle, and speed, were further expanded to form a joint optimization decision database using the artificial neural network method [7]. Z. Xia et al proposed a new emission reduction method, called ship scheduling with speed reduction (SSSR). Performance of the SSSR method has been tested through comparisons between the new and traditional ship emission reduction methods based on the navigation safety under different strategies [8]. Z. Wang et al studied on an optimal speed decision-making method for a coastal bulk carrier as an important energy efficiency practice. They established the ship resistance model considering the impact of multiple environmental factors, such as wind, waves and shallow water; on this basis, according to ship–engine–propeller interaction mechanism. Then, the ship speed optimization model was established and the multi-objective genetic algorithm was applied to obtain the most fuel-efficient speed set [9]. X. Li et al performed a speed optimization of a 4250 TEU container ship in which the influence of sea states and voluntary speed loss on ship sailing are considered. In this study, a speed optimization model is established for a single voyage, wherein the objectives are minimizing the main engine fuel consumption, and the ship operating costs [10].

This study investigates operational energy efficiency techniques applied for tanker vessels based on the Energy Efficiency Design Index (EEDI). A suitable data table was created for tanker vessels, which includes the CO2 reduction methods and reduction rates based on available public data. As an operational technique, the impact of speed reduction for fuel consumption and CO2 reduction for tanker vessels was analyzed. Voyage times and fuel consumption of tanker vessels are investigated in different engine types and in different fuels by studying the impact of optimizing ship speed between the Strait of Hormuz and the Port of New York and New Jersey at different speed levels annually. In addition, it was determined the fuel prices and freight rates affects on ship speed optimization for the ship operators. In the evaluation of ship speed affects on fuel consumption and reduction of CO2 emissions, the Full Mission Engine Room Simulator (ERS) at United States Merchant Marine Academy was used.

2. Operational Energy Efficiency Techniques to Reduce CO2 Emissions for Tanker Vessels

As far as ship energy efficiency is concerned, there are various techniques that can be used to reduce the CO2 emissions to the desired limits in maritime transportation. Some of the techniques can be applied to designing new vessels, and others, to modify the existing vessels. Generally, operational techniques could be applied to both new designs and existing vessels for reduction of fuel consumption. Ships do not require physical changes, investment costs and days out of service while the regular dry docking.

Applying a combination of these techniques and treating them together as an integrated solution, a truly efficient ship operation can be achieved by following the advanced vessel regulation control [11]. Thus, the focus of this research is on suggesting the applicable techniques for tanker vessels, as opposed to any other types of ships. The operational energy efficiency techniques for tanker vessels are evaluated as weather routing, trim optimization, voyage speed reduction, autopilot adjustments, turnaround time in port, energy saving operation awareness and power management.

2.1 Weather Routing and Voyage Planning

Planning vessel voyages according to expected weather has been an accepted practice for a very long time. For at least 50 years computers have been used to aid weather forecasting and evaluate simulated voyages [12] The goal of weather routing is to select an optimal course between two or more ports that provides the safest passage and reliable on-time arrival while considering actual wind, wave and current conditions expected during the voyage [13].

2.2 Trim, Draft and Ballast Optimization

Trim optimization is a significant indicator to improve fuel economy and reduce emissions. Vessel hull design is often optimized for a limited number of drafts (one or two) and zero trim. Small trim changes can cause significant differences in fuel consumption and resistance. Even lighter drafts can have a higher resistance than design if the trim is not even [14].

2.3 Voyage Speed Optimization

Ship speed optimization can be a potentially cost-effective, CO2 mitigation option for vessels. An optimal speed reduction can decrease required propulsion power and hull resistance. Less required propulsion power means lower fuel consumption and reduced CO2 emissions to the atmosphere. Roughly, a 10 % speed reduction will decrease fuel consumption by 27 %, and a 20 % speed reduction will use 45 % less fuel. These serious savings have led to substantial interest in speed reduction (i.e. 'slowsteaming'), especially when fuel prices are high [14].

2.4 Autopilot Adjustments

Efficient autopilot operations allow small deviations to course-line, but will use fewer and smaller angle rudder movements to maintain the course-line. This decreases the rudder movement and consequently reduces fuel consumption. The correct parameters or preventing unnecessary use of the rudder gives an anticipated benefit of up to 4% for all ships [15].

2.5 Power Management

The correct timing and changing of the number of generating sets is critical for the fuel consumption in Diesel Electric and auxiliary power installations. An efficient Power Management system is the best way to improve the system performance [11].

2.6 Turnaround Time in Port

The faster port turnaround time gives possibility to decrease the vessel speed at sea. Turnaround time can be reduced by improving maneuvering performance or enhancing cargo flows. This technique offers the vessel charterer, or owner, to decrease time spent in port, and possibly reduce voyage speed for fuel savings [13].

2.7 Energy Saving Operation Awareness

Energy saving operation awareness provides individuals and parties to draw on their knowledge, experiences and skills for energy efficiency onboard operations. The company, departments and the individuals in the organization should reveal the necessary expertise in energy efficiency in order to overcome difficulties in implementing of measures [16].

Table 1 was created to show all fuel consumption reducing techniques applicable for tanker vessels with CO2 reduction potentials.

Table 1. Operational CO2 reduction techniques and CO2 reduction percentages for tanker vessels [11,12,13,14].

Operational CO2 Reduction Techniques	CO_2 Reduction (%)
Weather Routing and Voyage Planning	<5
Trim, Draft and Ballast Optimization	<5
Voyage Speed Optimization	<23
Autopilot Adjustments	<4
Turnaround Time in Port	<10
Energy Saving Operation Awareness	<10
Power Management	<5

Reduction potentials of CO2 in Table 1 is arranged as the average values which are taken from various sources and studies on ship energy efficiency. According to Table 1, voyage speed optimization has the biggest CO2 reduction potential depending on speed reduction value with 23 %. However, freight rates and fuel prices would affect the cost and profit factors of the voyage. There is no need to take the ship from service while implementing this technique. However, reducing speed increases the service time of the ship to reach the port and the annual transportation capacity of the ship, therefore, is reduced. It is important that while reducing the service speed of the tanker vessel, the optimum speed reduction for energy efficiency should be analyzed. Otherwise, the company would need to buy additional ships to provide the same transportation efficiency. Such additional investment in ships would incur new investment costs and extra operational costs.

3. Ship Speed Reduction as an Operational Efficiency Technique for Tanker Vessels

Ship speed reduction can be a potentially cost-effective CO_2 mitigation option for vessels. The main principle that makes speed reduction important is that hull resistance increases exponentially as the vessel speed increases with the affects of wind, current and wave factors [17]. Reducing ship speed would necessitate longer voyage times and the need for higher number of ships. In some instances, speed reductions might be expensive since it directly impacts the freight capacity carried and the potential income. Thus, there is a trade-off between freight rates and cost. If the freight rates are low and fuel prices are high, it might be profitable to reduce ship speed.

The approach used in the study assumes a tanker vessel with different engine modes that departs from Strait of Hormuz and arrives at Port of New York and New Jersey. This study assumes two different tanker vessels that cruise between Hormuz and Port of New York and New Jersey. It is assumed that the tanker vessels have no any other ports to stop between theses ports. Each vessel has covered a total distance of 10006 nm [18] via Strait of Gibraltar from Strait of Hormuz and Port of New York and New Jersey. The fuel consumptions data due to the ship speeds are recorded by operating the ERS. It is assumed that total time at port for each trip is five days.

3.1 Collection and Evaluation of the Data

Full Mission ERS is used as a simulation of two tanker vessels. Table 2 shows the specifications of these two vessels.

Table 2. Specifications of tanker vessels.

	Tanker Vessel 1	Tanker Vessel 2
Model	SP Dual Fuel (HFO and LNG)	M22 PC T-AO-198
Engine	Steam power plant with dual boiler	Two medium speed diesels
Electric power plant	Two diesel, two turbo gensets	Two diesel, two power take off gensets
Engine power	27000kW (max)	MCR: 11760 kW
Service speed	19.5 knots	20 knots

The fuel consumption data at different speeds and loads were recorded by operating the ERS. Each vessel can be operated with different fuels and in different power generation modes. For vessel 1 (steam power plant), there are two options for operation. These are; HFO as fuel and Diesel Generator/ Turbo Generator as power generation as option 1 and HFO/LNG as fuel and Diesel Generator/ Turbo Generator as power generation as option 2. For vessel 2 (diesel power plant), there are four options for operation. These are; HFO/MDO as fuel and Diesel Generator as power generation mode as option 1, HFO as fuel and Power Take-off (PTO) as power generation mode as option 2, MDO as fuel and Diesel Generator as power generation mode as option 3 and MDO as fuel and Power Take-off as power generation mode as option 4.

Table 3. Fuel consumption of tanker vessel 1 in different service speeds with two engine mode options.

Speed (Knots)	Option 1 Steam HFO (HFO t/h)	Option 2 Steam (HFO+LNG)(HFO t/h)	(LNG t/h)
21	7.1	0	5.53
20	6.32	0	5.05
18	5.1	0.93	3.45
15	3.62	0.65	2.45
13	2.87	0.65	1.85
9	1.87	0.33	1.35
7	1.57	0.33	1.1

Table 3 depicted the changes of the fuel consumption values in seven different speeds for two engine mode options. According to the table, vessel 1 consumes only HFO in option 1. If the vessel reduces the service speed from 21 knots to 20 knots, the vessel fuel consumption reduces by 0.78 t/h in option 1. But the difference of fuel consumption value is only 1.48 t/h when reducing service speed by 3 knots from 18 knots. In option 2 vessel 1 consumes HFO and LNG. In higher speeds, vessel 1 is operated with only LNG. If the vessel reduces the service speed from 21 knots to 20 knots, the vessel fuel consumption reduces by 0.48 t/h. But the difference of fuel consumption value is only 1.0 t/h for LNG and 0.28 t/h for HFO when reducing service speed by 3 knots from 18 knots. It shows that reducing speed while operating the vessel in slower speeds is not as an efficient solution for tanker vessel 1.

Table 4. Fuel consumption of tanker vessel 2 in different service speeds with four engine mode options.

Service Speed	Option 1 Diesel (HFO+MDO)		Option 2 Diesel HFO(PTO))	Option 3 (Diesel MDO)	Option 4 Diesel MDO(PTO)
(knots)	(HFO t/h)	(MDO t/h)	(HFO t/h)	(MDO t/h)	(MDO t/h)
21	5.11	0.45	5.36	4.91	4.79
20	4.41	0.45	4.74	4.25	4.12
18	3.26	0.45	3.6	3.11	3.03
15	1.86	0.45	2.53	2.06	2.06
13	1.21	0.45	1.95	1.55	1.61
9	0.45	0.45	1.21	0.87	1.02
7	0.29	0.45	1.07	0.72	0.9

According to the table, vessel 2 consumes HFO for main engine and MDO for diesel generator in option 1, HFO for main engine with PTO in option 2, MDO for main engine and diesel generator in option 3 and MDO for main engine with PTO in option 4.

3.2 Speed regulations and limitations between Strait of Hormuz and Port of New York and New Jersey

The voyage between Hormuz and Port of New York and New Jersey has some regulations and speed limitations. In this research, the tanker vessel departs from Strait of Hormuz and sails through Gulf of Aden and arrives to Port of New York and New Jersey from Gibraltar. The routes of the vessel follow are expressed in Table 5.

Table 5. The routes, distances and speed limitations between Strait of Hormuz and Port of New York and New Jersey.

	Route	Distance (nm)	Speed Limitations (knots)
Route 1	Hormuz-Gulf of Aden	2200	No limitation
Route 2	Gulf of Aden-Bab Al Mandeb	300	> 18
Route 3	Bab Al Mandeb-Suez Canal	1900	No limitation
Route 4	Suez Canal-Gibraltar	2320	No limitation
Route 5	Suez Canal Entrance-Exit	100	< 7
Route 6	Suez Canal Exit-Gibraltar	2320	No limitation
Route 7	Gibraltar Entrance-Exit	36	< 13
Route 8	Gibraltar Exit- Port of NY/NJ	3150	No limitation

In Table 5, the voyage between two ports are separated into regions, which was mentioned as routes. It was investigated that there are some limitations because of international regulations and external factors (pirate attack risks, geography of the regions…etc.) According to the table, the vessel operates between Gulf of Aden and Bab al Mandeb Strait over 18 knots speed because of safety issues. Suez Canal has 7 knots limitations for the vessels passing through the canal. Cruise speed through Gibraltar should not be over 13 knots. All the calculations for fuel consumptions and total trip times were done depending on these speed limitations and distances

3.3 The impact of speed reduction on fuel consumption and total trip time for tanker vessels

The benefits of speed reduction factor as an energy efficiency option for tanker vessel operations can be investigated with the analysis of total fuel oil consumption and total trip time per trip. The time that the tanker vessel spends at sea depends only on speed, while the time at port depends on many factors, such as amount of cargo to be handled, loading and unloading speed, etc. For the time being, we assume that the time in port is 5 days for all port operations. The times that the vessel spends at sea and in port are expressed as follows:

$$\text{At sea: Total time at sea } T_0 = L / 24^* V_0 \text{ (days)} \quad (1)$$

L = Total distance between two ports (nm)

V_0 = Certain speed of the container ship (knots)

The hourly fuel consumption values are recorded from ERS while operating.

Total fuel consumptions at a certain speed of the tanker vessels are expressed as follows:

$$\text{At sea: Total fuel consumption per trip at sea } F = T_0 \text{ (h) } {*}24{*} \text{ f (t/h)} \quad (2)$$

T_0 = Total time at sea (days)

f = Hourly fuel consumption (t/h)

At port: It is assumed that no fuel consumption at port.

Table 6. Total voyage times and total fuel consumptions of tanker vessel 1with option 1 in different service speeds.

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption (t)	Difference of Voyage Time (days)	Difference of Fuel Consumption (t)
21	20.3	3367,31	-	-
20	21.3	3144.62	1	222.69
18	23.6	2826.68	2.3	317.94
15	28.0	2424.74	4.4	401.94
13	32.1	2227.94	4.1	196.8
9	45.8	2105.70	13.7	122.24
7	58.5	2262.24	12.7	-156.54

Table 6 suggests that voyage time increases and fuel consumption decreases as the service speed decreases. Although decreasing service speed from 21 to 20 knots saves 222.69 t fuel oil, lowering the service speed from 18 to 15 knots saves 401.94 t fuel oil in option 1 for vessel 1. Fuel saving amount is decreasing per knot when lowering the speed from 18 knots to 15 knots as there is between 21 knots to 20 knots. According to the table, reducing speed from 9 knots to 7 knots increase the fuel consumption 156,54 t. In conclusion, reducing the service speeds at lower speeds is not as efficient when analyzing the results of Table 3.

Table 7. Total voyage times and total fuel consumptions of tanker vessel 1with option 2 in different service speeds.

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption HFO (t)	Total Fuel Consumption LNG (t)	Difference of Voyage Time (days)	Difference of Fuel Consumption HFO (t)	Difference of Fuel Consumption LNG (t)
21	20.3	0	2620.01	-	-	-
20	21.3	0	2509.43	1	-	110.58
18	23.6	516.63	1912.49	2.3	-	596.94
15	28.0	436.88	1641.34	4.4	79.75	271.15
13	32.1	500.68	1440.12	4.1	-63.8	201.22
9	45.8	372.60	1515.78	13.7	128.08	-75.66
7	58.5	473.23	1582.94	12.7	-100.63	-67.16

In Table 7, reducing speed from 20 knots to 18 knots is the most efficient option. According to table, reduction of speed below 9 knots increases the fuel oil consumption. Reducing speed to lower speeds in not an efficient technique for fuel saving.

Table 8. Total voyage times and total fuel consumptions of tanker vessel 2 with option 1 in different service speeds.

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption HFO (t)	Total Fuel Consumption MDO (t)	Difference of Voyage Time (days)	Difference of Fuel Consumption HFO (t)	Difference of Fuel Consumption MDO (t)
21	20.3	2409.36	219.11	-	-	-
20	21.3	2180.77	229.37	1	228.59	-10.26
18	23.6	1795.08	254.31	2.3	385.69	-24.94
15	28.0	1248.53	302.16	4.4	546.55	-47.85
13	32.1	952.59	346.33	4.1	295.94	-44.17
9	45.8	539.60	494.64	13.7	412.99	-148.31
7	58.5	456.81	631.35	12.7	82.79	-136.17

In Table 8, reduction of service speed 21 knots to 20 knots saves 228.59 t HFO and increase the MDO consumption 10.26 t. It is obvious that diesel generator consumes 0.45 t/h for every speed. If the service speed is decreased, the time of the trip will increase and it will result in an increase in MDO consumption. According to the table, if service speed decreased from 18 knots to 15 knots, HFO consumption will decrease 546.55 t and MDO consumption will increase 47.85 t. This would be a good operational efficiency strategy for long trips depending on fuel oil prices and freight rates.

Table 9. Total voyage times and total fuel consumptions of tanker vessel 2 with option 2 in different service speeds.

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption (t)	Difference of Voyage Time (days)	Difference of Fuel Consumption (t)
21	20.3	2539.90	-	-
20	21.3	2356.43	1	183.47
18	23.6	1994.57	2.3	361.86
15	28.0	1694.71	4.4	299.86
13	32.1	1516.07	4.1	178.64
9	45.8	1368.33	13.7	147.74
7	58.5	1543.874	12.7	-175.54

In Table 9, tanker vessel analyzed with consumption HFO and PTO as power generation mode. There is no fuel consumption with PTO application for power generation. But PTO can be applied over some speeds in the operation of diesel engine. According to the table, if service speed reduced from 21 knots to 20 knots, fuel consumption will decrease 183.47 t. Reduction of service speed from 20 knots to 18 knots will provide 361.86 t decrease of fuel consumption. For this engine, it proves to be an efficient operation for long trips depending on fuel prices.

Table 10. Total voyage times and total fuel consumptions of tanker vessel 2 with option 3 in different service speeds.

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption (t)	Difference of Voyage Time (days)	Difference of Fuel Consumption (t)
21	20.3	2323.52	-	-
20	21.3	2113.19	1	210.33
18	23.6	1721.13	2.3	392.06
15	28.0	1381.93	4.4	339.2
13	32.1	1208.69	4.1	173.24
9	45.8	993.21	13.7	215.48
7	58.5	1051.73	12.7	-58.52

In this option, fuel consumptions are calculated for both main engine and diesel generator together because both of them consumes MDO. According to Table 9, reduction of service speed from 21 knots to 20 knots decrease the fuel consumption 210.33 t. If the speed reduced 2 knots from 20 knots there will be 392.06 t decrease on fuel consumption. Again, depending on fuel prices and freight rates, it would be a good option for long trips to reduce fuel consumption. In contrast, fuel consumption increased, if the service speed decreased from 9 knots to 7 knots.

Table 11. Total voyage times and total fuel consumptions of tanker vessel 2 with option 4 in different service speeds.

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption (t)	Difference of Voyage Time (days)	Difference of Fuel Consumption (t)
21	20.3	2270.28	-	-
20	21.3	2049.73	1	220.55
18	23.6	1680.84	2.3	368.89
15	28.0	1384.17	4.4	296.67
13	32.1	1255.10	4.1	129.07
9	45.8	1155.52	13.7	99.58
7	58.5	1300.77	12.7	-145.25

In Table 11, there is another PTO application for tanker vessel analyzed with consumption of MDO. There is no fuel consumption with PTO application for power generation. The PTO can be applied over some speeds in the operation of the diesel engine. According to the table, reduction of service speed from 21 knots to 20 knots decreases the fuel consumption 220.55 t. If the service speed decreased 3 knots from 18 knots, the fuel consumption will decrease only 296.67 t. This not as an efficient option.

3.3 The impact of speed reduction to number of trips of a tanker vessel in a year.

Service speed reductions decreases the annual total number of trips and increases the need for additional ships to provide the same transportation capacity. Annual total number of trips are expressed as follows:

$$\text{Annual total number of trips } T = 365 \text{ (days)} / T_0 + t_0 \text{ (days)} \quad (3)$$

T_0 = Total time at sea, t_0 = Total time at port (it is assumed 5 days)

Table 12. Number of trips due to the different speeds of a tanker vessel servicing between Strait of Hormuz and Port of New York and New Jersey.

Service Speed (knots)	Total Voyage Time (days)	Total Time at Port (days)	Total Time for a Trip (days)	Number of Trips (annually)
21	20.3	5	25.3	14.4
20	21.3	5	26.3	13.9
18	23.6	5	28.6	12.8
15	28.0	5	33	11.1
13	32.1	5	37.1	9.8
9	45.8	5	50.8	7.2
7	58.5	5	63.5	5.8

Table 12 shows the annual total number of trips between Strait of Hormuz and Port of New York and New Jersey for a tanker vessel including all routes and speed limitations. Number of annual trips decrease when the service speed is reduced.

4. Impact of Fuel Oil Prices on Speed Optimization

The changing prices of bunker fuel require cost savings by adjusting the speed optimization of ships. Reducing the cruising speed by 20% reduces daily bunker consumption by 50% [19]. Reducing ship speeds is the most effective way to reduce ship GHG emissions, however, not as effective as for reducing the cost of the trip. The extended duration of a ship's trip due to slow steaming will lead to additional operating expenditures, e.g for the vessel to cover the additional employment and insurance costs associated with the operation of more ships at any given time. [20]. In this section, it was analyzed that the total fuel oil costs of a trip with different vessel speeds in different engine options for tanker vessel 1 and tanker vessel 2. Fuel oil prices for HFO, LNG and MDO were taken from daily updated bunker price websites. In calculations, it was assumed average bunker oil prices for July-

2024. Total fuel oil costs per trip between Hormuz and Port of New York and New Jersey at a certain speed of the tanker vessels are expressed as follows:

$$\text{Total fuel oil consumption cost per trip at sea: } C_0(\text{USD}) = F^* \, c_0 \,(\text{USD/ mt}) \quad (4)$$

F = Total fuel consumption per trip, c_0 = Fuel oil price in USD per metric ton

Fuel oil prices for HFO, LNG and MDO were taken from different websites. IFO380 assumed as HFO with a price of 500 USD/mt, MGO assumed as MDO with a price of 800 USD/mt [21] and LNG with a price of 650 USD/mt [22].

Table 13. Total fuel oil costs of tanker vessel 1 with option 1 in different service speeds

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption HFO (t)	Fuel Oil Price HFO (USD/mt)	Fuel Oil Cost per Trip	Number of Trips (annually)	Annual Fuel Oil Cost (USD)
21	20.3	3367.31	500	1683655	14.4	24244632
20	21.3	3144.62	500	1572310	13.9	21855109
18	23.6	2826.68	500	1413340	12.8	18090752
15	28.0	2424.74	500	1212370	11.1	13457307
13	32.1	2227.94	500	1113970	9.8	10916906
9	45.8	2105.70	500	1052850	7.2	7580520
7	58.5	2262.24	500	1131120	5.8	6560496

In Table 13, if the vessel reduce speed from 21 knots to 20 knots, it will save 2.389.523 USD annually. if the vessel reduce speed from 18 knots to 15 knots, it will save 4.633.445 USD annually.

Table 14. Total fuel oil costs of tanker vessel 1 with option 2 in different service speeds

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption HFO (t)	Total Fuel Consumption LNG (t)	Fuel Oil Price HFO (USD/mt)	Fuel Oil Price LNG (USD/mt)	Fuel Oil Cost per Trip (USD)	Number of Trips (annually)	Annual Fuel Oil Cost (USD)
21	20.3	3367.31	2620.01	500	650	2096008	14.4	30182515
20	21.3	3144.62	2509.43	500	650	2007544	13.9	27904862
18	23.6	2826.68	1912.49	500	650	1788307	12.8	22890330
15	28.0	2424.74	1641.34	500	650	1531512	11.1	16999783
13	32.1	2227.94	1440.12	500	650	1402436	9.8	13743873
9	45.8	2105.70	1515.78	500	650	1398924	7.2	10072253
7	58.5	2262.24	1582.94	500	650	1265526	5.8	8717209

In Table 14, if the vessel reduces speed from 21 knots to 20 knots, it will save 2,277,654 USD annually. if the vessel reduces speed from 18 knots to 15 knots, it will save 5,890,546 USD annually.

Table 15. Total fuel oil costs of tanker vessel 2 with option 1 in different service speeds

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption HFO (t)	Total Fuel Consumption MDO (t)	Fuel Oil Price HFO (USD/mt)	Fuel Oil Price LNG (USD/mt)	Fuel Oil Cost per Trip (USD)	Number of Trips (annually)	Annual Fuel Oil Cost (USD)
21	20.3	2409.36	219.11	500	800	1379968	14.4	19871539
20	21.3	2180.77	229.37	500	800	1273881	13.9	17706946
18	23.6	1795.08	254.31	500	800	1100988	12.8	14092646
15	28.0	1248.53	302.16	500	800	865993	11.1	9612522
13	32.1	952.59	346,33	500	800	753359	9.8	7382918
9	45.8	539.60	494.64	500	800	665512	7.2	4791686
7	58.5	456.81	631.35	500	800	733485	5.8	4254213

In Table 15, if the vessel reduces speed from 21 knots to 20 knots, it will save 2,164,593 USD annually. if the vessel reduces speed from 18 knots to 15 knots, it will save 4,480,124 USD annually.

Table 16. Total fuel oil costs of tanker vessel 2 with option 2 in different service speeds

Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption(t)	Fuel Oil Price HFO (USD/mt)	Fuel Oil Cost per Trip	Number of Trips (annually)	Annual Fuel Oil Cost (USD)
21	20.3	2539.90	500	1269950	14.4	18287280
20	21.3	2356.43	500	1178215	13.9	16377189
18	23.6	1994.57	500	997285	12.8	12765248
15	28.0	1694.71	500	847355	11.1	9405641
13	32.1	1516.07	500	758035	9.8	7428743
9	45.8	1368.33	500	684165	7.2	4925988
7	58.5	1543.87	500	771935	5.8	4477223

In Table 16, if the vessel reduces speed from 21 knots to 20 knots, it will save 1,910,092 USD annually. If the vessel reduces speed from 18 knots to 15 knots, it will save 3,359,608 USD annually.

Table 17. Total fuel oil costs of tanker vessel 2 with option 3 in different service speeds

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption MDO (t)	Fuel Oil Price MDO (USD/mt)	Fuel Oil Cost per Trip	Number of Trips (annually)	Annual Fuel Oil Cost (USD)
21	20.3	2539.90	800	1858816	14.4	26766950
20	21.3	2356.43	800	1690552	13.9	23498673
18	23.6	1994.57	800	1376904	12.8	17624371
15	28.0	1694.71	800	1105544	11.1	12271538
13	32.1	1516.07	800	966952	9.8	9476130
9	45.8	1368.33	800	794568	7.2	5722089
7	58.5	1543.87	800	841384	5.8	4880027

In Table 17, if the vessel reduces speed from 21 knots to 20 knots, it will save 3,268,278 USD annually. if the vessel reduces speed from 18 knots to 15 knots, it will save 5,352,833 USD annually.

Table 18. Total fuel oil costs of tanker vessel 2 with option 4 in different service speeds

Service Speed (knots)	Total Voyage Time (days)	Total Fuel Consumption MDO (t)	Fuel Oil Price MDO (USD/mt)	Fuel Oil Cost per Trip	Number of Trips (annually)	Annual Fuel Oil Cost (USD)
21	20.3	2270.28	800	1816224	14.4	26153626
20	21.3	2049.73	800	1639784	13.9	22792998
18	23.6	1680.84	800	1344672	12.8	17211802
15	28.0	1384.17	800	1107336	11.1	12291430
13	32.1	1255.10	800	1004080	9.8	9839984
9	45.8	1155.52	800	924416	7.2	6655795
7	58.5	1300.77	800	1040616	5.8	6035573

In Table 18, if the vessel reduces speed from 21 knots to 20 knots, it will save 3,360,628 USD annually. if the vessel reduces speed from 18 knots to 15 knots, it will save 4,920,372 USD annually.

In the comparison of all engine options for both tanker vessels, tanker vessel equipped with diesel engine, consuming MDO and operating with a PTO as a power generation mode has the biggest fuel oil cost saving with 3,360,628 USD annually when speed is reduced from 21 knots to 20 knots. The best fuel oil cost saving option for reducing service speed from 18 knots to 15 knots is the tanker vessel equipped with a steam power plant which saves 5,890,546 USD annually.

5. Conclusion

In this study, it was analyzed that the importance of speed reduction for decreasing CO2 emissions and economic impact of the speed optimization for the profit of the shipowner is dependent on the changes in fuel oil prices and freight rates. The ERS at the USMMA was used for collecting fuel oil consumption data at different service speeds of two different tanker vessels. It was investigated that ERS can be used for calculating fuel oil consumption and fuel oil costs between two ports per trip and annually.

A tanker vessel equipped with steam power plant was operated with HFO type fuel oil and HFO-LNG type fuel oil in dual fuel engine mode. It was determined that operating this vessel in HFO-LNG mode option has the greatest benefits for fuel oil conservation. Especially, when reducing service speed from 20 knots to 18 knots, saving 596.94 t LNG per trip. This is the best option for reducing speeds for the steam power plant. In addition, steam power plant operated with HFO is better option for fuel savings at higher service speeds. It was found that HFO-LNG dual fuel engine option is the best option for overall fuel savings. Application of this option saves 5,890,546 USD annually in fuel oil costs when the speed decreases 3 knots from 18 knots.

A tanker vessel equipped with diesel engine operated with HFO type of fuel oil and MDO type of fuel oil. It was determined that the diesel engine in HFO fuel mode with diesel generator with MDO fuel mode application has the best fuel saving at higher speeds. However, if speed is reduced from 18 knots to 15 knots the fuel savings increased however, the MDO consumption increased for diesel generator. The vessel cannot be operated at higher service speeds according to the route and speed limitations. The vessel operated on MDO with diesel generator mode has the best fuel savings at medium speeds. The vessel operated with HFO as fuel oil and PTO as power generation mode has the lowest annual fuel oil cost in diesel engine simulation. At higher speeds, decreasing speed from 21 knots to 20 knots, MDO as fuel oil and PTO as power generation mode has the biggest saving with 3,360,628 USD annually. It was determined that MDO for diesel engine and diesel generator as a fuel oil option saves 5,352,833 USD for speed reduction at medium speeds annually because of MDO prices.

Theoretically, this study can be applied by vessel owner-operators to optimize the vessel speed with varying fuel prices and freight rates.

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SIMULATORS AND THE HUMAN ELEMENT

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Abstract: Published literature related to maritime technology often suggests the Human Element should not be divorced from advances within such technology. This paper explores certain of these issues in some detail. Amongst the issues debated, the increase in remote operation of simulators for training and assessment purposes is included, a situation partly created by travel restrictions during the Covid 19 pandemic. The data is largely compiled from secondary research based on published literature combined with the author's own experience of simulator training both in-person and on-line. Almost any shipboard operation will require interaction between humans. Effective communication, teamwork and leadership are arguably the most salient human factors to be involved in these operations and perhaps that is why they appear to receive such attention when debating issues associated with technological advancement. It may be argued that these may be the most vulnerable aspects of the human element when remote access is facilitated to simulators for training or assessment purposes. This paper aims to explore these human factors with the broad objective of helping the industry prepare for further transition within digitalisation.

Keywords: Human Element, Simulator Training, Remote Training

1. Ergonomics and interface

The travel and interaction restrictions brought about by the response to the Covid 19 pandemic, increased the practice of working from home (Birimoglu Okuyan and Begen 2022, p.173). To the benefit of the Maritime Education and Training (MET) sector, technological advancement facilitated most MET activity to be accessed remotely. In terms of attending classes on-line and the completion of course material, little had been compromised for the trainee and their training programmes. This included access to simulators for training and assessment purposes, whether navigating bridge, cargo or engine room simulation. In fact, the circumstances gave an opportunity for software developers to create ever more intricate control panels for the remote trainee to access. Maritime industry advisory bodies were flooded with state-of-the-art simulators, accessible remotely. The vision, creativity and entrepreneurship demonstrated by these IT technicians was truly remarkable and commendable. However, a more critical eye exposed accompanying shortcomings for the trainee, which it must be emphasised, in no way undermines the contribution of the IT sector to MET.

Having experienced and witnessed a variety of these remote access facilities, I am able to speak with first-hand experience. One aspect that struck me at an early stage of this development, was that the screen presented to the remote simulator operator, or trainee, often appeared overcrowded. What I mean by that is that there were so many control icons on a single page, that each icon was so small that they became increasingly difficult to manipulate. Of course, the interface design had to strike a balance between comprehensive visibility of what the operator needed to observe and the easy access to the relevant controls in order to complete the particular operation. Providing larger control icons on different pages of a programme may mean obliterating the very operation being managed, for example, the view from a bridge window. Where an in-built simulator in a training centre may be equipped with multiple screens, for whichever department of ship desired, this would not necessarily be the case for remotely located trainees. Most would access the simulator via a laptop, with a single screen and even those able to find a desktop PC, they would seldom find one with more than one screen. The tendency for all aspects of modern life to be facilitated by a smart phone, though ergonomically convenient, would not be practical where simulators are concerned. The screens are simply too small and though screen displays could be magnified, observation of an extremely localised area of activity, would be difficult to place within the overall context, the bigger picture, as it were, of the operation being undertaken.

As is the case with almost any technological appliance, manufacturers want to provide ever increasing 'bells and whistles' and of course distinguish their own brand from others. This does not always result in an easier experience for the end user. Such complications make life even more difficult for the instructors, who have to familiarise themselves with and ever-increasing variety of equipment. There needs to be a balance between appeal, functionality and practicality. The additional 'bells and whistles' need to be balanced with the need to enhance communication skills with shoreside parties and ship departments. Whilst trailblazing manufacturers like to demonstrate how technologically advanced their software capabilities are, it should not be forgotten that simulators are there for a purpose, in order to simulate reality. Reality involves communication, since it is unlikely any operation or activity on board a ship will be carried out in isolation. The operation will be part of an on-going plan, the stages of which need to be communicated with other departments or the shoreside terminal. It is for this reason that the technological capabilities of the simulator equipment need to compliment the human element, in terms of expedient communication techniques (Burmeister, Scheidweiler, Reimann and Jahn 2020, p.91). This leads into the next sub-topic

2. Communication, teamwork and leadership

Trainees accessing simulators remotely have the element of visual clues removed when transmitting a message, ie, speaking. Oft cited, though occasionally disputed academic guidance suggests 7% of a message is transmitted via words, 37% by intonation and 56% by visual clues such as facial expression and body language (Mehrabian 1971, p.30). Statistics aside, let us at least consider the notion that the non-verbal clues within the transmission of a message are highly significant. This rationale would suggest in person simulator course would be more effective, efficient and successful in meeting learners needs and course outcomes, than via remotely accessible simulators. When taking into account the relevance of communication within shipboard operation, be them between a navigating bridge department, engine department or cargo control room team, as would be the case during simulated exercises, then to remove these non-verbal clues would undermine the value of the exercise. Of course, practicalities have had to be considered. This paper explores the reality of MET during the Covid pandemic and all its implications against and ideal state of circumstances where training needs are more easily achieved. The real-world situation for over two years was that across the world, thousands of seagoing staff required training in bridge, engine and cargo operations, as well as other activities related to cargo work, such as the operation of cargo cranes. Instead of leaving these trainees behind, technology allowed then to continue their scheduled training by accessing such simulators remotely. The circumstances provided a motivation for the technologically gifted to trail a blaze with their highly advanced and remotely accessible simulators. The challenge was met with spectacular results enabling these vulnerable trainees to complete their training albeit from their own homes rather than training centre simulator rooms. However, not for the first time, it would be prudent to keep a check on these perceived advances. It's a case of technology blazing a trail but leaving human factors behind (Tam, Hopcraft, Crichton and Jones 2021 p.40). Observe what has resulted from the development of social media and the harm that has resulted from the 'freedoms' and technological advances. This is not to disparage advancement just to keep it in check and consider further implications.

To cite another transportation industry, autonomous road vehicles, many studies have already been undertaken to explore their practicality (Taylor and Bouazzaoui 2018, p.102) and rather like this paper, have suppressed an overwhelming expectation that humans will be removed from the operation entirely in the near future. Fatalities of both pedestrians and drivers of automated cars have been noted, so the road to autonomous vehicles, in this case, has resulted in the very outcomes the advances were designed to avoid. Whilst autonomous shipping may not be exposed to similar precarious conditions, other unfavourable outcomes might be considered. To the chagrin of remotely accessible simulators, we could end up in a situation where individual trainees who have passed any number of remote access training but have never stood next to another seafarer and exchanged information or held dialogue. The first time they do could be a traumatic experience for them, unless the Human Element, in all its subtle nuances is acknowledged. Even in a training centre simulator, with in person attendance, human interaction is considerably easier and more likely than if each participant is accessing the simulator alone from their kitchen or such like. Interaction is not impossible but is more cumbersome and thus more vulnerable to degradation.

Furthermore, it is inevitable that the very Information Technology specialists that have, to their great credit, developed such advanced simulator equipment will be involved in the significant change within the maritime industry as digitalisation expands. These individuals will harbour many qualities yet the extent to which they have been introduced to the notion of Human Factors remains a point for consideration. Even if the individuals are not involved in specific maritime operations themselves, an awareness of the importance of them within the maritime industry, as debated within this paper, will be critical.

3. Simulators and Learning

A compelling argument may be made suggesting there is one specific and focussed session within a simulator training session where most learning occurs, the de-brief. It is a session during which trainees concentrate and reflect on their own performance and one, may it be suggested, where they are most likely to learn from their own mistakes (Liu, Lan, Cui, Krishnan, Sourina, Konovessis, Ang and Mueller-Wittig 2020, p.101048)

This development even more effective when exercises can be recorded and played back. "Why did you turn to port?" "I didn't". "Yes, you did, look at the recording". Of course, this technique can be facilitated remotely as well as during in person courses, though the learning experience is likely to be accentuated with such an observation being made by the instructor in front of the trainees' peers, within a training centre, rather than remotely. As is often the case, the training and assessment needs to be related to the learners, not just their needs but the level of experience, so that the training will achieve its aims in terms of outcome. Simulators can be ideal for practice as well as training and assessment but the psychology of the student needs taking into account. They are performing in font of trainers, assessors and their peers. They will feel highly self-conscious, particularly younger students. Even more experienced students might feel vulnerable in front of younger peers, if they are uncertain. Newly qualified young learners are more resistant to learning than the seasoned professional, since they tend to focus on what they know instead of what they do not know (Aldosari, Pryjmachuk and Cooke 2021, p.103792). The experienced practitioner becomes more aware of the gaps in their knowledge, as they progress (Le Goubin 2009, p.739).

Another well documented point regarding the use of simulators within training programmes, is that whilst they most certainly assist the learner in developing technical skills, human factors and recognisable non-technical skills should also be nurtured (Sellberg 2017, p.252). The 'marketing potential' of ever increasingly elaborate simulators is but one aspect of simulator-based training. As cited already in this paper, effective use of simulators can also enhance the non-technical skills of the trainees, not just in communication skills which include leadership and teamwork but also individual non-technical skills such as situational awareness. In fact, Resource Management courses have developed considerably in the maritime field over the past few years which focus specifically on a blend of both technical and non-technical skills. Where simulators are used for assessment purposes, the criteria against which candidates are measured are inevitably dominated by the softer skills (Alavosius, Houmanfar, Anbro, Burleigh and Hebein 2017, p.142). At very least ship-owning companies have developed Bridge, Engine Room and Cargo Resource Management courses for delivery by either themselves or third-party train providers. For the sake of some consistency, the assessment of the non-technical skills follow congruent criteria across the various disciplines. Fortunately, it appears the balance between technical and non-technical skills is understood within the maritime industry where training is concerned (Praetorius, Hult and Österman 2020, p.578)

The psychology of an individual is likely to be considerably different if accessing simulators remotely as a contrast to being in a room with others. On the basis that trainees will generally seek the 'path of least resistance', based on effort versus reward (Shenhav, Rand and Greene 2016, p.1) whilst accessing simulators remotely, their minds are likely to be on the end of their shift, or session. They will not need to leave a training centre and travel home or back to an hotel, they will be at home already. The appeal of what's in the fridge, or on social media or on another TV channel will be more prominent and more likely to distract, than if they were interacting in person with their 'team' at a training centre (Galanti, Guidetti, Mazzei, Zappalà and Toscano 2021, p.e246). Training providers would do well to take this into account

4. In-person versus remote simulator access

An apposite comparison between these two contrasting scenarios and the promotion of working from home, as a response to the covid pandemic may be drawn. Psychological factors have been noted to be quite similar. Within a training context, there is a vast difference between classroom delivery and on-line access. Though technology has advanced to the degree that even operation of simulators is now possible remotely, similar concerns regarding 'group dynamic' have developed. Theories related to group versus isolated learning are nothing new and one of the most established and oft cited is Vygotsky's Zone of Proximal Development (ZPD) which may be "described as the gap between what a person can do on his or her own and what he or she can perform with the support of others, both in assessment and classroom learning environments" (Ghahderijani, Namaziandost, Tavakoli, Kumar and Magizov 2021, p.2). On this rationale, trainers and instructors will often prefer in person training since the 'classroom dynamic' can be seen to encourage students to become more engaged in proceedings.

Though this paper concentrates on access to simulator training, remotely or in-person, as the maritime industry becomes more digitalised, more operations will become remotely facilitated. My own experiences during the lockdown demonstrated some challenges and clearly, I have not been the only one to notice (Birimoglu Okuyan and Begen 2022, p. 174). More importantly, if we replace the term 'simulator' with operational equipment, as would logically be the next step forward, then all the concerns which have manifested themselves during the pandemic and the development of the working from home scenario, would re-appear. Whilst an intricate bulk liquid loading operation is about to come to completion, as a final cargo tank is loaded, the cat steps on the Emergency Stop button! Even finding a quiet space in the house proved challenging at times. One colleague with two children at home had his wife offering child-care services, not a quiet environment.

Reference to the effect of travel restrictions during the covid lockdown and the utilisation of distance or e-learning facilities in alternative industries have produced a variety of conclusions. The healthcare industry, for example, has not been idle in conducting such studies and favourable results from distance or e -learning programmes have been deciphered (Balmaks, Auzina Gross 2021, p.177). "However, there are also a few studies with negative statements gathered from the students using the e-platforms" (Co, Cheung, Cheung, Fok, Fong, Kwok, Leung, Ma, Ngai, Tsang and Wong 2021, p.e202). Amongst these negative aspects were included, poor internet connection affecting quality of video, the lack of in-person collaboration with other students, which subsequently led to a lack of concentration, motivation and active participation. Students reported finding difficulty in dedication, especially considering distractions in their remote access environment. The most frequently reported concern, amongst students, in a particular study, was the lack of personal contact with their tutor. My own experiences as an on-line tutor reflect several of these observations.

On the understanding that as technological advances have yielded more 'sophisticated' simulation equipment, partly aimed at a closer reproduction of real-world environments, then this path will be followed further as automated equipment for operational purposes is developed. Whether trainees are accessing simulators in-person or remotely, studies have consistently demonstrated that humans are prone to "automation complacency" where their own judgement is compromised due to over-reliance on digitalised information displays (Chan, Norman, Pazouki and Golightly 2022, p.125). Again, seasoned seafarers may recall how radar plotting aids and their digital assessment of 'Closest Point of Approach' appeared more compelling to a less experienced navigator than their own instinct of situational awareness would suggest. Another example of this would be an oxygen or flammable gas concentration reading on a digitised window going to four or more decimal places. The digitised figures may look alluring, yet there is no evidence to suggest they are more accurate than alternative, tried and tested means of measurement.

5. Simulators for Training

There is evidence within the published academic domain that both technical and non-technical skills can be learnt and developed via the use of simulators. What is less salient, however, is the interpretation of the distinction between the use of simulators for training and assessment. Gaps in maritime simulator training have been identified (Praetorius, Hult and Österman 2020, p.579) which have led to compelling proposals essentially linking training needs with desired outcomes, as per Biggs's Constructive Alignment (Biggs 2012, p.117). The difficulties cited by Praetorius et al (2020, p.579) might be overcome to some degree by separating training and assessment. My own experience has involved all manner of maritime related simulators, predominantly including navigating and tanker cargo simulators and the differences between two simulators purportedly designed for the same function can vary colossally. Even an experienced seafaring practitioner is going to have to familiarise themselves with any simulator before they can be trained on it. Then think of the instructor traying to come to terms with a new manufacture. By comparison, the emotive and potentially prickly non-technical skills of communication, teamwork and leadership seem far less challenging.

Just as in any other industry, equipment manufacturers like to distinguish their own brand from others, which often means a completely different interface, as cited earlier. The introduction of ECDIS (Electronic Chart Display Information System) taught navigating officers how technological advancement can present challenges. There have been frequent tales of experienced Captains having to seek the advice of more tech savvy, young, junior officers, even cadets, despite these seasoned Master Mariners having undergone their mandatory training and assessment. It would serve the industry and MET, in particular, well to recall the lessons such technological advancement taught both practitioners and instructors. As acknowledged earlier, the digitalisation of the maritime world will require the vast input, not to say patience, of IT technicians so planning and forethought of each challenge needs to be recognised long before training is promulgated.

The experienced computer end user may recall how computer operating systems on one's desktop or laptop, are purportedly 'updated' every few years. They will also recall how many glitches (malfunctions or anomalies) appeared during the early days of the roll out. The fact is that the end users were also, essentially, the testers. So complex were the fast-evolving systems that the manufacturers barely had time to 'end test' the systems before they were presented to a fashion-conscious public. Eager enthusiasts validated their passion by being amongst the first to feedback on these glitches, which much appreciated by both the manufacturers and future end users. Yet the manufacturers rarely acknowledged just how inadequate their own testing regimes were, in relation to what was genuinely required. It is not difficult to find an analogy between these systems and the type of challenge the maritime domain will encounter as digitalisation is drip fed to the practitioners. This, remember, will occur even as training programmes are being developed, let alone assessment routines. How many simulator instructors have to had to apologise to trainees for glitches whilst running programmes? After the first such incidence, trainees assume, in my experience, that an error has occurred because of such a glitch, rather than due to their own misjudgement (Wróbel 2021 p.107942).

As exciting as the digitalisation of the maritime world is, history has taught us salutary lessons in the past and we would all do well to recall such experiences (Scanlan, Hopcraft, Cowburn, Trovåg and Lützhöft 2022, p.25). The international convention related to training in the maritime domain, the Standards of Training, Certification and Watchkeeping (STCW) will need to embrace the necessary changes. Considering the previous changes to this code and convention after its inception in 1978, specifically the 1995 and 2010 changes, they will seem positively minor compared to what will be required once, for example, autonomous shipping vessels are incorporated (Shahbakhsh, Emad, and Cahoon 2022, p.14).

6. Simulators for Assessment

It is logical for training and assessment to be considered simultaneously, especially if espousing the aforementioned Constructive Alignment. Yet for reasons explained in the previous section, where simulators are concerned, it would be wise to think of the matters in isolation. Of course, training should be assessed, since there will be no evidence any change will occur in the trainees' abilities unless they are gauged. Yet a case can be made that, in line with the STCW 1995 changes, that some type of training is appropriate for junior staff, oft referred to as Operational Level training, whilst senior staff will take the more advanced Managerial Level training and this is where apposite assessment is most important.

As has been articulated earlier, Resource Management training and assessment has long been established in the maritime industry, in its various forms dependent upon which 'part of ship' is under scrutiny, bridge, cargo or engine room. This arguably is the most salient representation of how assessment may differ from training, with regard to the use of simulation. Though appropriate human factors, such as the willingness to contribute to teamwork and the effective use of communication are essential at all levels, a case can be made that leadership and management skills and the ability to perform under stress, are more likely factors to be expected at senior levels. Of course, it is a common observation that many soft skills, as detailed earlier, cannot be taught. But at the suggested Management level of training, assessments can incorporate gauging of these soft skills expected to be demonstrated by senior officers. It is worth emphasising here that perhaps less emphasis will be placed upon assessment of the technical ability to operate the simulation equipment and more on the soft skills required to lead a team into completing a task successfully, safely and without threat to the environment.

This stems back to the problem highlighted earlier where seasoned Captains have to rely on the technical ability of their 'tech savvy' junior officers to operate new, computerised equipment such as the ECDIS. Assessors will need to ensure they are focussing on the relevant skills. A management level candidate may point to the course assessment criteria, if devoted to soft skills, even if they fail to be able to operate the equipment capably. Assessors will need to be confident the assessment criteria produced matches the expectations of the institute concerned. They cannot fail a candidate if they do not appear to be confident in the operation of the simulator equipment if the only assessment criteria listed are related to the demonstration of soft skills (Ernsten and Nazir 2020 p. 104775).

There is certainly a psychology involved in assessing with simulators. Candidates often expect drama from the start of an exercise and will take some kind of action even if not necessary, simply to demonstrate the fact they are paying attention. For example, some bridge exercises can be completed successfully without the need for any alteration of course or speed. The decision to be made is not to take any action. Under similar circumstances, a simulated cargo operation may involve distractions and minor malfunctions. Though the tension may increase gradually, the decision to stop operations completely, what might be called Emergency Shut Down (ESD) in the tanker trade, may buy the candidate time but does not allow them to demonstrate an ability to deal with each distraction. Naturally, safety must never be compromised but repeated activation of shut-downs do not suggest the candidate possesses sufficient acumen to be able to run an operation without such minor events to confront and manage. Senior employees will be expected to take into account a degree of commercial concerns, as well as an overriding responsibility for safety.

Conclusion

The digitisation of the maritime industry is an on-going and has gained unstoppable momentum. However the term is defined and whenever it first started is still a matter of debate but as each change occurs, it is incumbent upon the practitioners of the industry to embrace these changes (Mallam, Nazir and Sharma 2020 p.334) Perhaps more than ever, the involvement of Information Technician (IT) staff will be greater than has been experienced in the past with existing changes, particularly if controlling equipment or even entire ship remotely. If the practitioners of the industry on board ship and ashore are to adapt to a new digital environment, an awareness of the challenges that lay ahead will be of value. This paper has endeavoured to highlight some of the issues that previous experience has taught us. In particular, it deals with the use of simulators and the difference in group dynamics between remote and in-person access. If the term digitisation means anything at all, the implication of remote access is inescapable. Recent experience has been of value in judging how future challenges may be addressed.

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THE IMPORTANCE OF INTERDISCIPLINARY EDUCATION IN THE DESIGN OF FLOATING STRUCTURES: NAVAL ARCHITECTURE AND MARINE ENGINEERING AND ARCHITECTURE COOPERATION

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Abstract: Climate change and the need of new terrestrial settlements on the earth increase the interest in living above and underwater. This situation causes new needs in building types and vessels. It is anticipated that a single discipline will be insufficient in terms of education and practical application in the design of floating structures for new needs, and it is expected that the Architecture and Naval Architecture and Marine Engineering Departments will come in interaction. An Interdisciplinary Project 1 course was created at Yıldız Technical University in order to bring together Architecture and Naval Architecture and Marine Engineering students on a common platform. The aim of the course is that students from both disciplines work in teams and produce projects of floating structures and vessels for the use on surface or underwater. In this study, the aim, content, application and outcomes of the course which is successfully carried out since ten semesters is presented and the contributions of the course to the teamwork, communication and design approach of the students are discussed.

Keywords: Naval Architecture and Marine Engineering education; engineering education, Architecture education, floating structures, underwater structures

1. Introduction

The exhibition space for architectural activity is the Earth. People have used the surface of our planet, and rarely some natural formations related to the surface, to construct various types of buildings, which are complex organizations formed by the combination of spaces that accommodate their various needs.

Until very recently, the surface and especially the depths of the sea were never considered as living spaces, and architects never regarded these parts of the planet as potential areas for architectural activity. However, it has now become a common belief that the world, with its increasingly insufficient resources, can no longer ignore these previously overlooked areas. The surface of the globe covered by seawater, although not very deep, and the total surface area covered by seas is approximately three times that of the current terrestrial areas. Naturally, for a world with a rapidly growing population and beginning to experience resource shortages in every aspect, these areas are now inevitably being considered as potential spaces for agriculture, mining, settlements, etc. The knowledge, experience, and skills acquired during architectural education are very inadequate for designing and constructing buildings in extraordinary areas such as the sea surface and especially under the sea. To achieve this, architects must seek support from different disciplines and even collaborate with them. Architects can be equipped with fundamental knowledge from various disciplines, and this level of knowledge can only meet the minimum requirements for collaborative work with different disciplines. However, this knowledge can never be large enough to enable architects to solve the design problem entirely on their own.

Water structures can be categorized into three main groups based on their characteristics:

Floating Structures

- Floating structures with their own propulsion system.
- Floating structures without their own propulsion system.

Semi-submersible Structures

- Semi-submersible structures partially resting on the seabed.
- Fully floating semi-submersible structures.

Submersible Structures

- Submersible structures with the ability to relocate.

- Submersible structures without the ability to relocate.

Knowledge necessary for designing floating structures but not included in architectural education [1,2]:

Designing structures in water environments, which can be seas or large lakes, is impossible for an architecture student or an architect who has not specifically trained in this area with the current classical education curriculum and course content. The main components of the missing knowledge in this context are listed below:

- The physical limits of the human body (resistance to pressure, metabolic reactions in cases of sudden pressure increases or decreases).

- The psychological limits of the human body.

- Material behavior in extreme conditions.

- Structural design.

- Safety issues and solutions (partition system and water drainage).

- Life support.

- Electromechanical equipment.

- Sanitary installations.

- Oxygen supply in submersible structures.

- Meeting maritime and atmospheric requirements in floating structures (corrosion and storm resistance).

- Energy supply.

- Transition between different pressure areas in the operational use of submerged structures.

- Housing vehicles in submerged structures and their access to the sea.

- Problems in securing supplies.

- Emergency escape, fire protection.

- Stability issues of structures.

- Requirements to keep submersible structures on the seabed.

- Pressure, tension, buckling, and torsion moments.

- The importance of geometry in hull shaping and shell design.

- Insufficient knowledge about materials used in construction, such as reinforced concrete, steel, acrylic, glass, and carbon fiber.

Knowledge necessary for designing floating structures but not included in Naval Architecture and Marine Engineering education [3]:

Similar knowledge and skill deficiencies are also present for students and professionals in the naval architecture and marine engineering discipline. These deficiencies are as follows:

- Knowledge about the use of concrete as a material

- The difference between structures and vehicles

- Continuity of the structural system

- Selection of the structural system

- Space design

- Space organization

- Circulation within the building

- Fittings

- Actions not present in vehicles and specially organized spaces for these actions

- The physical limits of the human body (resistance to pressure, metabolic reactions in cases of sudden pressure increases or decreases)

- The psychological limits of the human body

- All dimensions of the human body

- Ergonomics
- User psychology
- The functional roof of the building
- Safety requirements
- Knowledge about many different types of buildings
- Oxygen supply in submersible structures
- Transition between different pressure areas in the operational use of submerged structures
- Housing vehicles in submerged structures and their access to the sea
- Problems in securing supplies
- Emergency escape, fire protection
- Requirements to keep submersible structures on the seabed
- Pressure, tension, buckling, and torsion moments
- The importance of geometry in hull shaping and shell design
- Insufficient knowledge about materials used in construction, such as reinforced concrete, steel, carbon fiber, acrylic, and glass

As can be seen, designing and constructing floating structures requires a knowledge base that goes beyond the principles of both disciplines. It is evident that the existing knowledge in both disciplines is insufficient, especially for designing and building submerged structures. Therefore, it is inevitable to seek assistance from other disciplines [4]. However, it is also clear that students in both fields need to be familiar with fundamental principles from various disciplines to design conceptual projects effectively. This knowledge could be acquired by incorporating some elective courses into the program. In this case, working groups composed of architecture and naval architecture and marine engineering students could participate as designers in the process of producing conceptual projects for floating, semi-submersible and submersible structures. They could then reach a level where they can produce preliminary projects and later seek assistance from different disciplines for the implementation of the projects.

2. Design of the Interdisciplinary Project Course Architecture and Naval Architecture and Marine Engineering

This section presents the objectives, content, process and outcomes of the interdisciplinary project course designed for Architecture and Naval Architecture and Marine Engineering students in Yıldız Technical University. This elective course has been available each semester since the Spring 2020 semester and has been conducted for ten semesters. The goal of the course is to enable students to create and develop a collaborative project in floating structure design, leveraging interdisciplinary knowledge from both the Department of Architecture and the Naval Architecture and Marine Engineering program.

This course provides a comprehensive overview of floating structures, integrating insights from both the Naval Architecture and Marine Engineering and Architecture departments. It covers essential topics such as space and ergonomics in small and restricted areas, reinforcement, and materials used in surface-floating environments. Students explore floating space designs on both micro and macro scales, including parametric surface designs. The course also includes fundamental concepts of naval architecture, focusing on small-scale floating structures. Key aspects include design expression, determining design requirements through the design spiral, basic construction methods, design standards, and the equipment and materials specific to floating structures. Additionally, it addresses the general characteristics of vessel types, form design, and engineering calculations essential for effective design and implementation.

The course begins with an introduction to floating structures, exploring their significance within the fields of Naval Architecture and Marine Engineering, as well as Architecture. In the initial weeks, students are grouped, select topics and themes, and engage in job sharing (Table 1). They then move on to sketch drawing, which serves as a foundation for their design work. Subsequent weeks will cover key areas such as space and ergonomics in small and restricted areas, and the use of reinforcement and materials in surface-floating environments. Students will also explore floating structures designs from micro to macro scales, including parametric surface designs. As the course progresses, participants delve into fundamental concepts of naval architecture, focusing on small-scale floating structures, design expression, and the determination of design requirements through the design spiral. The curriculum includes a review of basic construction methods, design standards, and materials specific to floating structures. A midterm examination is conducted in Week 8, followed by continued development of joint projects by student groups in Weeks 10 through 14. The course culminates in a final presentation of these projects in Week 15.

Table 1. An example of student groups topics and team information from spring term 2022

Gr. Nr.	Project Topics	Place	Condition	Architecture Student	Naval Architecture and Marine Eng Student
1	Underwater art gallery	Sivri Ada	Submerged	1	3
2	Underwater gym	Heybeliada	Submerged	1	4
3	Boutique hotel	Burgazada	Floating	1	3
4	Boutique hotel	Sivri ada	Floating	1	3
5	Floating village	West of Kargı Bay	Floating	1	3
6	Research center	Prince Islands	Submerged	1	4
7	Polar research center	South Pole	Floating	1	3
8	Restaurant	Büyükada	Floating	1	3
9	Center of art and culture	Sivri Ada	Floating	1	3
10	Research center	Bozcaada	Floating	1	3
11	Research center	Inside of Sivri Ada Breakwater	Submerged	1	3

This course aims to provide students with a robust understanding of design processes across both Architecture and Naval Architecture. It is aimed that participants gain in-depth knowledge of floating platforms addressing the specific challenges and solutions associated with these fields. By engaging in interdisciplinary studies, students will experience collaborative approaches that enhance teamwork and integration of diverse perspectives. The course guides students in creating a structured roadmap for managing interdisciplinary project processes, ensuring effective collaboration and project execution. Ultimately, it is aimed that students develop the skills necessary to conceive and implement interdisciplinary joint projects, promoting innovation and strategic problem-solving.

3. Examples of Projects conducted within the Interdisciplinary Project Course

In this section, examples of each type of water structure mentioned in the previous section are presented, drawn from student projects completed during various semesters of the course.

3.1. Floating Structures

3.1.1 Floating structures with their own propulsion system

Figure 1. Floating restaurant.

3.1.2 Floating structures without their own propulsion system

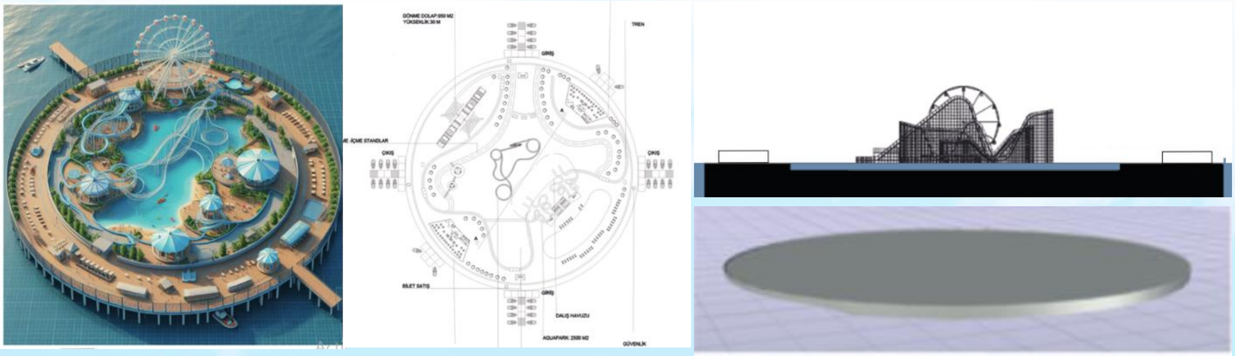

Figure 2. Floating entertainment center.

3.2. Semi-submersible Structures

3.2.1 Semi-submersible structures partially resting on the seabed

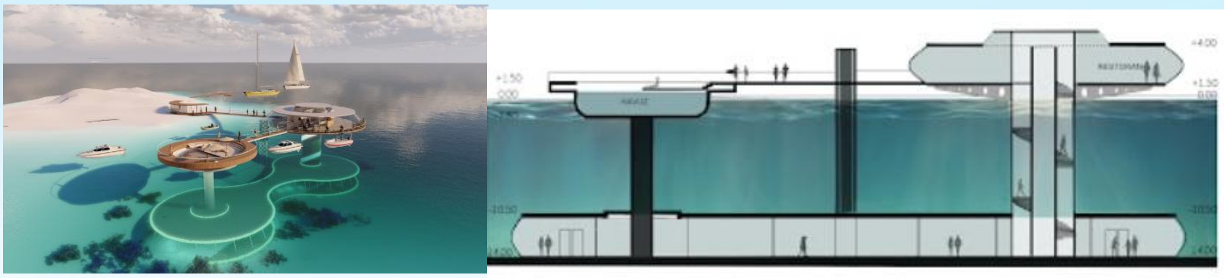

Figure 3. Semi-submersible boutique hotel.

3.2.2 Fully floating semi-submersible structures

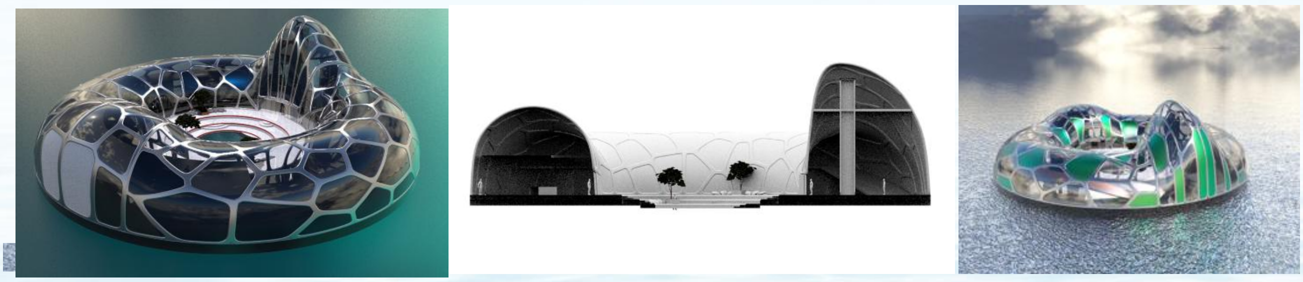

Figure 4. Semi-submersible museum.

3.3. Submersible Structures

3.3.1 Submersible structures with the ability to relocate

Figure 5. Subcarrier project.

3.3.2 Submersible structures without the ability to relocate

Figure 6. Submerged boutique hotel.

4. Feedback from students

The feedback from students are analyzed in order to improve the functioning of the course. A survey is conducted with the following questions in spring term 2021.

1. Do you think the number of class hours for the Interdisciplinary Project 1 course was sufficient for the project you worked on?

2. How was the communication you established within your group at the beginning of the term?

3. How was the communication you established within your group at the end of the term?

4. Do you think you were able to understand the other discipline well enough?

5. Do you think you were able to benefit from the design approach and knowledge of the other discipline?

6. Did the course meet your expectations?

7. Would you be interested in pursuing a Master's thesis on a topic that covers floating structures?

The answers are listed as presented in Figure 7 where the color blue stands for poor, red for mediocre, orange for sufficient, green for very good and purple for excellent.

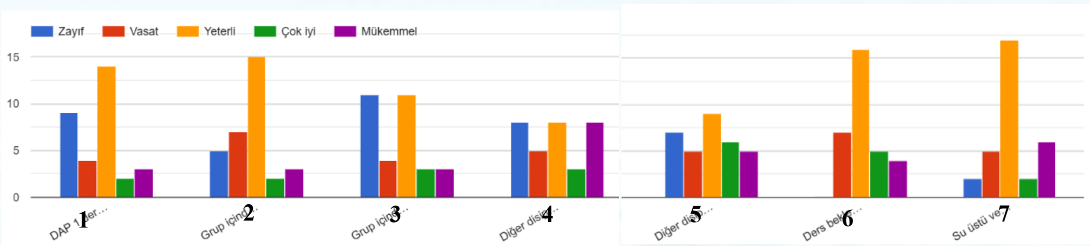

Figure 7. Answers from Spring semester 2021

Most students expressed that the course met their expectations and that they would be interested in pursuing a master's degree focused on floating structures.

The responses to the question, 'What can you say about the advantages of group work?' can be summarized under the following headings:

Collaboration: Working together enhances results and fills individual gaps.

Task Management: Timely and correct task execution by group members leads to positive outcomes.

Complementary Skills: Group work helps in completing each other's deficiencies and benefits from diverse perspectives.

Team Dynamics: Learning to work as a team, managing mistakes, and learning from them is crucial.

Communication and Coordination: Effective communication and task distribution are essential.

Mutual Support: The collaboration between departments helps in identifying and addressing deficiencies.

Learning Opportunities: Joint efforts aid in learning and personal growth, adapting to different viewpoints, and benefiting from each other's knowledge.

Patience and Time Management: Group work teaches patience and efficient time use.

Professional Experience: The experience gained is valuable for future careers.

Efficient Workflow: Distributing tasks among team members, such as rendering, 3D modeling, and documentation, allows for productive parallel progress.

The disadvantages of group work mentioned can be summarized as follows:

No Major Disadvantages: Some respondents did not find any disadvantages.

Mistakes and Stubbornness: Mistakes by group members, especially when stubbornly defended, can lead to issues.

Communication Issues: Poor communication and members not fulfilling their responsibilities can cause delays.

Unequal Effort: Some group members put in less effort than others.

Conflict: Occasional heated arguments and disagreements.

Responsibility Imbalance: Some members have to cover for those not taking responsibility.

Scheduling Difficulties: Finding mutually available time for group work can be challenging.

Uneven Work Distribution: One discipline may end up doing more work, especially if technical knowledge is lacking.

Online Communication Problems: Difficulties in communication due to the online nature of the work.

Disparity in Numbers: An uneven number of students from each discipline can create initial communication challenges.

Lack of Design Knowledge: Expecting students from one discipline to work on design without adequate training.

Dependence on Others: Relying on group members and taking on the responsibility of those not working.

Motivation Issues: Communication problems can lead to decreased motivation.

Non-contributing Members: Some members may not contribute effectively.

Slow Progress: The process can be slow to reflect everyone's input and performance.

Inconsistent Quality: Inconsistent effort and quality of work among group members.

These responses are used to refine and organize the course in future semesters to enhance students expectations and better organize the workflow.

5. Conclusions

Climate change and the need for new terrestrial settlements have heightened interest in living above and underwater, leading to new building and vessel requirements. Recognizing that a single discipline is insufficient for designing floating structures, Yıldız Technical University established the Interdisciplinary Project 1 course to unite Architecture and Naval Architecture and Marine Engineering students. The course aims to have students collaborate on projects for surface and underwater structures designs. This study presents the course's objectives, content, implementation, and outcomes, highlighting its contributions to teamwork, communication, and design approaches among students over ten successful semesters.

Acknowledgements

The authors would like to express their gratitude to Assistant Professor Derya Güleç Özer, Associate Professor Bekir Şener, and Assistant Professor Hande Düzgün Bekdaş for their invaluable contributions to the development of this course. Special thanks are extended to the first two for their significant input during the initial semesters.

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THE INNOVATION CULTURE AS A FACTOR FOR SUSTAINABLE DEVELOPMENT OF THE MARITIME SECTOR

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Abstract: The achievement of the goals for sustainable development in maritime transport, the challenges faced by the modern business environment and the digitalization of the maritime sector are factors that require a transformation in the thinking and behavior of employees. Our main thesis is that creativity related to new ideas, as well as the successful implementation of innovations - economic, technological and social, depend on the innovative organizational culture. In this regard, the paper aims to present the tools to increase the innovation capacity and culture of employees in the maritime sector as a necessary condition for achieving the goals for sustainable maritime transport.

Keywords: sustainable practices in the maritime sector; innovation culture; innovation tools

1. Introduction

The transformation of the maritime industry due to global climate change, digitalisation, decarbonisation, military (terrorist) conflicts and efforts to achieve sustainability focus the efforts of scientists and practitioners on new trends in the development of knowledge and practices of innovation and entrepreneurship [Lloyd's Register et al. 2017; Lam et al. 2020]. In response to the new ecological, social and economic challenges, the application of innovative models for the sustainable functioning of maritime organizations is required, through which the improvement of the well-being of employees and communities, the protection of the environment and the efficient growth of the wealth of companies are aimed [Empyrea Consulting 2024]. The innovation culture has a significant contribution to the achievement of sustainable development goals in the maritime sector through cooperation between stakeholders, creativity, ingenuity and innovation.

In this regard, the paper aims to analyze the threats and tools to increase the innovation capacity and culture of the maritime organizations as a necessary condition for achieving the sustainability goals of the maritime industry. To achieve this goal, the research sets the following tasks:

- First task: to justify the interdependence and interrelationship between the UN's sustainability goals and the implementation of modern technologies to apply sustainable maritime practices and realize sustainable business models.
- Second task: to reveal the obstacles and threats to the innovation culture in the maritime sector.
- Third task: to suggest measures to increase the abilities, knowledge and motivation for innovations by applying targeted interdisciplinary methods and approaches: formal and informal lifelong learning, development of new soft and hard skills, creative techniques, application of the principles of innovation management and culture.

In order to achieve the last two tasks, pilot in-depth interviews were conducted with the management of 20 innovative companies located in the North-East region of the Republic of Bulgaria. The subsequent analyzes predetermine guidelines, summaries and conclusions regarding the achievement of the goals for sustainable development of the maritime transport.

2. Relevance of the study

The global maritime industry occupies its significant place in the international trade. Serving over 80% of the world's merchandise volume, it is a complex industrial sector that is characterized by the vertical and horizontal interrelationship of various participants in transport, logistics, regulatory, engineering, information, financial and insurance activities. [GHADERI 2020] In today's society, there is growing concern about the impact of the maritime industry on the environment, as a result of which it is under increasing pressure due to its environmental footprint. [Empyrea Consulting, 2024] The reason for this is the direct connection of the sector with some of the 17 goals for sustainable development until 2030, adopted by the member states of the United Nations, among which [Sornn-Friese et al. 2021]:

- Goal No. 6 “Clean water and sanitation” aims at sustainable water management. To achieve it, the UN calls for the reduction of water pollution and the protection of ecosystems that depend on water;

- Goal No. 9 “Industry, innovation, infrastructure” is related to building a sustainable infrastructure and achieving sustainable industrialization through the production of high-tech products. The technological improvement in the maritime industry is also directly related to SDG No. 9;

- Goal No. 11 "Sustainable cities and communities", through which the UN appeals for the development of safer settlements by improving air quality and monitoring and controlling waste management. This goal also covers the reduction of water and ocean pollution;

- Goal No. 13 “Tackling climate change” focuses efforts on tackling climate change and its impacts. Maritime companies can contribute to its achievement by monitoring air quality and taking measures to reduce its pollution;

- Goal No. 14 “Life under water” aims at preventing marine pollution to protect marine coastal areas and ecosystems.

In connection with the set goals for sustainable development, it is imperative that companies engaged in the maritime sector take actions to develop their sustainable profile. There are strong arguments for this, related to the complexity of the business environment and the growing pressure in three directions [Serra et al. 2020; Chhabra 2022]: regulatory and institutional pressure; market factors and resource availability; social pressure, environmental awareness and responsiveness. The companies’ sustainable profile shall ensure the implementation of alternative energy sources, technological advancement and commitment to sustainable practices. At the same time, it shall ensure the protection of the welfare and rights of seafarers.

The sustainable practices in the maritime sector are essential as they have a significant impact on the environment, economy and society. The need for them is becoming more urgent especially in the context of growing environmental problems and the associated stricter environmental regulations. [IMO 2013; SINAY 2023] The expectation is that environmental, social and management performance reporting will become a key priority for the industry, providing companies with a framework to declare and measure their ethical impact on the society and the environment. The contribution of sustainable practices to overcome environmental, economic and social challenges can be illustrated in Table 1.

Table 1. Contribution of sustainable practices in the maritime sector to overcome environmental, economic and social challenges of the business environment

Indicator:	Challenges	Contribution of sustainable practices
Environmental	Greenhouse gas emissions and hydrocarbon footprint	Use of cleaner fuels, implementation of energy efficiency measures, use of renewable sources
	Pollution of the marine environment (oil spillage, sewage discharge, release of harmful chemicals)	Improved waste management, introduction of stricter regulations and implementation of environmentally friendly technologies
	Overfishing, destructive fishing practices, habitat destruction	Sustainable fishing methods, marine protected areas; ecosystem approach in the management for the protection and conservation of biological diversity
Economic	Increased fuel consumption from non-renewable energy sources	Deploying energy efficient vessels and land vehicles, resulting in reduced operating costs
	Reluctance to finance unsustainable activities	Opportunities to attract investment and funding from governments, organizations and consumers that prioritize green initiatives
	Lack of environmental norms	The introduction and compliance with international regulations and environmental standards open up enterprises’

		access to markets with strict requirements, which provides them with a competitive advantage.
Social	Increased fuel consumption from non-renewable energy sources	Deploying energy efficient vessels and land vehicles, resulting in reduced operating costs
	Reluctance to finance unsustainable activities	Opportunities to attract investment and funding from governments, organizations and consumers that prioritize green initiatives

Note: Adapted from [Sornn-Friese et al. 2021]

Innovation and entrepreneurship stand out as key areas in the maritime industry for the application of sustainable practices. Innovation is perceived as one of the main factors for the success of the industry in the future. To ensure the competitiveness of the sector through innovation, it is necessary to develop the innovative corporate culture that stimulates innovation and removes obstacles to maritime enterprises [Kalinova 2023]. On the other hand, it is necessary to unleash the potential of entrepreneurship to create strong sustainable innovations and models [Chhabra 2022; Stefanova, Kanev 2022].

Innovation culture as knowledge and practice has gained particular popularity and significance after the eighties of the last century. Despite the critical mass of research on the subject, science is in debt to study the category of interest to us through the prism of maritime business [Lutzkanova, Mednikarov, Chesnokova 2022]. There is a number of neglected opportunities which the application of innovation culture tools can reveal to maritime companies in view of the growing changes of the modern business environment to achieve the goals of sustainable development, innovation and creativity [Chandler, Krajcsák 2021]. Nowadays, the innovation culture has not only economic, but also strong ecological and social importance as sustainability priorities. [Narlev 2016]. In this regard, for the purposes of this study, the innovation culture will be defined as a dynamic organizational category – a set of cultural elements: values, norms, traditions and practices to achieve sustainable goals and innovation in the maritime organizations.

3. Methodology of the study

The choice of methodology refers to the need to study and analyze the innovation culture as a factor to achieve the sustainability goals. The object of research are managers of 20 innovative companies with many years of experience in the maritime business on the territory of the North-Eastern Planning Region of the Republic of Bulgaria. The pilot study - in the form of structured, in-depth interviews - was conducted over two years (2021 - 2023) and included two research panels. The first panel establishes the companies' sustainable innovations in social, economic and environmental terms. The second panel aims to identify the threats and tools to increase the innovation capacity and culture of the maritime organizations as a necessary condition to achieve to a greater extent the sustainability goals of the maritime sector.

A statistical software product XLSTAT 2024 is used to identify and analyze dependencies between the factors of interest. This product has been chosen due to its objective capabilities for appropriate analyzes that contribute to a better understanding of the role of the innovation culture and the context in which the variable is realized.

4. Results from the study

A primary task of the study is to establish the innovations of the management employed in the maritime sector to achieve the goals of sustainable development. The results (Figure 1) of the survey carried out show that 60% of the corporations have realized goals aimed at environmental responsibility: these companies prioritize responsible practices that apply the principles of the circular economy, reduce carbon footprint and protect scarce and valuable resources. 50% of the respondents declare implementation of innovations corresponding to social equality: respect and strengthen human rights, ensure fair labor practices, support human resource development, promote diversity and inclusive workforce. 80% of the companies apply innovations regarding economic efficiency. 65% of the respondents show stakeholder engagement: from direct participants in the maritime sector to local and central government.

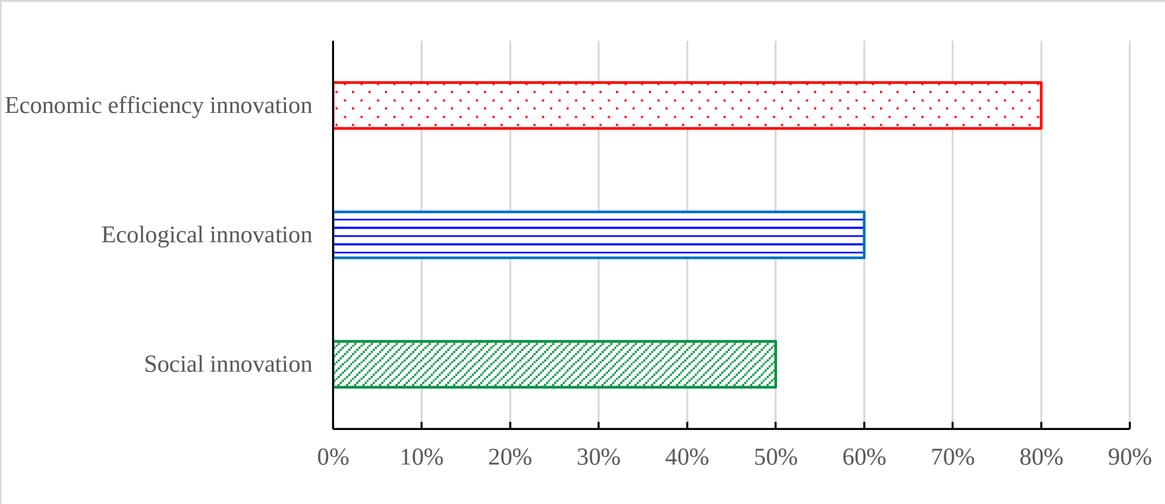

Figure 1. Innovation carried out by the management of the maritime companies

To achieve the goals of sustainability of maritime transport, more than 70% of the organizations have a working system of rules and measures to stimulate and develop sustainable innovation (Figure 2), of which 50% implement systemic social innovation, i.e. plan, organize, lead and control the process of formation and development of social entrepreneurship.

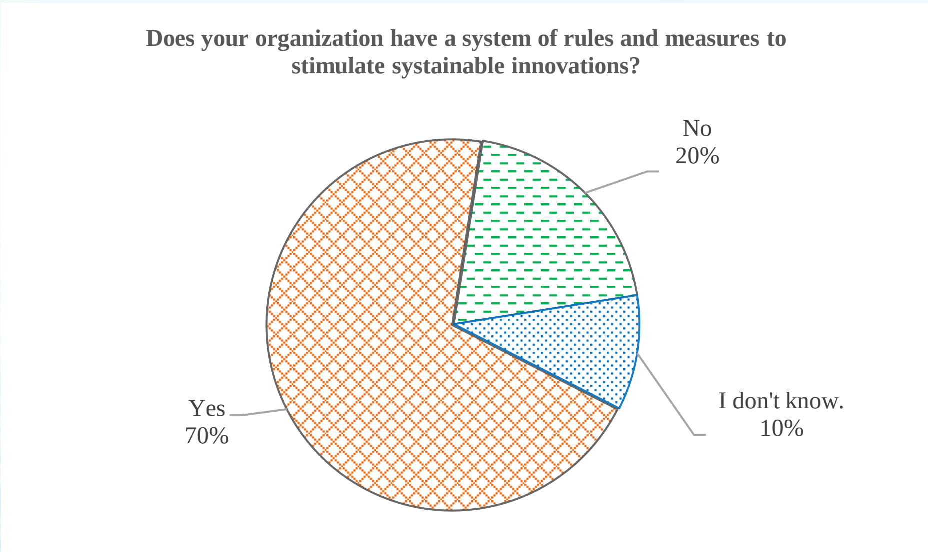

Figure 2. Rules and measures to develop sustainable innovation.

The in-depth structured interviews conducted with managers of companies from the maritime industry have established the willingness of the management to invest resources for the formation and development of innovation culture as a key factor for the goals of sustainable development. However, 70% of respondents report numerous threats and obstacles accompanying and hindering the application of measures to implement sustainable innovation. Key among them are the following (Figure 3):

- the need to transform the supply chain: carried out by integrating sustainable practices throughout the supply chain, which must ensure that environmental and social standards are respected at every stage (35%);

- a rapidly growing amount of information generated as a result of the implementation of digitization and the development of artificial intelligence. Studies of the problem show that not all companies in the supply chain succeed in digitalizing their business, which is one of the reasons for the slower introduction of innovative technologies in the sector (30%);

- technological threats resulting from the technological transformation of the maritime sector create opportunities for cyber-attacks and data theft. Managers believe that the personnel is not fully prepared to deal with these issues (25%);

- a new role of consumers: increasing customers' awareness of sustainable choices and motivating their responsible behavior towards sustainability (15%);

- the complexity and uncertainty of the environment in which maritime companies operate increases due to their interrelationship and interdependence with participants from other economic sectors (12%);

- other obstacles related to incomplete and non-transparent information, mistrust of innovation, and political obstacles (25%).

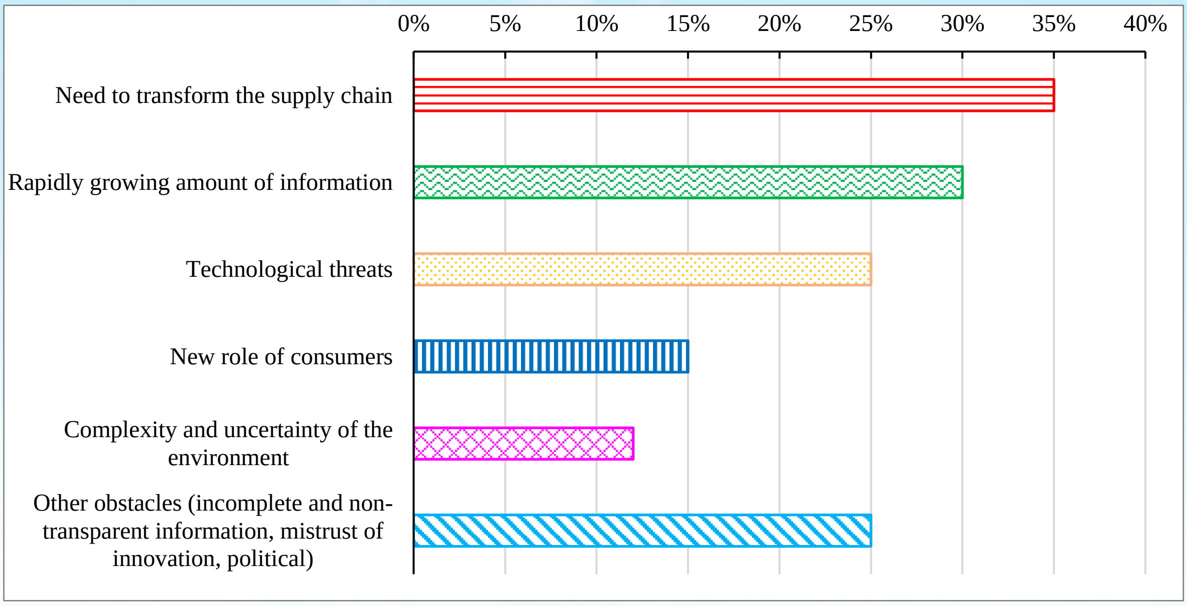

Figure 3. Obstacles and threats to the implementation of sustainable innovation in the maritime sector

The innovation culture is a management mechanism for overcoming some of the studied threats and a tool for stimulating sustainable innovations. According to 70% of the respondents, the innovation culture with its moral charge has a strong positive effect for more transparency and accountability, taking into account the efforts of employees and management to achieve sustainability in line with the challenges facing maritime organizations and the impacts of their activity. In addition, 30% of the managers hold the opinion that the innovation culture contributes to fairer labour practices that support talent development. Last but not least, according to 40% of the cases studied, the strong innovation culture has an effect on the so-called value proposition (Value proposition), which requires companies to rethink their products or services in order to deliver value corresponding to sustainability goals.

Maritime organizations with strong innovation culture possess the potential to explore, understand and formulate problems and seek their solutions. According to the managers, the innovation culture has a role in solving problems such as: poor quality primary data (12%), poor human-machine interface (10%), as well as overcoming the high degree of non-compliance with the forecasts in the conditions of extreme fragmentation in the management of the maritime supply chain (8%).

Training and education rank among the main management tools for the development of the innovation culture of the maritime sector. According to 15% of the management, the challenges in the training are posed not by the innovative technologies and their development, but by the transformation of the entire ecosystem. The training mechanisms aim at joint work of all participants, as inefficiencies lead to losses for the entire industry. Another important aspect of the training concerns the implementation of new technologies and an international legal framework. 17% of the cases show that the rapid advancement of technology poses a number of challenges to the current legal framework, which changes at a slow pace.

5. Sustainable innovation perspectives

The personnel is at the heart of overcoming a lot of interdisciplinary challenges on the way to sustainable behavior of the companies, thus it shall possess certain sustainability competences acquired through training.

Cross-sectoral key competences help society to keep up with technological progress and globalization. They provide for coping with the increasing complexity and uncertainty, increasing individualization and social diversity, expanding economic and cultural unification, deterioration of ecosystem functions, greater vulnerability and exposure to natural and technological hazards [UNESCO 2017]. All these circumstances require creative and self-organized actions as the complex environment transcends the basic principles of problem solving.

People gain advantage from certain key competences which enable them to understand the complex world in which they live and to participate constructively and responsibly in the sustainable processes. Key competences for sustainable development include: systems thinking skills, prognostic skills, strategic skills, collaboration skills, critical thinking skills, self-monitoring skills, integrated problem-solving skills.

A better understanding of the SDGs needs specific training in the cognitive, socio-emotional and behavioural domains/areas. The cognitive domain includes knowledge and thinking, skills needed to better understand the SDGs and the challenges of achieving them. The socio-emotional domain includes social skills that enable learners to collaborate and exchange ideas to promote the SDGs, as well as self-assessment skills, values, attitudes and motivation that enable learners to develop and improve themselves. The behavioural domain deals with entrepreneurial skills.

All this requires the development of the innovation culture of maritime companies as a condition for stimulating creative attitudes in solving complex challenges [Eschberger-Friedl 2023.] On the other hand, innovation processes feature transversality whose standards and values are formed and maintained by all participants in the process. That is why, the adequate innovation culture is perceived as a powerful tool that can stimulate employees and contribute to the growth of the innovation capacity of the companies in the maritime sector. The innovation culture in the maritime industry is considered unified and indivisible in its three mutually influencing dimensions: innovation ability, innovation readiness, and innovation potential. Therefore, the ideas can be developed into sustainable innovations only if the right conditions for innovation capability, readiness and potential are created, with the following characteristics:

1. Innovation ability

To generate ideas and turn them into sustainable innovations, employees must be supported and encouraged to develop and deploy their creative potential. On the one hand, this requires management that promotes innovation, and on the other hand, increasing the innovative capabilities of the employees by developing specialized knowledge through which:

- to make innovation culture a top priority and build processes from top to bottom throughout the company;

- to familiarize employees with modern methods and tools for collective discussion of problems, evaluating and implementing ideas (intensive course on innovation, creativity techniques, innovation management);

- to hold seminars on observed current trends and related future projects;

- to enrich the technical, technological and economic knowledge of the employees;

- to implement internal knowledge transfer by providing newly acquired or already existing knowledge within internal training courses [Dimitrakiev et al. 2023]; use of external know-how and open innovation approach (cooperation with universities, scientific and research institutions, and other companies, external innovation consultants; research of Internet information and specialized literature; interviews/surveys with experts; research/study of patents) [Velinov 2013b];

- to use new techniques and technologies [Velinov 2013a].

The main obstacles to the development of the employees' innovation competences include: prejudices and ignorance of innovation methods; tight deadlines and stress which impede off routine thinking.

2. Innovation readiness

Internal motivation is required to build sustainable innovation culture in the company, because willingness for innovation cannot be forced. This means that maritime companies need motivated and idea-driven employees who are willing to abandon traditional ways of thinking and behaviour in order to turn ideas into innovation. Motivated managers and enhancement of the innovation culture stimulate the drive to implement innovation by:

- promoting awareness of the importance of the innovation for the companies (training to improve communication skills, to increase awareness; Innovation Day during the year;

- contributing to the perception of the employees' ideas (e.g. acceptance of the employees' ideas and their joint evaluation);

- encouraging change and risk-taking by creating an atmosphere of innovation where employees can make mistakes and learn from them;

- creating motivation through incentives and evaluating the contribution to the innovation process (bonuses, career opportunities [Bakalova 2023], contests for providing ideas, contests for innovation, praise and recognition);

- reviewing and changing the role of superiors within the creative process (the superior becomes a moderator and a partner).

The innovation readiness has an impact on the personnel in the maritime companies: it increases the confidence of the employees and their propensity to take risks, as well as their motivation and creativity in approaching a given innovation. It should not be overlooked that the implementation of innovative ideas by motivated employees needs the approval and involvement of the upper management.

3. Innovation potential

Permission is a necessary condition for the transition from 'ability' and 'will' to action. Therefore, a company shall create framework conditions to provide employees with the opportunity to think and act innovatively and creatively, which means:

- creating time resources by providing part of the employees' working time for the realization of promising ideas;

- providing financial resources by allocating a budget for innovation;

- defining clear goals, responsibilities, competencies and processes regarding the development and implementation of innovative ideas [Velinov 2013-a];

- ensuring fast and effective communication at all hierarchical levels and creating a free space for informal communication (e.g. break rooms);

- creating fast and efficient decision-making structures;

- forming creative teams between units for joint development of ideas;

- involving employees in the innovation process from the very beginning (project teams between units and between management levels, cascade seminars);

- promoting personal initiative and entrepreneurial actions by creating confidence in the desire to work, commitment and efficiency of the employees.

6. Conclusion

The innovation culture is a management mechanism for achieving sustainable goals in the maritime organizations. To achieve these goals, in a social, ecological and economic plan, it is necessary to overcome a number of challenges and obstacles in order to establish systematicity and sustainability of the maritime innovations and organizations. The key obstacles to sustainability include the need for transformation of the supply chain, the rapidly growing amount of information, technological threats, the new role of consumers, and last but not least - the complexity and uncertainty of the environment in which maritime companies operate.

The challenges facing the maritime sector to implement the principles of sustainability to a greater extent make educational institutions and maritime universities in particular important educational and innovation hubs for the training of qualified personnel in the maritime industry. The cooperation between educational institutions, maritime businesses and creators of innovative technologies for the exchange of culture, knowledge, qualified personnel and innovation is increasingly important.

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CHALLENGES AND OPPORTUNITIES OF MARITIME EDUCATION AND TRAINING (MET) IN THE CONTEXT OF MARITIME DIGITALIZATION AND DECARBONIZATION

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Abstract: The maritime transport sectors are experiencing a revolutionary shift while running in a constantly changing global environment affected by digitalization and decarbonization in full force. Technological advancements and climate change issue, especially the new digital technologies such as artificial intelligence, big data and augmented reality, and the international maritime strategy of reducing greenhouse gas (GHG) emissions from ships, are profoundly and rapidly transforming and remolding the shipping industry. This trend requires a need for new skills and competencies for seafarers who are the heart of shipping to safely and efficiently operate the autonomous and low/zero carbon ship in the future. The maritime education and training (MET) institutes, therefore, must perform the corresponding reform for providing appropriate knowledge and expertise to educate, train and retrain the future-ready seafarers. This paper discusses some of the challenges arising from this trend and the opportunities the trend offers for the MET in terms of preparing the adequate seafaring workforce.

Keywords: maritime education and training; digitalization; decarbonization

1 Introduction

The development and reform of maritime education are facing new requirements, particularly in promoting the deep integration of new technologies such as big data, artificial intelligence, and augmented reality with maritime transportation. One of the crucial factors in ensuring the safe operation of modern and technologically advanced ships is the seafarers themselves. There is a clear correlation between the lack of capabilities caused by insufficient education and training and human error. Therefore, maritime education and training (MET) must undergo reforms to provide up-to-date knowledge and professional skills. Facing new opportunities and challenges, it is necessary to utilize modern information technology to explore new modes of digital and low-carbon maritime education and elevate maritime education to a new height.

Projections indicate that the requirements for crew skills in ship transportation will continue to increase. Technological progress and digitization have transformed maritime transportation from a labor-intensive industry to a high-tech job. Notable advancements in maritime transportation include the rise of ship automation and autonomous ships, advanced navigation systems, energy efficiency and low-carbon emissions, remote monitoring, improved weather routing, and collision avoidance systems, all of which contribute to improving maritime safety and transportation efficiency.

Under the new situation of modern information development and new requirements for crew training, it is necessary to utilize modern information technology to explore new modes of intelligent maritime education to improve the quality of maritime education. Traditionally, crew training has often been limited to daily operations, while simulator-based training and education have laid a solid foundation for acquiring maritime technology and complex skills. Promoting ship greening, digitization, and autonomous navigation marks the vigorous development of maritime transportation while also placing higher demands on seafarers' knowledge reserve, operational skills, and the existing MET and regulatory system. With the trend of ship green transformation and the realization of low-carbon or even zero-carbon targets, the shipping industry is exploring new energy sources, requiring the crew to master more safety operational skills. Ship digitization includes digital technologies in ships' design, manufacturing, and operation processes, including computer-aided systems, manufacturing execution systems, modeling and simulation technologies, product data management technologies, and virtual reality technologies [1].

Based on the development trend of MET under digitization and decarbonization, this article faces unprecedented challenges and opportunities. Introducing advanced technologies and exploring new modes of intelligent education can provide a new development path for maritime education, enhance training quality, and cultivate high-quality seafarers who meet the needs of the new era, laying a solid foundation for the sustainable development of the shipping industry.

2 Research Status

The digital transformation of maritime education emphasizes the intelligent and digital processes of all elements, processes, businesses, and domains. The comprehensive informatization, intelligence, and personalization of education are achieved through the upgrading and transformation of digital technologies. In this context, artificial intelligence and big data applications play a central role, such as AI-powered education software, big data analysis platforms, and intelligent educational hardware, driving the in-depth transformation of educational digitization and exploring new modes of intelligent education.

With the continuous updating of technology and the sustained development of digital education, educational informationization equipment is constantly upgrading and evolving. Aditi Katariar[2] argues that the current MET cannot meet the requirements of modern and future ship operation dynamics. Despite the existence of international conventions specifically for MET, maritime accidents still occur frequently, necessitating a comprehensive review of the changing maritime education landscape. Cristina Campos analyzes emerging content related to autonomous navigation, mechanical systems, cybersecurity, and remote-control systems. These emerging contents will contribute to developing training courses to establish new educational and proficiency standards to address the impact of this technology. The goal is to comprehensively conceptualize new-era maritime autonomous surface ships (MASS) within the MET framework, promote the development of MASS, and integrate them into maritime curricula [3].

Michael Ekow Manuel [4] and Yuthana Autsadee [5] both emphasized the transformation of educational models and their support for developing personal potential, particularly in terms of abilities, business, and management levels. They proposed the need for different levels of support in education and training. Samrat Ghosh[6], based on past and present research as well as the first steps in constructing and implementing this framework, identified the challenges faced in doing so within the context of maritime education and training. The shift from traditional to digital education has not only altered the teaching environment but, more importantly, revolutionized teaching methods for educators and learning styles for crew members. With artificial intelligence technology, personalized teaching plans can be implemented, and intelligent learning suggestions can be provided. Extensive data analysis can assist in accurately evaluating learning outcomes and optimizing the allocation of teaching resources.

Goran Vukelic [7] and By.N. Kumar[8] simultaneously emphasize the importance of practical training. Goran Vukelic focuses on fire and evacuation training for crew members on large passenger ships, introducing VR technology to change traditional training models. Meanwhile, By. N. Kumar pays attention to transforming traditional teaching methods into practical-oriented blended learning, utilizing augmented reality and virtual reality technology to enhance students' interest and effectiveness in learning.

The viewpoints of Eduardo Ma R Santos and Ahmad Faizal Ahmad Fuad [9] can be combined as the need for technology protection and application. Eduardo Ma R Santos pointed out the issue of network security in the education industry, emphasizing the importance of MET network security. Ahmad Faizal Ahmad Fuad discussed the significance of technologies such as the Internet of Things, cloud computing, automation, artificial intelligence, and drones in nautical education and future operations. The research of Olena Diahyleva [10] and others is like the views of Goran Vukelic and By. N. Kumar, both emphasize the enhancement of educational effectiveness through interactive technology. Diahyleva pointed out that interactive whiteboards improve student participation and teachers' teaching abilities, while Vukelic and Kumar discussed the application of VR and AR technology in training.

Numerous scholars have emphasized the need for transformation in maritime education and training regarding technology, methods, and content. By introducing new technologies and blended learning methods, education has become more personalized and intelligent, enhancing student participation and learning outcomes. This cultivates high-quality crew members, promoting the sustainable development of the shipping industry.

3 Challenges

Maritime education reform is a multidimensional educational revolution that transforms traditional higher education into a digital format through the extensive application of information and simulator technology and other digital tools. This transformation includes but is not limited to online education, virtual educational resources, learning management systems, distance learning, and blended learning. The core objective of digitizing maritime education is to optimize the educational and teaching environment, improve teaching quality and crew participation, and provide more flexible and personalized learning opportunities. It represents a revolutionary challenge to the traditional university education model, bringing maritime education into the digital era through technology-driven and innovative educational methods.

New training and education will still rely on issues such as navigation, safety, planning, navigation equipment, positioning, meteorology, and emergency procedures. However, it will also incorporate knowledge in areas like artificial intelligence, remote operations, cybersecurity, and data transmission. These new technologies cover fields such as artificial intelligence, automation systems, new ship design, and environmental protection technology, posing new requirements for traditional maritime training models.

3.1 New Technology

3.1.1 AI ChatGPT

The introduction of AI ChatGPT's intelligent question-and-answer model provides maritime education and training with brand-new tools and methods. Maritime education and training often involve complex practical operations and specific professional knowledge. Integrating AI ChatGPT technology into existing education and training systems requires addressing technical adaptability, data compatibility, and operational convenience. Additionally, AI ChatGPT may need to handle a large amount of professional terminology and dialogue in specific contexts, posing higher demands on its model training and dataset quality. In the maritime field, the accuracy and professionalism of educational content are crucial, necessitating rigorous content review and update mechanisms to ensure that the information and advice provided by AI ChatGPT meets industry standards and requirements. While AI ChatGPT can provide convenient online question-answering and learning assistance services, more is needed to fully replace the role of teacher-student interaction and emotional communication in traditional education. In maritime education and training, direct communication and interaction between teachers and students are crucial for cultivating students' practical abilities and team collaboration skills. Therefore, while using AI ChatGPT, it is also necessary to maintain and enhance direct communication and interaction between teachers and students.

3.1.2 MASS

The development of MASS represents a significant technological advancement in the maritime sector. The application of MASS enables ships to complete complex navigation tasks with less human intervention. According to the BIMCO/ICS Seafarer Workforce Report in 2021, 1.89 million seafarers currently serve the world merchant fleet, operating over 74,000 vessels around the globe, and it predicts that there will be a need for an additional 89,510 officers by 2026 to operate the world merchant fleet.

Table 3.1 Crew size for ocean-going cargo ships

Age	Crew number on board	Ship type
1860	250 crews	sailing ship
1880	140 crews	steam engine
1900	100 crews	coal to oil
1950	40 crews	steam to diesel
2000	20 crews	automation
xxxx	No crew?	autonomous

Modern ship operations' increasing complexity and automation require crew members to possess a broader range of skills and knowledge. This has led to the expansion of crew training programs, with training institutions needing to increase teaching resources and facilities to meet the growing demand for training. Additionally, the diverse backgrounds of crew members pose new challenges to teaching methods, requiring educators to develop more diversified and adaptive teaching strategies to cater to the needs of different trainees.

The application of MASS requires maritime professionals to possess new skills, such as remote monitoring, data analysis, and system maintenance. Therefore, maritime education must promptly update its curriculum content and add training modules related to automation and intelligent systems to ensure crew members can adapt to this new operating environment.

However, educational reforms may lead to an increase in the turnover of seafarers in terms of industry operations. As more seafarers receive academic education (thus having more options onshore), their tendency to leave maritime careers increases, resulting in a growing number of junior seafarers and a dwindling number of experienced senior officers. Nonetheless, the international community must seek solutions to these issues, not by establishing systems that deprive potential seafarers of academic education but by making maritime careers more attractive in the long term [4].

Meanwhile, the emergence of MASS ships poses new requirements for existing maritime laws, regulations, and ethical norms. Maritime education and training need to strengthen education on these new laws, regulations, and ethical norms to ensure that trainees can safely and effectively operate MASS ships while complying with legal and regulatory requirements.

3.1.3 The Emergence of Large Ships and Specialty Ships

With the growth of global trade, large and specialty ships have gradually become the mainstay of the shipping industry. Specialty ships include large Luxury Cruise Lines, semi-submersible ship and various engineering vessels. These ships are highly complex in design and operation, placing higher demands on crew members' professional knowledge and operational skills. Maritime training needs to develop specialized courses and simulation training tailored to the characteristics of these large and specialty ships to ensure that crew members can proficiently master relevant technologies and operational procedures. For example, specialty ships such as oil tankers and liquefied natural gas carriers involve specific safety operations and cargo handling processes. Maritime education and training need to provide professional training courses and practical operation opportunities tailored to the characteristics of these ships. However, the limited number and scale of large ships and specialty ships pose a challenge in providing trainees with sufficient practical operation opportunities. Educational institutions need to actively collaborate with shipping companies to create more practical opportunities for trainees. Cultivating teachers with professional knowledge and practical experience in large ships and specialty ships is also a challenge. Educational institutions need to strengthen the training and capability enhancement of teachers to meet the needs of education and training. Simultaneously, educational institutions need to strengthen cooperation with shipyards and shipping companies to update training content and reflect the latest technologies and operational standards.

3.1.4 Development of Decarbonization Technologies

With the enhancement of environmental protection awareness and the improvement of shipping emission standards by the International Maritime Organization (IMO), decarbonization technologies have been widely applied in the shipping industry. This includes the use of alternative fuels (such as liquefied natural gas, hydrogen fuel, etc.), optimization of routes, and improvement of energy efficiency. Maritime education must incorporate these emerging environmental protection technologies into training programs, cultivate trainees' environmental awareness and technical capabilities, and ensure that they can effectively apply these technologies in practical operations to reduce ship emissions [11].

Since the late 19th century, the global warming trend has continued, with carbon dioxide emissions accounting for up to 98% of the dominant greenhouse gases and the shipping industry accounting for nearly 3% of total carbon emissions. To jointly address global climate change, the shipping industry should also pursue green development. The IMO has formulated a series of mandatory rules and guidance documents and adopted an initial strategy for reducing greenhouse gas emissions from ships in April 2018, setting a vision for achieving zero carbon emissions from global seagoing ships in this century [11]. The IMO's strategy to reduce greenhouse gas emissions from ships is an important measure to address climate change. The strategic goal is to reduce greenhouse gas emissions from international shipping by at least 50% by 2050 and achieve zero emissions by the end of this century. This strategy poses the following requirements for maritime education and training [12]:

1. Low-carbon Technology Training: Educational institutions must increase training content on low-carbon and zero-carbon technologies, such as liquefied natural gas (LNG), hydrogen fuel, battery technology, and wind-assisted propulsion.

2. Energy Efficiency Management: Strengthen training on energy efficiency management and optimized operations to ensure crew members can reduce emissions through optimized routes, speed management, and using energy-efficient equipment.

3. Regulations and Standards: Ensure crew members are aware of and comply with the latest international and regional emission regulations and standards, including Emission Control Areas (ECA) and Carbon Intensity Indicators (CII).

These new requirements not only increase the complexity of training but also require close collaboration between educational institutions, research institutions, and industry enterprises to develop and promote the latest environmental technologies and operational norms [13].

3.1.5 Data privacy and security issues

In a digital education environment, crew members' and universities' data are collected, stored, and processed on a large scale, making digital privacy and security issues particularly urgent. Crew members' personal information, learning records, and data exist in digital form, and disclosing or misusing these data may lead to severe privacy violations. Therefore, maritime educational institutions must establish robust data protection measures to ensure the security and privacy of all data. Additionally, emergency response plans should be formulated to quickly recover and protect data in the event of data loss or system failure. Meanwhile, cybersecurity is the practice of defending critical systems and sensitive information from digital attacks. As Priyadarshini defines in "Introduction to Cybersecurity" (Priyadarshini, 2019), it is the ability to defend against cyberattacks and recover from them. Since digital MET has a system infrastructure composed of digital sensors, controllers, computer systems, telecommunications networks, and the internet, ensuring security in all domains is crucial.

3.2 New Regulations

3.2.1 Revision and Review of the STCW Convention

Revisions to the STCW Convention may drive the restructuring and optimization of maritime education and training systems. This includes a shift from a fragmented, superimposed training system to a systematic, composite training system to enhance the systematicness and professionalism of seafarer training. Certificate system optimization: New regulations may integrate certificates for some functions or positions, reducing unnecessary certificates and easing the burden on shipping companies and crew members. Meanwhile, some new professional knowledge and skills may be integrated into systematic professional education, enhancing the professional quality of new crew members. New regulations on bullying and harassment: The revision of the STCW Convention also involves new regulations on dealing with bullying and harassment in maritime training departments. This requires maritime education and training institutions to strengthen mental health education and training for trainees, improving their ability to deal with bullying and harassment.

3.2.2 IMO Strategy on Reducing Greenhouse Gas Emissions from Ships

With the IMO's advancement of strategies for reducing greenhouse gas emissions from ships, maritime education, and training need to keep pace with technological developments, continuously updating and expanding teaching content to cover the latest knowledge in greenhouse gas emission reduction technologies, clean energy applications, low-carbon ship design, and other areas. The IMO's greenhouse gas emission reduction strategy includes a series of standards and norms, such as the Greenhouse Gas Fuel Standard (GFS) and Carbon Intensity Indicator (CII). Maritime education and training need to ensure trainees are aware of and familiar with these standards and norms so they can comply with and implement them in practical operations. Innovation and transformation of education and training models: Maritime education and training institutions need to strengthen environmental education for trainees, fostering their environmental awareness and sense of responsibility. With alternative zero and near-zero greenhouse gas fuels, maritime education and training institutions need to strengthen training on new energy technologies, improving trainees' understanding and proficiency in these technologies.

3.2.3 Polar Code

Implementing the Polar Code requires maritime education and training institutions to strengthen training on polar environmental adaptability, improving trainees' survival and response capabilities in polar environments. The navigation environment in polar regions is highly complex, requiring ships to possess high-level ice and cold resistance capabilities. Therefore, maritime education and training need to continuously update and expand teaching content, covering the latest polar ship design, construction, and operation technologies, as well as related safety rules and operating procedures. The uniqueness of the polar environment requires seafarers to possess specific skills, such as ice navigation and polar rescue. Due to the high degree of specialization of the Polar Code, educational and training institutions need to possess corresponding professional training teachers. These teachers must possess rich polar navigation experience and professional knowledge to provide high-quality training services to trainees. Maritime education and training institutions need to strengthen training in these specific skills to ensure trainees are competent in working in polar environments.

In summary, the revision and review of the STCW Convention, the IMO's strategy for reducing greenhouse gas emissions from ships, and the Polar Code have had profound impacts and challenges on maritime education

3.3 New Navigational Environment

3.3.1 Extreme weather

Global warming has led to rising sea levels and frequent occurrence of extreme weather events (e.g. typhoons, hurricanes, tsunamis), which have increased the risk of marine navigation. At the same time, marine pollution, seawater acidification and marine ecological imbalance are becoming increasingly serious, affecting navigation safety and water quality safety.

3.3.2 Prevalence of anthropogenic activities at sea

With the prosperity of global trade, the volume of maritime transportation has increased dramatically, and the density of ships has increased, leading to increased congestion and collision risk in shipping lanes.

The increase in anthropogenic activities such as sea ranching, wind farms, and oil, gas and mineral development farm has taken over waters originally intended for navigation, making the navigational environment more complex. Overfishing of fishery resources and illegal fishing activities not only affect the marine ecological balance, but may also pose a threat to navigational safety, such as entanglement of propellers in fishing nets.

3.3.3 Force majeure and other uncertainties

Force majeure and uncertainties such as maritime terrorism, armed conflicts, cyber-attacks in maritime communications and piracy increase the risks of maritime navigation, which not only threaten the lives of crew members, but also may lead to property damage and cause serious impacts on international trade and maritime transportation.

In summary, the complexity of the maritime navigation environment in the natural environment, man-made activities, as well as environmental uncertainty and other aspects have undergone significant changes. These changes require new requirements for maritime education and training to ensure the safety and efficiency of maritime navigation.

3.4 New Generation

The new generation of young people poses multifaceted challenges to maritime education and training due to their pragmatism, openness, and independence, particularly in developing countries.

3.4.1 Challenges posted by Pragmatism

The new generation of young people pays more attention to practical skills and knowledge, expecting to acquire capabilities that can be directly applied to work through education and training. Therefore, maritime education and training need to focus more on the practicality of content, ensuring that the knowledge and skills taught can meet the actual needs of students' future work. Additionally, they value actual benefits and career development prospects, and the maritime industry may lose attractiveness in career choices due to factors such as working environment and compensation. They expect to acquire skills closely related to market demand, requiring maritime education and training institutions to constantly update their curriculum content to meet this pragmatic career demand.

3.4.2 Challenges posted by Openness

Students' learning styles have become more diversified and personalized in an era of diverse and open information. Traditional classroom teaching methods can no longer satisfy all students' needs, and they prefer multiple learning methods such as autonomous learning, online learning, and collaborative learning. With more channels to access information and understand different industries and job opportunities, young people expect the maritime industry to be more competitive to attract their attention. The new generation of young people has a broader international perspective and may prefer to develop internationally, posing higher requirements for internationalizing maritime education and training.

3.4.3 Challenges posted by Independence

Young people pursue personalized and customized learning experiences, expecting training content and methods to align with their interests and needs. This challenges the flexibility and innovation of maritime education and training. They value self-drivenness and self-fulfillment, expecting more autonomy and choice in the learning process. This places new demands on the teaching mode and management methods of maritime education and training.

3.4.4 Challenges posted by Rising Living Standards

With the improvement of living standards, the younger generation's willingness to work on ships has been declining, especially in developing countries, where they may prefer more comfortable and stable jobs in cities. The increase in living standards has also led to higher salary expectations among the younger generation, further reducing the attractiveness of the maritime industry if its salary levels cannot compete with those of other industries.

3.4.5 Unique Challenges in Developing Countries

Maritime education and training in developing countries may face resource constraints such as insufficient teachers and outdated equipment and facilities, which will affect the quality and effectiveness of training. The maritime employment environment in developing countries may be flawed, lacking stable career development paths and good compensation packages, further reducing the attractiveness of maritime education and training.

In summary, the characteristics of the new generation pose multifaceted challenges to maritime education and training, especially in developing countries. It is necessary for training institutions and relevant policymakers to work together to adapt to these changes and improve the attractiveness and quality of maritime education and training.

4 Approaches

With rapidly developing artificial intelligence (AI) and maritime autonomous surface ships (MASS) technology, maritime education and training must actively welcome and embrace these changes. It is crucial to fully recognize the potential and limitations of these technologies. Although the realization of unmanned ships still faces many challenges, a positive attitude will help cultivate a new generation of seafarers who can adapt to the future maritime environment.

4.1 Cultivating a Positive Attitude

A positive attitude not only means accepting new technologies but also includes proactive learning and adaptation. Maritime education and training should encourage students to face technological changes with a proactive attitude, cultivating their innovative spirit and continuous learning ability. By constantly updating curriculum content and training methods, educational institutions can help students keep up with technological advancements and enhance their competitiveness in the future shipping industry. Welcoming and embracing new technologies such as AI and MASS with a positive attitude is one of the key approaches to maritime education and training. Educational institutions need to adopt practical-oriented training, diversified curriculum, and innovative teaching methods to cultivate a new generation of seafarers with interdisciplinary knowledge and skills, ensuring that they are qualified for future shipping work in the context of technological changes.

4.1.1 Coping with Technical Complexity and Autonomous Navigation Challenges

Autonomous navigation and maintenance pose significantly greater challenges in the maritime sector compared to land-based transportation. While small cars have achieved unmanned autonomous driving on land, the maritime environment's complexity and the vessels' technical intricacies make this goal harder to accomplish. A small car consists of 10,000-20,000 parts, whereas a container ship may have over 100,000 components, and a large cruise ship can have up to 25 million parts. The length of cables on ships can even exceed 4,300 kilometers, further increasing the difficulties in developing and maintaining automated systems.

Maritime education and training must address these technical challenges by fostering interdisciplinary knowledge and skills among crew members. This includes operating and maintaining automation systems, managing complex systems, and adapting to the ever-changing maritime environment. Through practical-oriented training and simulation exercises, crew members can remain competitive amidst technological advancements.

4.1.2 The complexity of the maritime environment

The ever-changing nature of the marine environment makes autonomous navigation of ships more complex than cars and airplanes. Maritime weather, ocean currents, tides, and other natural factors all pose higher demands on ship operation. Maritime education needs to strengthen the training of crew members' adaptability and decision-making abilities in the marine environment, including training for extreme weather and emergencies.

Through scenario simulation and case analysis, educational institutions can help students understand and master the skills and strategies of operating automated systems in complex maritime environments, thereby enhancing their practical abilities, for example, simulating navigation under different weather conditions and training crew members on how to operate vessels using automated systems in adverse environments safely.

4.1.3 Economic Value and Shipowners' Trust

The high value of ships and their cargo determines that shipowners will not fully rely on unmanned systems in the short term. A 10,000 TEU container ship is worth about 100 million US dollars, and the value of the cargo is even higher. Shipowners need to have a high degree of trust in the reliability and safety of automated systems. Therefore, the future shipping system may adopt a model of "shore-based control as the mainstay, supplemented by onboard monitoring," with sailors taking over in critical moments or when necessary. Maritime education and training need to prepare for this new model, cultivating sailors' capabilities in remote operation and monitoring. Through simulated training and hands-on practice in remote control technology, trainees can familiarize themselves with operational procedures and emergency handling under "shore-based control," ensuring prompt and effective takeover when issues arise with unmanned systems.

4.2 Adaptive Methods

As in most other fields, the biggest challenge facing higher education today comes from the information technology revolution represented by artificial intelligence. Traditional work methods and the knowledge they contain will inevitably be disrupted and replaced, including the shipping industry and maritime education serving it. Currently, this transformation is likely to occur faster than most people imagine. This factor must be considered in designing reforms and construction measures for maritime education and training.

4.2.1 Good Quality of MET Instructors

The importance of good quality MET (Maritime Education and Training) instructors cannot be overstated, as they have a crucial impact on the successful operation of the entire maritime education and training system and the effective learning of trainees. The quality of instructors directly relates to teaching quality. Instructors with good qualities can accurately understand and impart maritime knowledge and skills, ensuring that trainees can comprehensively and deeply grasp the required knowledge, laying a solid foundation for their future careers.

At the same time, high-quality MET instructors can inspire trainees' interest, shape their character, adapt to industry changes, promote training innovation, enhance industry attractiveness, and establish good teacher-student relationships. Therefore, strengthening the quality of instructors is a top priority in maritime education and training.

4.2.2 Appropriate Teaching Methods and Facilities

The importance of appropriate teaching methods and facilities in maritime education and training is self-evident, as they play a crucial role in improving teaching effectiveness, ensuring the quality of trainees' learning, and promoting the sustainable development of the maritime industry. Good teaching methods can enhance trainees' interest in learning, promote knowledge absorption and understanding, cultivate trainees' practical abilities, and meet the needs of different trainees. Adopting personalized teaching methods can satisfy the learning needs of different trainees and improve the overall teaching effect. Good facilities can guarantee teaching quality, improve trainees' learning efficiency, promote training innovation, and enhance the practical operation ability of trainees.

In summary, appropriate teaching methods and facilities are important in maritime education and training. They not only improve teaching effectiveness and trainees' learning quality, but also promote the sustainable development and innovation of the maritime industry. Therefore, attention should be paid to the construction and improvement of teaching methods and facilities in maritime education and training.

4.2.3 Actively Participate in Discussions on IMO Regulations Revising as IMLA Members

Actively participating as a member of IMLA (International Maritime Lecturers Association) in IMO (International Maritime Organization) rule discussions is crucial for various reasons. These reasons not only contribute to the development of maritime education but also play a vital role in the safety and regulations of the entire maritime industry.

As an official consultative body of the IMO, IMLA has the right to participate in the entire process of drafting, revising, attending meetings, and discussing international maritime organization decision documents. Therefore, the active participation of IMLA members in IMO rule discussions helps to promptly reflect the voices and needs of the international maritime education sector and advance the improvement and updating of relevant regulations. By engaging in IMO rule discussions, IMLA members can engage in extensive exchanges and collaborations with peers in the international maritime community, share teaching experiences and methods, and enhance the international influence of maritime education. Furthermore, IMLA members can also promptly convey the latest IMO regulations and developments to domestic maritime educational institutions, promoting the development of domestic maritime education in line with international standards. IMO's legislative work mainly focuses on environmental protection and intelligence. Participating as IMLA members in IMO rule discussions contributes to promoting the formulation and implementation of regulations concerning maritime safety and environmental protection. Through participation in IMO rule discussions, IMLA members can access the latest maritime technologies and development trends, thus driving innovation and advancement in maritime education. By introducing new teaching content and methods, IMLA members can nurture more maritime professionals with innovative spirit and practical skills, providing strong support for the development of the maritime industry.

In conclusion, actively engaging as a member of IMLA in IMO rule discussions is significant for the development of maritime education, safety, regulations, and innovation in the maritime industry. This not only enhances the international influence of maritime education, strengthens international MET cooperation, and builds closer links with IMO, but also contributes to the continuous and healthy development of the entire maritime industry.

4.3 Cultural building

History and reality tell us that ships and seafarers take mankind to discover and change the world, carry and disseminate civilization, and facilitate global trade and economy. Especially during the difficult times of a global pandemic, the ability of shipping services and seafarers to deliver vital goods, including medical supplies and foodstuffs, will be central to responding to and eventually overcoming this pandemic. Seafarers have inscribed their monumental feats on the history of human civilization. This has been true in the past and is even more so in the future.

With the 2021 World Maritime Theme “Seafarers: at the core of shipping’s future”, the world maritime community has been drawing greater attention to seafarers as key workers in the world economic and social development.

With the intensification of global climate change, the maritime industry, as one of the significant sources of carbon emissions, needs to actively respond to the transition to low-carbon. The establishment of maritime education and training culture contributes to fostering environmental awareness among trainees, prompting them to pay more attention to energy conservation and emission reduction in their daily work. Through maritime education and training, a group of environmentally conscious maritime professionals can be cultivated, enhancing the industry's image and strengthening public recognition and trust in the maritime sector.

Digital technology offers more possibilities for maritime education and training. By introducing online learning, virtual simulation, and other teaching methods, maritime knowledge and skills can be presented more vividly and intuitively, increasing students' interest and learning effectiveness. Digital technology breaks the constraints of time and space, allowing maritime education and training to reach a broader range of regions and demographics, thus providing strong support for supplying the maritime industry with more outstanding talents.

By setting clear educational goals, strengthening the construction of teaching staff, innovating teaching methods, and enhancing cooperation between schools and enterprises, active cultural development is being pursued.

In conclusion, in the context of low-carbonization and digitalization, establishing maritime education and training culture is of great significance for nurturing maritime talents with environmental awareness and digital skills. By setting clear educational goals, strengthening the construction of teaching staff, innovating teaching methods, and enhancing cooperation between schools and enterprises, we can promote the continuous development and improvement of maritime education and training culture, providing strong support for the sustainable development of the maritime industry. At the same time, the creation of maritime education and training culture also helps enhance the competitiveness and influence of the entire industry, laying a solid foundation for the future development of the maritime industry.

5 Summary

The decarbonization and digitalization of shipping have brought unprecedented challenges and opportunities to maritime education and training. Only through measures such as strengthening technological research and development, updating educational content, enhancing faculty development, improving practical teaching, increasing student engagement, and strengthening international cooperation and exchange can we adapt to the industry's evolving needs and provide strong talent support for the sustainable development of the shipping industry. Despite the unpredictable nature of technological development, we must approach it cautiously to ensure that specific interests do not limit seafarers' lifelong learning and career development. Seafarers' personal growth and potential contributions to society should be valued and enhanced through education to avoid marginalization and exploitation caused by limited educational systems in history. In conclusion, in the face of technological advancements and changing industry demands, maritime education must remain forward-looking and practical by regularly revising teaching plans, enhancing international cooperation, continually updating curriculum contents, cultivating more competitive and adaptable professionals, and promoting the sustainable development of the shipping industry.

For thousands of years, the maritime pioneers have left us with the powerful spirit of "venturing ahead, overcoming difficulties, unity, and selfless dedication," which drives humanity, especially the younger generation, to explore the oceans and expand maritime horizons continuously.

The maritime spirit represents a positive attitude, persistent life pursuits, and a confident and optimistic life philosophy. It is not only applicable to navigation itself but also symbolizes the human spirit of facing challenges, exploring the unknown, and overcoming difficulties.

Various maritime academies, shipping companies, the maritime industry, and society as a whole must continuously promote maritime culture, engage in rich and effective activities, allowing the blue genes to be inherited and magnified among generations of young people. This will inspire more young men and women to love the oceans and venture into them.

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EMPLOYEE RESPONSES TO ORGANIZATIONAL COMMITMENT, JOB SATISFACTION, AND WORK INVOLVEMENT IN SHIP AGENCY COMPANIES

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Abstract: The purpose of this study was to determine the perception of organizational commitment, job satisfaction, work involvement of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia. The population in this study amounted to 30 people. The sampling method is nonprobability sampling method with saturated sampling technique (census) totaling 30 respondents. The data analysis used is descriptive analysis of each research variable. The analysis method used in this research is descriptive frequency which is qualitative in nature. Based on the research results obtained, respondents' perceptions of the work involvement of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia are relatively high with an average score of 4.11. In addition, respondents' perceptions of the job satisfaction of employees of the Seabridge Port Agencies Corp-Indonesia ship agency company were relatively high with an average score of 4.11. It was also obtained that the respondents' perceptions of the organizational commitment of employees of the Seabridge Port Agencies Corp-Indonesia ship agency company were relatively high with an average score of 4.09.

Keywords: Organizational Commitment, Job Satisfaction, Work Involvement

Introduction

Human Capital is a crucial element for the advancement of organizations, corporations, and nations. Human Capital essentially comprises individuals hired by an entity to support, strategize, and execute the entity's objectives. Essentially, the workforce is comprised of individuals employed to facilitate the realization of the company's objectives, and the pace of achievement hinges on the workforce size.

Recent shifts in management perceptions within organizations have reframed employees from mere resources to capital or assets for the institution or organization. A new term in HR, human capital, has gained traction. In this light, HR is not only recognized as the primary asset, but a valuable asset that can be cultivated, expanded (reminiscent of an investment portfolio), and not solely seen as a liability (a burden or expense). This underscores the perspective of HR as an investment for institutions or organizations.

Humans as social creatures who always try to interact will always find problems. However, various problems in interacting between groups can be minimized by knowing the behavior of individuals and groups who are opponents in their interactions (Suhendi and Anggara, 2018). Human resource management is very important because humans are a very important resource in the industrial and organizational fields. Human resource management includes ensuring that the workforce is qualified, maintaining quality, and controlling labor costs. However, problems often arise from employees themselves who cannot control themselves. In the process of human resource management. Humans as a resource of a corporate institution, have a relationship with several factors that will advance and develop the organization. One of the issues related to human resources is organizational commitment.

Organizational commitment is an individual's feeling to stay in an organization and pour all his abilities to achieve organizational goals. Organizational commitment as a psychological state that characterizes the employee's relationship with the organization or its implications that affect whether the employee will stay in the organization or not, which is identified in three components, namely affective commitment, continuous commitment, and normative commitment (Zurnali C, 2010, p.127).

Shipping companies are state-owned or private business entities, in the form of state companies (Persero), Limited Liability Companies (PT), Comanditer Companies (CV), and others, which carry out service businesses in the field of providing sea vessel space for the benefit of transporting cargo of passengers (people) and goods (merchandise) from a port of origin (loading) to a port of destination (unloading), both domestically (interinsulair) and abroad / ocean going shipping (Suwarno, 2011, p. 128).

Import-export intermodal carriers by sea are business materials engaged in the activities or activities of ships or shipping companies. If a ship is anchored at a port, the ship requires service and has various needs that must be met. To serve various needs that must be met. To serve these various needs, the shipping company will appoint a ship agent. Broadly speaking, there are three types of ship agents, namely general agents, sub agents or agents, and branch agents (R.P. Suyono, 2005).

In its management, the ship agency company necessitates a committed workforce in the form of Human Resources. Human Resource Management (HR) emerges as a vital component pivotal in maintaining the operational momentum of the company. Essentially, it is the workforce that steers the management of the company.

Seabridge Port Agencies Corp-Indonesia stands as a foremost maritime agency, catering to diverse needs encompassing ship agency services, marine agency services, and offshore support across the Asia region. The array of services rendered includes:

Liner Agency Services: encompassing Main Line Operations, Container Carriers, Common Carriers, Multi-Purpose Vessel Operators, ISO Tank Operators, Pure Car and Truck Carriers.

Marine Agency Services: comprising Load and Discharge Supervision, Superintendents and Port Captains, Crew Change Coordination, Medical Attendance Coordination, Dry Dock Supervision, Bunker Call Coordination, Spare Part Procurement and Delivery, Running Repairs, Surveys, and Document Handling.

Offshore Support: encompassing operational permitting, bunker and fresh water provisioning, cash to master services, crew handling, customs clearance, full vessel clearance, surveys, and warehousing.

This company is a newly established company in 2020, which based on Law No. 20 of 2008 concerning small, micro and medium enterprises, Seabridge Port Agencies Corp-Indonesia is included in the criteria of small businesses. The company is engaged in ship agency, brokerage and charter services.

The development of organizational commitment in a company will be built by all employees, positive attitudes and behaviors in the workplace are needed in achieving company performance and goals. The importance of employee commitment to the organization, that the organization really expects employee commitment to the organization regardless of employee status. (Yateno, 2020,p.234).

In addition, as shown by Desi Prasetiyani et al. (2021), job satisfaction is positively correlated with organizational commitment. According to Sethi (2016), people who do not participate in their organization will perceive that their work is not important to their self-esteem and have no emotional attachment to the organization. Ultimately, this will lead to poorer performance. Eka Maryanti (2014) found that work involvement and job satisfaction have a positive and significant impact on organizational commitment. In addition, according to I Gde Raka Ariana et al. (2018), organizational climate has a positive and significant impact on organizational commitment, and job satisfaction has a positive and significant impact. Just like the findings of research conducted by F. Gheisari, A. Sheikhy, and S. Salajeghe (2014), it was found that there is a positive relationship between organizational climate and organizational commitment, work involvement, and organizational citizen behaviors and organizational climate and work engagement.

Drawing upon various theories and relevant research, it becomes imperative to gauge the depth of employee perceptions regarding organizational commitment, job satisfaction, and work involvement within Seabridge Port Agencies Corp-Indonesia. Findings from an initial survey conducted by researchers, employing Zikmund's (2013) theoretical framework with a sample size of 30 respondents, indicate that overall employee organizational commitment to the company remains relatively low.

There are 3 (three) dimensions of organizational commitment, namely the affective commitment dimension, the continuous commitment dimension, the normative commitment dimension (Fuad Mas'ud, 2004) and based on the results of the initial survey found several indicators of real scores still below the standard score (score = 540), these indicators include completing work on time (score = 512), prioritizing work over personal interests (score = 494), understanding the institution's strategic policies (score = 481), being ready when assigned by the institution (score = 450), getting attention from the institution related to needs and desires (score = 482), paying attention to the rules and regulations of the institution (score = 515), happy to work and be part of the institution (score = 431) and working at the institution until retirement (score = 504).

Assessing job satisfaction poses a considerable challenge as it is inherently subjective, influenced by individual desires that are continually evolving, often leaving a sense of perpetual discontent. Each employee harbors unique criteria indicative of their satisfaction levels.

Job satisfaction is a feeling that employees have towards their work, either in the form of pleasant or unpleasant feelings. If employees feel happy with their work, it will cause motivation to work as well as possible. Conversely, if employees feel unhappy with their work, the motivation to carry out work will also be low, so productivity will be low as well (Machmed Tun Ganyang, 2018, p.229). Employees are very important assets for employees, thus companies must continue to strive to increase employee job satisfaction.

The results of an initial survey conducted by researchers on job satisfaction using the same method as organizational commitment, show that the majority of job satisfaction is still relatively low. There are 5 (five) dimensions, namely the dimension of salary / wages received, the dimension of promotional opportunities, the dimension of coworker relations, the dimension of supervision, the dimension of the work itself (Fuad Mas'ud, 2004) and based on the results of the initial survey found several indicators of real scores still below the standard score (score = 675), these indicators include wages (score = 521), benefits (score = 497), bonus (score = 418), career opportunities (score = 360), achievement (score = 329), position (score = 547), interaction (score = 360), cooperation (score = 466), communication (score = 572), working relationships (score = 536), support (score = 370), guidance and supervision (score = 422), interesting work (score = 565), responsibility (score = 538) spirituality (score = 264).

In the integrative model of organizational behaviors (Colquitt, LePine and Wesson, 2015), organizational commitments an outcome, alongside job satisfaction, that is heavily influenced by other variables. In an organization, many factors are related to job satisfaction.

Furthermore, according to Robbins and Judge (2015, p. 134), what makes people more likely to be involved in their work. One of the keys is the existence of which workers believe the benefits of being involved with work. This is partly determined by the characteristics of the job and access to adequate resources to perform effectively. Another factor is the congruence between individual values and organizational values. Leadership behaviors that inspires workers towards a higher mission spirit can also increase employee engagement.

Albert (2015) argues that organizational commitment involves a strong sense of trust and acceptance of the organization's values, willingness to work hard, and maintain the integrity of its members. Besides the strong desire of members to stay in the organization and have psychological ties.

The results of the initial survey conducted by researchers on work involvement using the same method as organizational commitment and job satisfaction show that work involvement is generally still relatively low. There are 3 (three) dimensions of mental and emotional involvement, the dimension of motivation for contribution and the dimension of responsibility (Fuad Mas'ud, 2004), based on the results of the initial survey found several indicators of real scores still below the standard score (score = 540), including actively involved in every activity of the institution (score = 488), involved in every meeting / meeting conducted by the institution (score = 432), always carry out tasks well (score = 527), always show good performance (score = 512), always provide input and suggestions for the progress of the institution (score = 455), always be innovative in carrying out work (score = 492), provide new ideas in carrying out work (score = 464), always try to complete every job (score = 512), priorities institutional work over personal work (score = 494).

Building upon the findings of the preliminary survey, the persistence of this condition could potentially evolve into a significant organizational challenge. The evaluation of individual employee perceptions regarding organizational commitment, job satisfaction, and work involvement becomes imperative for organizations to conduct a comprehensive review and analysis of HR management practices, ensuring their vitality and health. The aim of this study is to ascertain the breadth of employee perceptions concerning organizational commitment, job satisfaction, and work involvement within Seabridge Port Agencies Corp-Indonesia.

The research team employed a survey methodology utilizing descriptive explanatory techniques. These techniques aim to elucidate perceptions based on respondent feedback. Data were sourced from both primary and secondary sources. Primary data originated from employee records at Seabridge Port Agencies Corp-Indonesia, while secondary data were gleaned from relevant documentation or reports. Data collection methods included questionnaire administration to gather primary data through a series of inquiries distributed to respondents, complemented by observational techniques for acquiring additional information not readily quantifiable.

Research Methodology

The method used by the research team was a survey method with descriptive explanatory techniques. Descriptive explanatory techniques are used to obtain information about perceptions.

The data sources collected by researchers are primary data sources, sourced from employee data of the ship agency company Seabridge Port Agencies Corp-Indonesia, and secondary data sources derived from documentation or reports available at related companies.

Data collection techniques consist of questionnaire techniques, namely collecting primary data using a list of questions and distributed to respondents, and observation techniques, namely by direct observation to obtain other information that cannot be estimated.

Population according to Sugiyono, 2013, p.61 is a 137eneralization area consisting of objects / subjects that have certain qualities and characteristics set by researchers to study and then draw conclusions.

The population in this study were 30 employees of the ship agency company Seabridge Port Agencies Corp-Indonesia.

The sample according to Sugiyono, 2013, p. 62 is part of the number and characteristics possessed by the population. In this study, the sampling method used nonprobability sampling method with saturated sampling technique (census). Saturated sampling (census) (Sugiyono, 2013, p. 65) is a sampling technique used to determine samples with all members of the population used as samples. So in this study the sample amounted to 30 respondents.

This research, using data processing methods with a quantitative approach. Arikunto (2006, .12) argues that quantitative research is a research approach that is widely required to use numbers starting from data collection, interpretation of these data, and the appearance of the results.

Data Analysis and Discussion

Data analysis for this study raised 3 (three) research variables consisting of organizational commitment, job satisfaction and work involvement. Responses from respondents to each research variable through descriptive analysis of each dimension per variable.

Descriptive analysis is used to determine the basic characteristics of respondents' perceptions of the three variables used from respondents. The analysis method used in the descriptive analysis of this research is frequency distribution. Descriptive analysis is used for variables that are qualitative in nature by classifying, tabulating and describing the data obtained in the field.

Based on the distribution of questionnaires as many as 30 samples to employees of the ship agency company Seabridge Port Agencies Corp-Indonesia, who served as respondents. After collecting the results of filling out the questionnaire by the respondents, it turned out that 30 were returned (all returned) and all were declared valid.

Analysis of the respondent's profile is with the characteristics of respondents who have been determined to consist of Four characteristics, consisting of:

Gender

The characteristics of respondents according to gender and the majority of respondents of the ship agency company Seabridge Port Agencies Corp-Indonesia are men at 97.2% while women are 2.8%. This shows that the ship agency company Seabridge Port Agencies Corp-Indonesia is dominated by men.

Last Education

The characteristics of respondents based on the latest education of the Seabridge Port Agencies Corp-Indonesia ship agency company show that most of the respondents are Bachelor Degree Graduates Strata-1 (S1), namely 68.1%, followed by respondents with Diploma-3 (D3) graduates as many as 22.9%, and respondents with Bachelor Degree graduates Strata-2 (S2) are the least respondents, namely 9%. This shows that most of the employees of the ship agency company Seabridge Port Agencies Corp-Indonesia are Strata-1 (S1) graduates with managerial skills and relatively young age.

Age

The characteristics of respondents based on age, it can be seen that the age of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia shows that most of the respondents are between 20 and 30 years old, namely 40.6%, followed by respondents aged 31 to 40 years as many as 30.3%, and respondents aged 51 to 60 years are the least respondents, namely 4.6%. This shows that most employees of the ship agency company Seabridge Port Agencies Corp-Indonesia are employees at productive age.

Position

The characteristics of respondents based on the position of the ship agency company Seabridge Port Agencies Corp-Indonesia show that respondents in the position of director 3.3%, general manager position 3.3%, operational manager position 3.3%, accounting manager position 3.3%, operational officer position 33.3%, marketing officer position 33.3% and accounting officer position 20.2%. These respondents are all permanent employees of the company.

Descriptive analysis of each variable studied was carried out by calculating the score and average of the total score of each variable, determining the interval in five categories. The measurement scale with unfavourable 1 to 5, namely Strongly Agree (score 1), Agree (score 2), Disagree (score 3), Disagree (score 4), and Strongly Disagree (score 5). The intervals in the categories were determined using data transformation (Zikmund, William G., et. Al., 2013, p. 494), that is the interval range calculated using the above equation is as follows:

Interval Range = (5-1) : 5 = 0.8 (Zikmund, William G., et. Al. 2013, p.494). By using a range value of 0.8, the interval class is determined from the lowest to the highest by adding the interval range to each interval class level. Based on the description of these stages, the value categories for the research variables are shown in the table below.

Table 1. Value Ranges and Categories

Score	Score Interval	Categories
1	1,00-1,80	Very Low / Very Poor
2	1,81-2,60	Low/Poor
3	2,61-3,40	High enough / Good enough
4	3,41-4,20	High/Good
5	4,21-5,00	Very High / Very Good

The results of the analysis of employee perceptions of organizationalCommitment, Job Satisfaction, Work Involvement of the ship agency company Seabridge Port Agencies Corp-Indonesia are divided into 3 (three) perceptions:

Based on the results of data analysis of respondents' perceptions of the work involvement of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia according to the figure below:

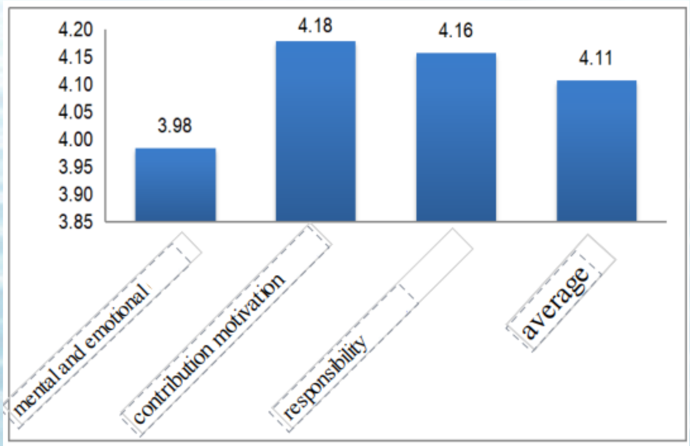

Figure 1. The results of the recapitulation of work involvement of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia

The work involvement of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia with an average total score of 4.11 is in the interval 3.41 to 4.20, this shows that the average work involvement of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia is perceived by respondents as relatively high. The high level of work involvement is dominated by respondents' perceptions of the motivation dimension with a total average score of 4.18 in the good category. While the dimension of mental and emotional work involvement is the lowest perceived work involvement dimension with an average score of 3.9 in the good category.

Based on the results of data analysis of respondents' perceptions of job satisfaction of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia according to the figure below:

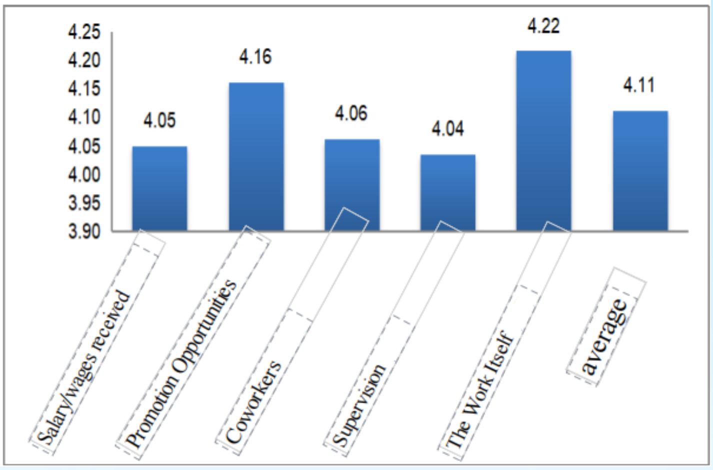

Figure 2. The results of the recapitulation of job satisfaction of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia

Job satisfaction of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia with an average total score of 4.11 is in the interval 3.41 to 4.20, this shows that the average job satisfaction of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia is perceived by respondents as relatively high. The high job satisfaction is dominated by respondents' perceptions of the dimensions of the work itself with a total average score of 4.22 in the very good category. While the supervision dimension is the lowest perceived dimension of job satisfaction with an average score of 4.04 in the good category.

Based on the results of data analysis of respondents' perceptions of the variable organizational commitment of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia according to the figure below:

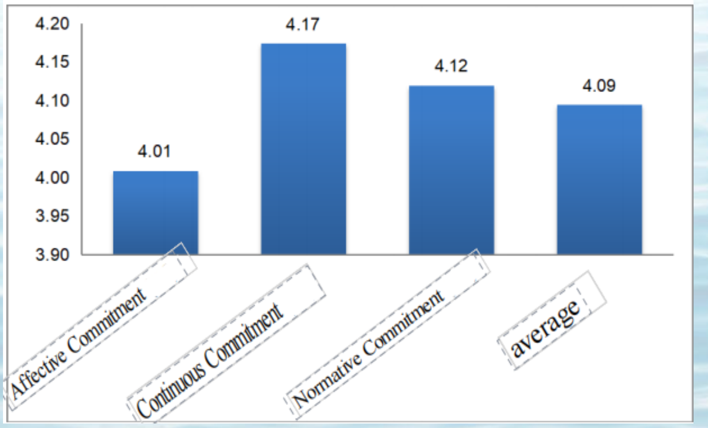

Figure 3. Results of recapitulation of organizational commitment of employees of ship agency company Seabridge Port Agencies Corp-Indonesia

The organizational commitment of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia with an average total score of 4.09 is in the interval 3.41 to 4.20, this shows that the average organizational commitment of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia is perceived by respondents as relatively high. The high level of organizational commitment is dominated by respondents' perceptions of the continuous commitment dimension with a total average score of 4.17 in the good category. While the affective commitment dimension is the lowest perceived organizational commitment dimension with an average score of 4.01 in the good category.

Conclusion

Work involvement contributes to increasing Job Satisfaction according to the results of data analysis researchers increase work involvement by increasing the mental and emotional dimensions and increasing the responsibility dimension. The results of the analysis of the highest description of the work involvement variable is to maintain the Motivation dimension of the contribution of 4.18. The work involvement of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia with an average total score of 4.11 is in the interval 3.41 to 4.20, this shows that the average work involvement of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia is perceived by respondents as relatively high. Job satisfaction contributes to increasing organizational commitment according to the results of data analysis researchers increase job satisfaction by increasing the dimensions of the dimensions of salary / pay received, the dimensions of promotional opportunities, the dimensions of colleagues and the dimensions of supervision. The results of the analysis of the highest description of the job satisfaction variable is to maintain the dimension of the work itself of 4.22. Job satisfaction of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia with an average total score of 4.11 is in the interval 3.41 to 4.20, this indicates that the average job satisfaction of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia is perceived by respondents as relatively high. Work involvement, job satisfaction contributes to increasing organizational commitment according to the results of data analysis researchers increase organizational commitment by increasing the dimensions of affective commitment and dimensions of normative commitment. The results of the analysis of the highest description of the organizational commitment variable is to maintain the dimension of continuous commitment of 4.17. organizational commitment of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia with an average total score of 4.09 is in the interval 3.41 to 4.20, this indicates that the average organizational commitment of employees of the ship agency company Seabridge Port Agencies Corp-Indonesia is perceived by respondents as relatively high.

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IMPLEMENTATION OF MECHATRONIC SYSTEMS TEACHING IN UNDERGRADUATE (BACHELOR) AND MASTER'S DEGREE PROGRAMS IN MARITIME EDUCATION

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Abstract: The strategic priority of Georgia is to promote the development of the maritime industry, which implies the improvement of academic educational programs and learning environments by international standards of marine education. Most modern industrial installations (offshore and seagoing vessels) are controlled by software (processors, microcontrollers, mini and microcomputers). It is essential to ensure the smooth operation of such systems, which directly affects the technological process. Training qualified personnel in this field is the main guarantee for solving the problem. Active educational programs at Batumi State Maritime Academy (BSMA) are focused on the management, maintenance, assembly/operation, and planning of automated systems in accordance with the level of education (Bachelor's and Master's). BSMA provides appropriate laboratories for conducting practical and research works. Purchasing of laboratory stands of mechatronic systems at BSMA has become possible within the framework of the grant project "Implementation of Mechatronic Education Systems at Bachelor's, Masters and Vocational Education Levels in BSA Education Programs" which was financed by the World Bank and the Ministry of Education of Georgia (Georgia I2Q - Innovation, Inclusion, and Quality, Competitive Innovation Fund (CIF)). The article discusses the implementation of mechatronic systems teaching in BSMA educational programs of Engineering Faculty. Implementation of the mentioned changes will contribute to the preparation of appropriate personnel for maritime industry infrastructure to meet the requirements of the modern international market.

Keywords: mechatronic system, bachelor's degree, master's degree, study program.

1. Introduction

In general, mechanization and automation of industrial facilities, including ships and ports, is the main stage of scientific and technological progress.

Mechanization is a stage of technological development characterized by the individual's liberation from hard physical labor. Automation is logically the next stage of mechanization, providing automatic control of mechanical, hydraulic, pneumatic, or electrical systems. The intensive implementation of automatization and automatics in the industry, including vessels and ports, contributes to the development of such branches of sciences as electrotechnics, electronics, informatics, and cybernetics. Combining these fields for one purpose, which is shown by the development of a mechanism motion module that is a synergistic combination of mechanical, electronic, and electronic components and information and software, creates a new direction - Mechatronics.

The term mechatronics (MECHATRONICS) is derived from the combination of two words - “MECHAnics” and “elecTRONICS”. It was first presented in 1969 by the Japanese firm Yaskawa Electric and registered as a trademark in 1972. In the 1980s, the term mechatronics became well-established in the industry.

Nowadays, more and more courses are appearing in the program of engineering at higher educational institutions, the purpose of which is to discuss the issues of automatic control of mechanical, electromechanical, hydraulic, or pneumatic systems, which is carried out through microelectronics and cybernetic systems, i.e. intellectualization of these systems. Discussion of these issues is precisely the purpose of introducing such training courses into existing BSMA engineering training programs, such as: “Fundamentals of Mechatronics”, and “Mechatronic Control Systems”.

2. Main text

The combination of electronic and mechanical/hydraulic/pneumatic systems gives us a mechatronic system in which energy is converted based on relevant information.

Most modern industrial installations (offshore and sea-going vessels) are controlled by software (processors, microcontrollers, mini- and microcomputers). It is very important to ensure the continuous operation of such systems, which directly affects the technological process. Training of qualified personnel in this field is the main guarantee for solving the above task.

Similar to modern ships, the port and terminals operating in the Adjara region are also equipped with automatic control systems. It should also be noted that in the Adjara region, electro-engineering and electrical power engineering courses at Bachelor's and Master's levels are taught only at BSMA Academy, therefore it is very important to enhance these training courses by considering robotized automatic control systems.

Duties and responsibilities for employment as a marine engineer, electrical engineer, and rating electrician in the maritime industry are regulated by the STCW International Convention in Part A-III (Engine Room).

Based on the final report of the 5-year joint research between the International Chamber of Shipping (ICS) and the Baltic and International Maritime Council (BIMCO), which was presented to the Maritime Safety Committee (MSC) meeting of IMO in May 2016, shows that the requirement for the personnel of exploitation level has been increasing annually since 2010. It especially refers to the operating personnel of electrical installations like electrical engineers, engineers, and rating electricians.

The current BSMA bachelor's degree programs " Marine Engineering", and "Marine Electrical Engineering" are regulated and the goals, objectives, and learning themes of the programs fully correspond to the model courses published by the International Maritime Organization: STW 44-3-1 MODEL COURSE ON ELECTRO-TECHNICAL OFFICER, 2014" [1]," Model Course 7.04 – Officer in Charge of an Engineering Watch, 2014" [2].

Based on such documents, the development of competencies of motormen and rating electricians working on the deck or in the engine room is carried out according to the vocational training programs ("Ship Engine Room Operation", "Ship Deck Operation"). ("Model Course Electro-Technical Rating" 2018 Edition [3], „IMO T709E Model Course: Ratings Forming Part of a Watch in a Manned Engine-Room or Designated to Perform Duties in a Periodically Unmanned Engine Room, 2017 Edition [4]).

The engine room of modern ships is equipped with RT-Flex propulsion systems and other similar systems, which implies software for control and monitoring of the main propulsion system. In automatic mode, the speed and volume of fuel injection are controlled, maintaining stable pressure. The system is equipped with a microprocessor control system. Based on this, there is an increasing demand for the qualifications of service personnel.

In the model courses, the number of questions related to microprocessor control has increased. Up to now, this has only been taught at a theoretical level at BSMA. only during the onboard training period, students are familiarised with practical mechatronic systems and their functions.

Vessels in the ports of Batumi and Poti, on which students undergo onboard training, are less equipped with modern mechatronic systems. BSMA graduates are interviewed for jobs in the world's maritime agencies, and crewing companies where competition is high. Accordingly, the chances for employment depend on the knowledge and skills demonstrated in the interview. As we have already mentioned, the automation of modern ships is increasing day by day, and, logically, the demand for professionals with relevant competencies is also growing. That is why it is important to implement the teaching of the principles of Software Control Systems into the current maritime engineering educational programs at the Academy.

The current BSMA marine engineering educational programs, depending on the level of education (vocational, bachelor's, and master's), consider the management, maintenance, assembly/operation, and planning issues of automated systems. The Academy has adequate Laboratories where practical and research work can be carried out. Regarding the study of automatic systems within the grant project "Introduction of mechatronic systems teaching at undergraduate, graduate and vocational levels in BSMA educational programs", which was funded by the World Bank and the Ministry of Education of Georgia (Georgia I2Q - Competitive Innovation, Inclusion and Quality (CIF) Fund) there was an opportunity to purchase mechatronic system laboratory stands in the relevant laboratory.

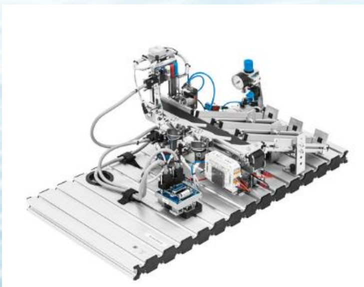
A course on “Mechatronics Fundamentals” will be included in the Bachelor's degree programs “Marine Engineering”, “Marine Electrical Engineering”, “Ports and Transport Terminals Operation”, and a course on “Mechatronic Systems Management” will be added to the Master's degree program “Ship Power and Electric systems and Plants”. The goal of this modification is to enable the student to maintain mechatronic systems, determine mechatronic system assembly, fabricate mechatronic system parts, assemble nodes and sub-nodes, install electrical devices, and assemble devices and mechatronic systems in accordance with various levels of education. He/she should be able to: correctly describe the technological process of manufacturing parts of mechatronic systems; correctly list the tools and equipment required to fabricate mechatronic system parts; follow safety rules when working with mechatronic systems; Identification of potential risks. After completion of the course, when testing assemblies and mechatronic systems of the machine, the student must correctly select the testing procedure according to the instructions, draw up the test document for the mechatronic system according to the standard, consult the user based on the documentation of the mechatronic system, establish professional relations with consultants/specialists during repairs, and be able to obtain the necessary resources and methods required for the job. Selecting and implementing an optimal work plan.

To solve the above-mentioned tasks, it is necessary to conduct laboratory works on a complex laboratory stand, which can be used for electro-mechanical, electro-pneumatic, and electro-hydraulic exercises [5]: assembly and control of circuits containing programmable logic controllers; Assembly and testing of mechatronic systems (Electro-mechanical, electro-hydraulic and electro-pneumatic) nodes. Stands and equipment purchased at BSMA (Figure 1):

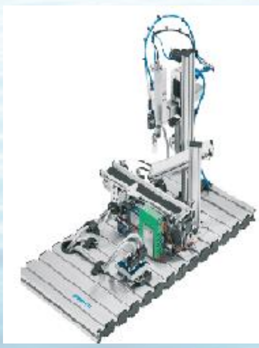
- Edutrainer D:ETER2-MOD-POWER-24-DE;
- ROBOTINO D-RO4-BG-KPL/ROIV-A-LG2;
- D:MP4-S-SO-KPL;
- D:MP4-S-VE-BD-KPL.

a

b



c



d

Figure 1. FESTO Laboratory devices: a- EduTrainer Siemens S7-1500; b-Teaching Robotino 4 (MPS 400); c-Sorting station MPS D; d-Distributing station MPS D

Methods for building integrated mechatronic modules and systems are provided in the undergraduate curriculum literature:

- Analysis of the mechatronic system by the indicator of functional-structural integration;

- mechatronic motion modules (motor-gearboxes, linear motion, “motor-working body”, etc.);
- Analysis of intelligent sensors of mechatronic modules and systems.

At the master's level, basic concepts and definitions in computer control of mechatronic systems and computer-based hardware for motion control systems will be discussed. Accordingly, in the laboratory, tasks related to the operation of a network production line and control station are discussed.

3. Conclusion

Adding courses on new mechatronic systems to the curriculum will promote the training of appropriate personnel in the maritime industry and land-based infrastructure to meet the requirements of today's international market.

Analysis of the BSMA student survey revealed a strong interest in developing skills to operate/maintain robotic systems. Therefore, training sessions are provided. These sessions are mostly planned for those students who are not able to make changes to their curriculum during their studies (mainly fourth-year bachelor's degree students and second-year master's degree students.).

Students of maritime vocational education (“Ship engine room operation”, “Ship Deck Operation”) will also be able to undergo training.

Acknowledgements

The introduction of a new education courses is provided by the grant project "Introduction of Mechatronic Systems at Bachelor's, Master's and Vocational Education Levels in the BSMA Educational Programs", which is financed by the World Bank and the Ministry of Education of Georgia (Georgia I2Q - Innovation, Inclusion and Quality within the framework of the Competitive Innovation Fund (CIF)).

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THE GLOBAL MARITIME CITIZENSHIP PROGRAM: INTEGRATION OF THE GCED FRAMEWORK TO THE BOK-STCW-TRB LEARNING OUTCOME MATRIX FOR BS MARINE ENGINEERING PROGRAM

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Abstract: With the current pace towards decarbonization and digitalization in the maritime industry, being technically competent in conformance with the STCW is inadequate. A modern seafarer must possess critical thinking and soft skills to be at pace with the sophistication of the industry, which is the main objective of establishing the Global Maritime Professional- Book of Knowledge (GMP-BoK) by IAMU. Despite integrating the two frameworks, STCW and GMP-BoK, there is still a lacking component for futureproofing the next generation of resilient seafarers, and that is the shifting of their mindset and perspective through the lens of the United Nations Sustainable Development Goals (UNSDG). This is where the integration of the elements of Global Citizenship Education (GCED) comes into play. To address such a problem, this study has developed a learning outcome matrix integrating the frameworks of the STCW, GMP-BoK, Training Record Book (TRB), and the GCED, leading to a holistic, resilient, and paradigm-shifting BS Marine Engineering curriculum. A qualitative research design utilizing theory triangulation with document analysis was employed in the development of the four-axis matrix which could serve as a guide in the crafting of the learning outcomes that will lead to the transformation of future global maritime professionals into future global maritime citizens.

Keywords: global citizenship education; sustainable development goals; curriculum development; maritime education and training

1. Introduction

The shipping industry is now on the brink of transformative change with all the different developments that are occurring, such as the emergence of Maritime Autonomous Surface Ships (MASS), decarbonization technologies such as alternative fuels, wind power systems, and electrification, and digital technologies such as blockchain technology, digital twin, Internet of Things (IoT), and big data analytics (Stefani & Apicella, 2022). With the increasing call towards climate change mitigation brought about by the different natural calamities and phenomena felt across the globe coupled with the recently occurred COVID-19 pandemic, the toppling of the dominoes towards digitalization and decarbonization is now faster than ever (Transport 2040: Automation, Technology, Employment- The Future of Work, 2019). This can be felt in the progress of the new regulations being set forth by the International Maritime Organization (IMO) with the progress in the adoption of medium-term measures for greenhouse gas emissions (GHG), the development of the MASS Code, and the evolving discussions in cybersecurity which goes hand in hand with the technological and operational development by other stakeholders (Kaspersen et al., 2022). Seafarers, being the primary unit of the workforce, are not immune from these changes. Rather, they are at the receiving end of the ever-enlarging snowball of development and thus will need to adapt to stay relevant in the 21st century (Transport 2040: Impact of Technology on Seafarers- The Future of Work, 2023). One such impact is shifting the skills required to be effective in the modern shipping industry, which results in a skills gap. According to Kitada et al. (2024), the most important skills a seafarer should have to be resilient are soft and critical thinking. The rapid changes in the industry require seafarers who have these skills to keep up with the pace, but as of now, current figures point to approximately 800,000 seafarers who need reskilling and upskilling in response to the new technologies brought forth by decarbonization, which is exacerbated by the parallel evolution in digital technology (Kaspersen et al., 2022).

Responding to the challenges brought forth by the said developments, maritime education and training (MET) plays a critical role in preparing the manpower resources to effectively handle the new technologies developing now and, in the future, (Sharma et al., 2021). Despite efforts to revise the STCW Code, the convention, as presently constructed, only addresses the technical competencies needed for the mature and current technologies, which can be said of the same as the TRB. Thus, IAMU initiated the GMP-BoK framework to address the gaps presented by the STCW Code and the TRB by expanding the approach to a more holistic one with the inclusion of additional focus areas for soft skills, technological skills, sustainability awareness, etc., across the three learning domains (IAMU, 2019). However, according to Dewan and Godina (2024), aside from equipping seafarers with the needed skills, a critical factor that needs to be considered to assess the effectiveness of training and education is the motivating factor. It has been observed that external factors, which leave a lot to be desired, such as incentives and appraisal, can go a long way in influencing seafarers to incorporate the mantra of efficiency and sustainability into their normal shipboard routine. However, to take this one step further, intrinsic motivation must be utilized for a much more sustainable effect, which can be done through a fundamental shift in the paradigm and mindset of the workforce, developing their inner "moral responsibility" in their line of work (Dewan & Godina, 2023).

An emerging trend developing in other strands of education is the inculcation of Global Citizenship Education (GCED), in which the primary aim is to mold students to become global citizens, taking part in addressing the contemporary and looming global issues for a more sustainable planet. The philosophy behind GCED is that students become more part of the solution if their mindsets and perspectives about global issues are honed as part of their education (Alvero, 2023). GCED is being promoted by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as an instrument of transforming young people towards attaining the 17 UNSDGs (UNESCO, n.d.). There are various ways of integrating GCED into education, from full-scale curriculum integration to elective course development, and even supplementation of extracurricular activities (UNESCO, 2014). With the integration of GCED into MET lagging behind other educational programs, a plethora of possibilities are waiting to be unlocked with such innovation, including the shaping of the mindset and perspective of future global maritime professionals in preparation for a future of green, efficient, and digital shipping (Nhleko, 2022).

This study explores the full-scale integration of the GCED framework into the BS Marine Engineering (BSMARE) program, specifically in the Philippines, by cross-mapping the GCED framework provided by UNESCO with the GMP-BoK, STCW Code, and the TRB (UNESCO, 2014). Incorporating the GCED supplements the technical development in compliance with the international regulation of the STCW Code, the practical approach of TRB, and the holistic approach of the BoK with the mindset development needed towards sustainability and efficiency. This also enhances the sustainability dimension of the GMP-BoK, which is only encapsulated in one knowledge, skill, and attitude (KSA). Curriculum integration is the most recommended and most effective way of integrating GCED as the mechanism of honing global citizens involves an evolutionary method across a longer period (Cox, 2017). The scope of this study is significant to establish due to the difference in the MET structure across different countries wherein the BSMARE program in the Philippines only covers Table A-III/1 of the STCW Code, and the application of the GCED framework varies according to the local context of each country or region (UNESCO, 2014). To attain the primary objective of the study, which is to integrate the GCED framework into the BSMARE program through the development of the learning outcome (LO) matrix, the following specific objectives should be met:

- Analysis of the triumvirate of the STCW-TRB-BoK for learning outcome matrix
- Analysis of the GCED framework in relevance to the BSMARE program
- Cross-mapping of the GCED learning outcomes to the STCW-TRB-BoK matrix
- Development of the LO matrix with the incorporation of the GCED learning outcomes

2. Methodology

The research methodology utilizes a qualitative approach with an exploratory method, specifically document analysis and theory triangulation. Document analysis was done on the GCED framework by cross-referencing it with the specialization framework catered to the maritime industry to ensure that relevant and applicable elements of the framework are integrated into the matrix (UNESCO, 2014). Another stage of document analysis was performed to ascertain the compatibility and alignment of the STCW-TRB-BoK triumvirate map to that of the GCED framework. The STCW KUPs utilized were in conformance with the BSMARE program being offered in the Philippines, which covers Table A-III/1 (CHED, 2022), which were cross-map with the intended learning outcomes (ILOs) of the GMP-BoK together with the TRB tasks (Bayotas, 2023). The triumvirate map was supplemented with another x-axis on the other side comprising the relevant LOs in the GCED framework from relevant SDGs covering the three learning domains. This theory triangulation resulted in a quadrilateral matrix with four encapsulating axes, which can be used as a guide in the development of the learning outcomes across different courses in the BSMARE program, fostering a progressive outcomes-based adult learning education (Nikolitsa-Winter et al., 2019).

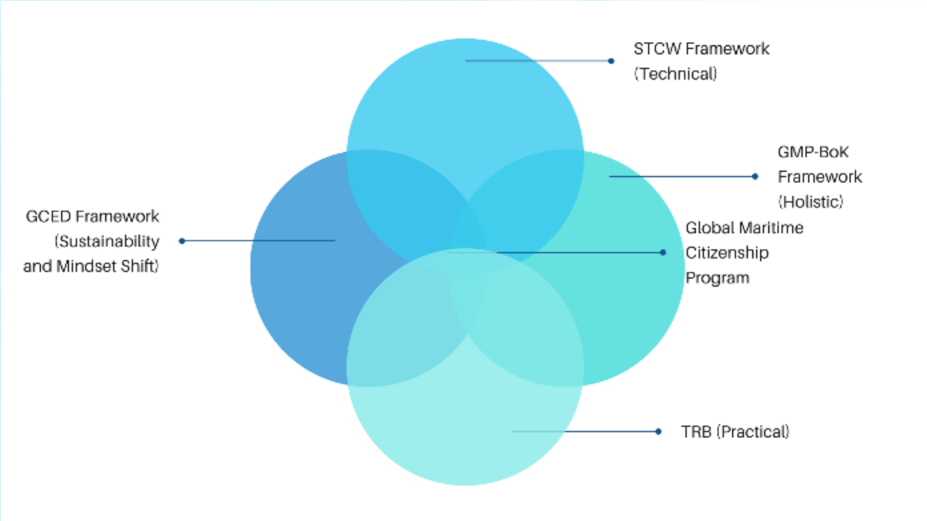

Figure 1. The concept behind the Global Maritime Citizenship Program.

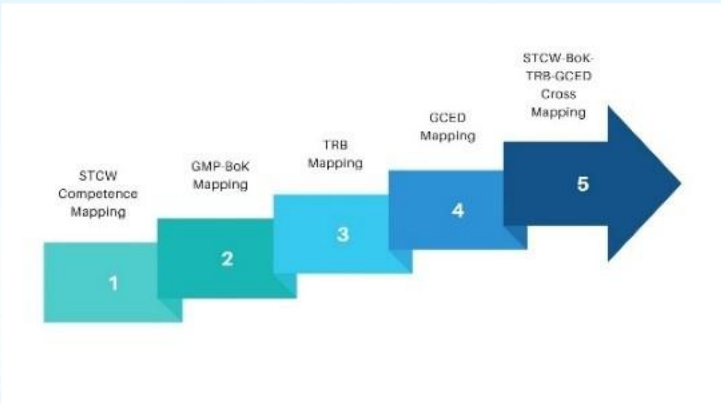

Figure 2. Process towards the integration of the GCED into the BSMARE program.

3. Results and Discussion

3.1. GCED Full-Scale Curriculum Integration: Rationale

Contemporary issues and trends emerging at a global and local scale, such as globalization, cultural diversity, environmental awareness, sustainability, and technological sophistication, prompted the initiation of the GCED by the United Nations to mold future global citizens who can positively impact the world by becoming part of the solution (Wintersteiner & Grobbauer, 2019). With the philosophical approach of lifelong and progressive learning promoted by GCED, which is also in line with the educational philosophy of the GMP-BoK, the incorporation of such a framework into any educational program can vary. Still, full-scale curriculum integration is deemed most effective, especially in the adult learning education environment implemented at the tertiary level (Nikolitsa-Winter et al., 2019). With the GCED having shallow infiltration amongst the different academic institutions across different disciplines, especially in MET, integrating such a framework will greatly contribute to producing a global maritime professional with the correct mindset of sustainability and efficiency suitable to the current trend of the maritime industry (Nhleko, 2022) (Cox, 2017). The GCED framework's salient features include the universality of the learning outcomes and its complementary structure that can be readily integrated into any education program. Curriculum developers must ensure that the LOs derived from the framework match the level of education of the learner as well as the relevance of such in their respective disciplines (UNESCO, 2014). A pioneering innovation such as the integration of GCED into MET can foster double-loop learning wherein future seafarers become more critical of their knowledge by assessing such knowledge through observation, research, and experience, leading to the development of characteristics such as adaptation, continuous learning, and critical thinking skills which are necessary tools in the 21st-century maritime industry (Ozdemir et al., 2023). This thought process has led to the exploration of the GCED framework as the missing link in the upgrading of the MET for the development of future global maritime professionals catering to the projected industry's demand.

3.2. STCW-TRB-BoK Analysis

Analyzing the content and structure of the three different frameworks, namely the STCW, GMP-BoK, and the TRB, it can be inferred that the three frameworks can be cross-referenced with one another due to their common content and converging outcome-based approach (Bayotas, 2023). However, triangulating the three frameworks with the GCED framework resulted in the following analysis: (1) the three functions of the STCW Code (Function 1-3) deal with purely technical competencies, with Function 4 solely allocated to the skills beyond the technical ones (soft skills, environmental protection, etc.) (Transport 2040: Impact of Technology on Seafarers- The Future of Work, 2023), (2) only the KSAs under the focus area of Professional- Soft Skills of the GMP-BoK covers the non-academic and non-technical aspect which is relevant to the GCED framework (Kitada et al., 2024), (3) since the TRB is developed based on the STCW framework, the same can also be said in which Function 4 tasks are the only ones relevant in the GCED integration (GlobalMET, 2011). This confirmed the compatibility of the GCED framework for cross-mapping with the other three frameworks anchored in the commonality covering the non-academic and non-technical aspects. It is noteworthy that the BSMARE program offered in the Philippines has only two courses covering Function 4 KUPs, excluding the competencies for stability and seaworthiness, namely Maritime Law and Management. Table 1 shows a representative triumvirate of the STCW-TRB-BoK under Maritime Law covering the three domains: cognitive, affective, and psychomotor. There are no ILOs included for the psychomotor domain as the BoK expects the students to manifest such psychomotor outcomes in the actual workplace after the academic program with the knowledge and skills developed in the METIs (IAMU, 2019).

Table 1. STCW-TRB-BoK representative triumvirate mapping under the course Maritime Law.

BoK ILO	**Knowledge of the Precautions to be Taken to Prevent Pollution of the Marine Environment**	
Cognitive Domain		
Explain how current global issues impact the maritime industry and professional practice		
Affective Domain		
Demonstrate belief in the need to have all stakeholders aware of and contributing to the discourse of global issues of relevance to the maritime industry		
Demonstrate knowledge and understanding of MARPOL Annex VI- Prevention of air pollution from ships. Know the SOx Emission Control Areas (ECA). Also understand limit imposed on sulphur content in fuel oil used within and outside ECA		

3.3. GCED Framework Integration

After analyzing the STCW-TRB-BoK framework, the compatibility and relevance of the GCED framework were established with the help of the determined anchoring points and non-academic and non-technical components. The GCED framework was then subsequently analyzed following the guidelines provided in the UNESCO Framework by identifying the relevant SDGs contributing to the program objectives of the BSMARE program as provided by the Commission on Higher Education of the Philippines. 13 SDGs were identified that are relevant which were then narrowed down into the learning outcomes per SDG that are relevant to the program across the three learning domains (UNESCO, 2014). Finally, the determined LOs from the GCED framework were then triangulated with the STCW-TRB-BoK, forming the fourth axis to the right of the BoK ILOs. This formed the LO matrix with four axes, one for each framework, wherein the curriculum developer can utilize such matrix in the development of learning outcomes considering the criteria set forth by the four relevant frameworks leading to a MET curriculum that is technical, practical, holistic, and sustainable, thus the Global Maritime Citizenship Program. Table 2 shows the representative LO matrix for the cognitive and affective domain, and Figure 3 shows the comprehensiveness of the whole matrix.

Table 2. STCW-TRB-BoK-GCED representative LO matrix for BSMARE program.

GMP-BoK Intended Learning Objectives		Knowledge of the precautions to be taken to prevent pollution of the marine environment	**GCED Learning Objectives**
Cognitive Domain			
25. Environmental Awareness, Sustainability, and Stewardship	**Demonstrate** environmental awareness and stewardship in simulated or real scenarios and **use** relevant equipment for environment preservation in compliance with all relevant legal instruments		The learner knows about prevention, mitigation, and adaptation strategies at different levels (global to individual) and for different contexts and their connections with disaster response and disaster risk reduction.
Affective Domain			
25. Environmental Awareness, Sustainability, and Stewardship	**Display** a professional commitment to environmental management and sustainable development and influence others		The learner is able to debate sustainable shipping methods.
Demonstrate knowledge and understanding of MARPOL Convention Annex I- Regulations for Prevention of Pollution by Oil. Understand what is meant by "Special Areas." Name these areas as per MARPOL Annex I			

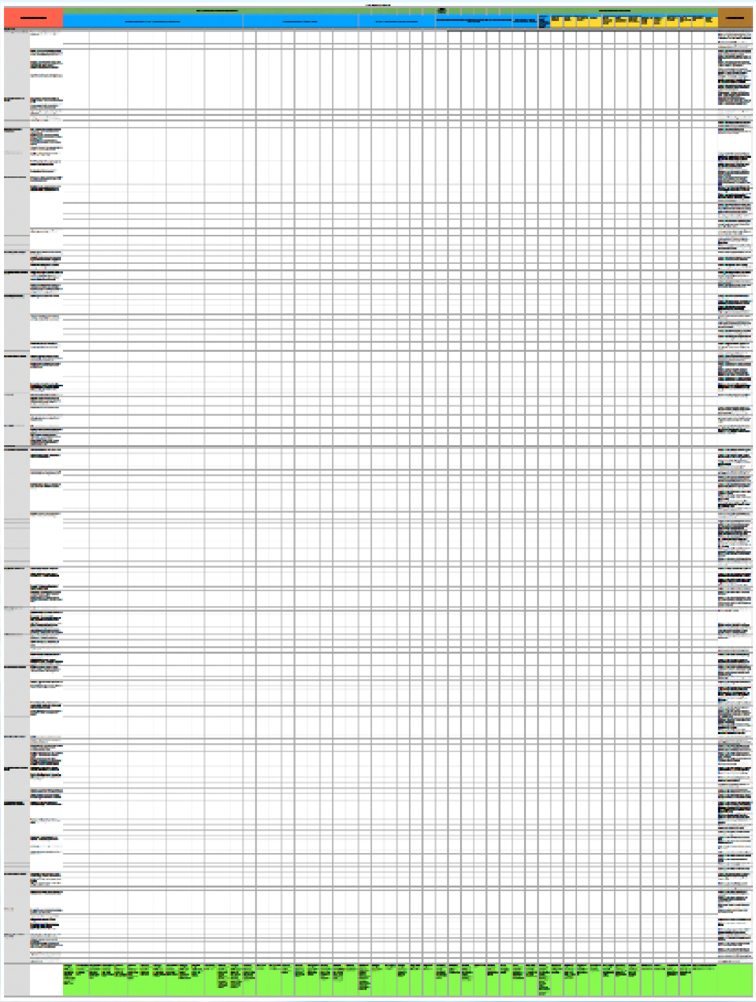

Figure 3. Comprehensive STCW-TRB-BoK-GCED LO matrix.

4. Conclusion

Based on the results and discussion, it is concluded that only the non-technical and non-academic components of the STCW-TRB-BoK triumvirate map can be cross-mapped with the learning outcomes from the GCED framework. This is composed specifically of the competencies in Function 4 of the STCW Table A-III/1, excluding the seaworthiness and stability competencies, along with the corresponding tasks indicated in the TRB, while for the GMP-BoK only the KSAs under the Professional-Soft Elements are relevant. In addition, guidelines are provided by UNESCO to determine the relevant SDGs for a particular field of study, along with the specific ILOs per SDG that could be incorporated in the GCED. Anchoring the triangulation of the four frameworks converging with the non-technical and non-academic aspects, an LO matrix with four axes consisting of the corresponding learning outcomes from the frameworks is formed, which can be used in the curriculum development towards a global maritime citizenship program, a global maritime professional with the sustainable mindset well-equipped for the 21st-century maritime industry. Moving forward, an alpha-test phase is recommended for applying such a matrix and a subsequent beta-testing phase should be done to ascertain its applicability across various institutions or local settings.

Acknowledgments

The author would like to extend his thanks and appreciation to his family and wife for their support and unending love. Finally, to AMOSUP and MAAP, headed by Chairman Conrado Oca and President VADM Eduardo Ma R Santos, for their unwavering support and mentorship.

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CHARTING A COURSE FOR COMPREHENSIVE EDUCATION OF FUTURE SEAFARERS THROUGH ENHANCED ACADEMIC PROFICIENCY

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Abstract: This article presents the authors' initiative to enhance the proficiency of future seafarers in academic disciplines related to fundamental sciences and humanities as an essential strategy to guarantee the long-term sustainability and competitiveness of the maritime sector. Understanding the fundamental concepts behind marine operations requires a strong foundation in the sciences, particularly chemistry, mathematics, and physics. We hope to promote a deeper comprehension of important ideas linked to navigation, ship stability, fuel efficiency, and environmental sustainability by raising seafarers' level of expertise in these areas. To this end, we are aiming at creating an online platform for learning and testing based on the fundamental knowledge acquired in the first two years of study.

Keywords: maritime higher education; fundamental sciences; maritime English; online platform for learning and testing

1. Introduction

This article presents the authors' initiative to enhance the proficiency of future seafarers in academic disciplines related to fundamental sciences and humanities as an essential strategy to guarantee the long-term sustainability and competitiveness of the maritime sector. Understanding the fundamental concepts behind marine operations requires a strong foundation in the sciences, particularly chemistry, mathematics, and physics. Moreover, English is the international language of shipping and therefore the ability to communicate effectively in English is of vital importance to the safe operation of ships. English language training is a mandatory requirement of the STCW Convention, which sets international standards of competence for seafarers. We hope to promote a deeper comprehension of important ideas linked to navigation, ship stability, fuel efficiency, and environmental sustainability by raising seafarers' level of expertise in these areas.

To this end, we aim to create an online learning and testing platform based on the fundamental knowledge acquired by students in the first two years of study and which will provide a continuous framework for information, learning, support and information transfer. The platform will be a Moodle (Modular Object-Oriented Dynamic Learning Environment) platform with a free Open Source license, with a Course Management System (CMS), also known as a Learning Management System (LMS) or Virtual Learning Environment (VLE). The platform will provide support for distance education and training, so that students and teachers have access to the training materials at all times; the system will allow the teacher to monitor the progress of learners towards the achievement of indicators, and support online training through virtual classroom sessions.

The platform will contain a set of components and modules, communication tools, virtual classroom and digital library. Teachers will be able to plan and carry out online training sessions in virtual classrooms with different training materials, check the students in the virtual classroom, observe whether the participants are logged in or not; the platform will allow communication through messages, video interaction, launch different tests for users and automatically calculate the results obtained for grid questions.

For all subjects, the teaching activities will be supported by materials with specific content, designed to support and guide the learning processes: online courses made available to students on the virtual platform, but also thematic applications created with a well-defined teaching intention, that is to say the structuring of knowledge and the application of procedures and approaches to solving problems presented in the course sessions. All these teaching materials will also prove their usefulness for the effective organization of learning in the context of the new educational scenario, focused on online education.

The development of this platform subscribes to the main objective pursued by the authors of this study, namely to offer support to students enrolled in the first two years of undergraduate studies by means of remedial and personal development sessions, with the aim of increasing their level of fundamental science knowledge, but also to prevent them from dropping out and to encourage them to continue their academic studies. Throughout their years of study, as they prepare for the future, education is an important part of students' lives, and their subsequent careers are a result of the academic training they have acquired.

The curricula and study programs are in line with international maritime requirements for seafarers' training (the STCW Code with the Manilla Amendments) and are aligned with the objectives of the Bologna Declaration. Thus, the curriculum for students in the 1st and 2nd years of study comprises several specialized subjects and a number of fundamental science and humanities subjects. These fundamental subjects are necessary for pursuing a career as a marine engineer/officer.

2. Background and motivation

In a context of continuous technological innovation, any university needs to provide their students with the necessary skills to meet the needs and demands of today's emerging society. Thus, the university curriculum is constantly changing, and the subjects with a maritime industry interface, such as digital, IT and database applications, computer-assisted training, etc. are changing or even periodically replaced.

Moreover, the expectations of employers in the maritime sector focus on the need for good practical training of employees, supported by modern information technologies and appropriate equipment. (Dinu et al., 2023)

Maritime officers should possess the necessary knowledge and skills for the competent operation of the computer systems with which modern ships are equipped, as well as various equipment and machinery controlled by computers. Systems such as engines, fuel supply, electrical power, and climate control require constant monitoring. Changes in temperature, fuel and oil flow rates and other parameters must be monitored, recorded, and analyzed. By using computers, the task of keeping track and analyzing is easier and improves overall performance.

Modern ships contain many different pieces of equipment and machinery that operate non-stop. Systems such as engines, fuel supply, electrical power, climate control, among others, require constant monitoring. Temperature changes, fuel and oil flows and other parameters must be observed, recorded and analyzed. By using computers, the task of keeping track and analyzing would be easier, which in turn improves overall performance.

Furthermore, the use of modern information and communication technologies (ICT) and their application on board ships makes life on board more manageable. Ships and their crews depend on different types of supplies. These include food, water, fuel, oil, spare parts and many others. By using computerized inventory management systems, records of supply utilization can be analyzed, and the data can be used to make utilization and supply more efficient. Routine maintenance can also be facilitated by systems that monitor daily machine utilization and record maintenance dates and times. Such systems help to remind the crew which systems need to be serviced and which need to be replaced.

Cargo operations require timely processing of cargo movements to and from ships. Systems that monitor the weight and trim balance of bulk and liquid cargo are vital not only for fast and efficient transfers, but also for the safety of transportation and port personnel.

ICT skills are also becoming increasingly important in port and port-related maritime industries, as technological advances require digitization of information exchange and automation of port operations (through connectivity to a local area network and the Internet, radio and satellite communication systems, computerized stock management systems, systems that monitor daily use of machinery and record maintenance data and schedules, automatic gate opening systems, development of container terminals, etc.).

As already stated, information technology education and training for students will be backed by an e-learning platform, built to enable participants to improve their knowledge and gradually assess their level of performance. The main aim of the training is to acquire skills in using the computer as a universal means of data processing, to use office programs for word processing, spreadsheets, graphics processing, communications, use of computer networks and the internet, etc.

The calculations for plotting the ship's course are based on knowledge of mathematics, specifically spherical trigonometry. As a critical aspect of promoting environmental sustainability, mathematics, i.e. mathematical models, are used by marine engineers to improve fuel efficiency and reduce emissions. Mathematical models also aid in planning and optimizing emergency response strategies for incidents like oil spills or ship collisions. And, most importantly, Mathematics is essential for budgeting, scheduling, and resource allocation in marine engineering projects.

Fundamental subjects entwine and basic knowledge in one of them makes it easier for students to understand and apply the other. Physics, for instance, is used to optimize the performance of propulsion systems, including engines and propellers. This involves thermodynamics, fluid dynamics, and vibration analysis which relies on mathematical calculus.

Mathematics also helps in modeling the dispersion of pollutants in the marine environment and devising strategies for minimizing environmental impact, which leads us to the importance of chemistry in maritime higher education. Marine engineers need to understand the chemical composition of various fuels (e.g., diesel, heavy fuel oil, LNG, etc.) to optimize engine performance and fuel efficiency. Moreover, the study of chemistry is essential for understanding the combustion processes that power marine engines, which is crucial for improving fuel efficiency and reducing emissions. Understanding the chemical reactions that cause pollution of the marine environment enables marine engineers to apply technologies aimed at reducing harmful emissions, such as sulfur oxides (SOx) and nitrogen oxides (NOx). At sea, marine engineers deal with the chemical processes involved in desalination in order to provide fresh water for ships and offshore platforms.

Technical manuals, research papers, and engineering documents used by maritime professionals are typically written in English, providing a common language for international collaboration and knowledge sharing. Thus, English serves as a common language for interdisciplinary teams working on maritime projects. As the nautical vocabulary in English is totally different from the general vocabulary, in the first two years of study students have to become familiar with the specialised terms concerning ship structure, ship types, crew structure, etc., and in the last two years, as they assimilate the specialised knowledge in their mother tongue, they have to master the corresponding professional terminology in English. Thus, at the end of their studies, graduates must be able to cope successfully with both job interviews and situations on board ship. As such, Maritime English provides students with the English language skills and knowledge necessary to perform their duties as future officers and marine engineers.

3. Scope of research and objectives

The economic, socio-cultural and technological transformations that shape the 21st century, namely globalization, internationalization, relocation of economic activities and the spread of digital technologies, proceed at an accelerated pace and pose new challenges for higher education institutions. Within this dynamic, teachers have to address groups of students with very diverse learning needs and abilities and who have diverse backgrounds in terms of their individual contexts, prior knowledge and training, belonging to a new learning culture in an interconnected digital environment.

In this context, one of our most important objectives is to harmonize the knowledge of the participants in the learning process, because there are obvious discrepancies in the educational background of high school graduates. Many of our students come from high schools with a humanities, sports, theological, artistic, etc. profile, where, obviously, the number of chemistry, mathematics, computer science classes in the school curriculum is much lower than in high schools with a real science profile, and, obviously, for these students the need for additional training arises for them to achieve the same level of knowledge as their peers.

One way to achieve this goal is the use of remedial sessions. This concept has been used in pedagogical practice especially since the period of the COVID 19 pandemic either online or in physical format in many higher education centers, as reported in the literature (Cascolan, 2024).

Thus, by implementing a system of remedial courses in the fundamental science courses that our students attend in the first academic year (or the first 2 years), we can ensure a starting point with all students at the same or fairly close to the same level of knowledge, and during the semester, topics/notions less understood during the courses are revisited as needed. In this way, we aim for the educational process to be carried out in optimal conditions and with improved results for all the beneficiaries of the educational act.

3.1. Methodology

Remedial classes are important educational and personal development tools in modern pedagogy. They are designed to help correct deficiencies, improve performance and achieve goals. (Topcsov, 2023) In order to achieve the objectives, the authors relied on several general stages to be attained in the implementation of remedial courses:

- **Identification of deficiencies**, in order to have a clear starting point and to see what needs to be improved or corrected.
- **Goal setting**, so that progress can be tracked and the success of the remedial plan can be evaluated. In this case, desiring to improve academic performance, the goal was for students to achieve better grades as a result of understanding the concepts studied in the subject areas. This step combines the goal regarding the deeper understanding of the subject, quantifiable by the grade obtained.
- **Planning actions**, specifically the remedial courses.
- **Resources and support**. An effective remedial plan requires adequate resources and support. The authors ensured that they have the necessary resources, i.e. textbooks, study materials, educational software, or other resources relevant to the area in which improvement is sought.
- **Monitoring and Evaluation**. During the implementation of the remediation plan the authors continuously monitored progress and evaluated the results so that the plan remained on track toward achieving the goals. Constant feedback is essential to measure the effectiveness of the plan and to make improvements along the way. It is important to establish evaluation periods to check whether goals are being met or if changes to the plan are needed. This ongoing monitoring process ensures that the plan adapts to changing circumstances or individual needs.
- **Finalization and Evaluation**. Once goals have been achieved and the remedial plan has been finalized, it is important to evaluate the entire process. This evaluation helps in learning from the experience and determining what worked and what could be improved in the future. The final evaluation gives an overview of the results achieved and shows whether the objectives have been achieved as expected or whether further efforts are needed.

The authors attained these stages by means of five steps as described below. For brevity reasons and to avoid redundance, the identical parts will only be described explicitly in the case of chemistry. For example, in step 1 below, all initial tests were taken during the first class and lasted for 50 minutes. If relevant, specific details will be provided for each subject.

3.1.1. Chemistry

Chemistry is a fundamental subject that is studied by the students of the Faculty of Marine Engineering in the first academic year. The development of the syllabus for this subject is in accordance with the STCW provisions, so that the cognitive items are covered in four chapters, as follows:

- Chapter 1. Fundamentals of Chemistry

- Chapter 2. Quality parameters for technical water used on board ship

- Chapter 3. Electrochemical corrosion. Corrosion protection methods in the field of naval materials.

- Chapter 4. Petroleum products. Marine fuels. Mineral oils

The STCW stipulates a certain number of hours for both teaching-learning and laboratory activities. For the understanding of theoretical knowledge and the training of practical skills a number of laboratory works are planned, mainly focused on the determination of physico-chemical characteristics of technical water and kinetic and rheological properties of petroleum products.

In order to ensure that the students have the necessary information to understand the specific chemistry concepts with applicability in the naval field, we implemented a series of consecutive stages of evaluation of the theoretical concepts known by the high school graduates and of the study that took place mainly in the first 4 weeks of the semester, that is exactly the time allocated to the first chapter.

- Step 1. Initial identification of individual level of theoretical knowledge

To this end, the students took an initial test of fundamental knowledge of chemistry, which they should have acquired during middle and high school. The test, which lasted 50 min, was given in the first lesson and the grades obtained are shown in Table 1. The results of the initial test gave the authors an overview of the students' level of knowledge, as well as future approaches to the structure and method of teaching.

- Step 2. Identifying cognitive problems and remedying them

From the analysis of the initial tests, several common problems were identified, uncertainties or misunderstandings experienced by most students. The most common were:

- writing chemical formulae and chemical reactions correctly;
- applying calculation algorithms to stoichiometry problems;
- calculating concentration types;
- knowledge of the types of chemical bonds and their role in determining the chemical properties of a substance;
- identifying, writing formulae and knowing the main properties of hydrocarbons.

Thus, following the analysis of the initial tests, one remedial course per week for 4 weeks was scheduled and held, which, together with the courses provided in the subject description, helped the students to clarify a number of uncertainties they had in relation to writing the formulae of inorganic substances, chemical reactions between inorganic substances, recognizing the chemical bonds in an inorganic substance, and calculating the concentrations of solutions. Modern and attractive teaching methods (chemical crossword puzzles, associations, chemical anagrams, chemical experiments, etc.) were used to consolidate the knowledge, so that the understanding and retention of theoretical concepts could be achieved in a relaxed way.

- Step 3. Evaluation of individual progress after the first cycle of remedial sessions

After the 4 weeks of initial remedial classes, students took a test with items similar to the initial test, but only from the updated and previously presented notions. The results show that in most cases there was a significant improvement in the knowledge and use of basic inorganic chemistry concepts, which is particularly important in understanding the specific aspects of chemistry used on board. The individual progress assessment grades are shown in Table 2.

Tables 1 and 2 show the results obtained by students on the initial test as well as after the first round of remedial classes.

Table 1. Results of the initial test - 100 students

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Number of students	26	18	18	11	8	10	6	3

Table 2. Results obtained when assessing progress after the first cycle of remedial classes

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Number of students	6	6	18	18	14	15	14	9

- Step 4. Identification of the misunderstood aspects during the semester and their remedial actions

During the following 8 weeks, remedial courses were carried out in which the subject matter taught at the faculty was explained in more detail, with emphasis on integrating theoretical concepts into various laboratory applications, as well as addressing real problems encountered on board vessels (technical water treatment, corrosion of metal installations, properties of fuels and lubricants, etc.), in accordance with the STCW requirements. Considering that organic chemistry was studied very little by most of our students in high school and that the properties of petroleum products depend very much on their hydrocarbon composition, more emphasis was placed on hydrocarbon classification, modeling the structures of the main aliphatic and aromatic hydrocarbons and on the knowledge of the main physicochemical properties of hydrocarbon classes.

- Step 5. Evaluation of individual progress on completion of remedial courses

At the end of the remedial courses, the students took a test on the concepts discussed, and the results are shown in Table 3. The results were encouraging and showed that, although chemistry is considered by most of them as a complicated and overly theoretical subject, with the help of additional time resources and diversified teaching materials, as well as more involvement from all those who participate in the educational process, it can become easier to approach, understand and use in solving practical applications.

Table 3 shows the results obtained by students in the final test (at the end of remedial courses)

Table 3. Results obtained in the assessment of progress on completion of remedial classes

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Number of students	4	5	12	18	18	17	14	12

3.1.2. Mathematics

Mathematical Analysis is a fundamental subject that is studied by students at the Faculty of Marine Engineering in the first academic year in both semesters. The development of the syllabus for this subject is in line with the STCW provisions (Appendix 2 to the Model Course 7.04 Officer in Charge of an Engineering Watch) that specifies that students need to be able to handle indices in their work on thermodynamics, for example. While students may not necessarily need to utilise logarithms in their day-to-day tasks, it is widely recognised that having a solid understanding of logarithms is crucial. The computation of numbers raised to power will be essential in other disciplines as well. Students may probably come across graphs with logarithmic scales at a later stage of their academic journey. [...] A marine engineer often analyses graphs and occasionally creates them. While it is not mandatory for students to do differentiation or integration, having a basic understanding of these ideas and how they are used can be beneficial. The concept of rates of change holds great significance in control engineering. The phrase dy/dx frequently appears in technical publications, making it essential for students to understand its meaning (IMO Model Course 7.04, 2013).

- Step 1. Initial identification of individual level of theoretical knowledge

The results of the initial test are shown in Table 4.

- Step 2. Identifying cognitive problems and remedying them

From the analysis of the initial tests, several common problems were identified, uncertainties or misunderstandings experienced by most students. The most frequent were:

- correctly writing mathematical formulae and applying them;
- applying calculation algorithms;
- knowing the links and relationships between the derivative of a function and the integral calculus;
- identifying, writing formulae and knowing the main properties of functions and their graphical representation.

- Step 3. Evaluation of individual progress after the first cycle of remedial sessions

After the four weeks of initial remedial classes, students took a test with items similar to the initial test, but only from the updated and previously presented notions. The individual progress assessment grades are shown in Table 5.

Tables 4 and 5 show the results obtained by students on the initial test as well as after the first round of remedial classes.

Table 4. Results of the initial test - 100 students

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Number of students	28	20	19	10	7	9	5	2

Table 5. Results obtained when assessing progress after the first cycle of remedial classes

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Number of students	17	14	21	15	10	11	8	4

- Step 4. Identification of the misunderstood aspects during the semester and their remedial actions

During the following eight weeks, remedial courses were conducted in which the content was explained in more detail, with a focus on integrating the theoretical concepts into various applications, as well as approaching real issues encountered on board ships in compliance with STCW requirements.

- Step 5. Evaluation of individual progress on completion of remedial courses

At the end of the remedial courses, the students took a test on the concepts discussed, and the results are shown in Table 6. The results were encouraging and showed that, after the remedial classes in several fundamental subjects, students became aware of the fact that, while the mathematical standards of the courses to be followed are not high, students will continue to use fundamental mathematics as a tool throughout their entire training and future profession.

Table 6 shows the results obtained by students in the final test (at the end of remedial courses)

Table 6. Results obtained in the assessment of progress on completion of remedial classes

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Number of students	10	8	12	18	16	15	12	9

3.1.3. Maritime English

Maritime English, although part of the Humanities, is studied as a fundamental subject during the first two years of study at the Faculty of Marine Engineering. The syllabus complies with the provisions of the STCW Code and with IMO Model Course 3.17, Maritime English which deals with maritime terminology and the use of English sufficient to allow the use of engineering publications and the performance of engineering duties concerned with the ship's safety and operation. The course also includes the terminology needed by an officer in charge of an engineering watch to make use of and understand manufacturers' technical manuals and specifications to converse with technical shore staff concerning ship and machinery repairs. (IMO Model Course 7.04, 2013)

Since Maritime English is totally different from the general vocabulary, in the first two years of study students have to become familiar with the specialized terms related to ship structure, types of ships, crew structure, engineering vocabulary etc. Once the specialized knowledge is acquired in Romanian, they will be also be expected to master the specialized notions in English. Thus, at the end of their studies, graduates must be able to successfully cover both job interviews and situations on board ship.

- Step 1. Initial identification of individual level of theoretical knowledge

The results of the initial test are shown in Table 7.

- Step 2. Identifying cognitive problems and remedying them

From the analysis of the initial tests, several common problems were identified, uncertainties or misunderstandings experienced by most students. The most common were:

- confusing similar spellings and words;
- misunderstanding of false friends;
- misuse of adjectives instead of adverbs
- the sequence of tenses;
- the use of conditionals.

- Step 3. Evaluation of individual progress after the first cycle of remedial sessions

After the four weeks of initial remedial classes, students sat for a similar test, which included the reviewed notions. The results showed an improvement in the knowledge and use of English both in terms of reading comprehension and in writing. The individual progress assessment grades are shown in Table 8. Although there were still students who showed a certain level of underachievement, their feedback showed that their results were also based on the personal linguistic background. As opposed to the other subjects that are taught in Romanian, which is the mother tongue of around 99% of the students, English is more difficult to cope with for Ukrainian and Moldavian students. Despite of the fact that they are registered as Romanian minorities from abroad, apparently their school and home environment rely mostly on the use of Russian. Moreover, some of them come from the countryside and did not study English at all in school and as such have had almost no contact with English so far.

Tables 7 and 8 show the results obtained by students on the initial test as well as after the first round of remedial classes.

Table 7. Results of the initial test - 100 students

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Number of students	8	13	14	14	13	15	16	7

Table 8. Results obtained when assessing progress after the first cycle of remedial classes

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Number of students	6	10	20	12	13	11	19	9

- Step 4. Identification of the misunderstood aspects during the semester and their remedial actions

During the following eight weeks, further remedial classes were held, in which the content was explained in more detail and more interactive applications were integrated, with a focus on the four language skills stipulated by the Common European Framework of Reference for Languages in a maritime context based on case studies from real situations on board vessels.

- Step 5. Evaluation of individual progress on completion of remedial courses

At the end of the remedial courses, the students took a test on the topics discussed and on the reviewed aspects of grammar and vocabulary. The results are displayed in Table 9, and they showed the students' progress in the use of general and maritime English.

Table 9 shows the results obtained by students in the final test (at the end of remedial courses)

Table 9. Results obtained in the assessment of progress on completion of remedial classes

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Number of students	3	7	24	14	12	12	20	8

4. Conclusions

The educational environment is constantly changing and evolving. Technological progress, economic, social and cultural changes and shifts in the requirements of the labor market all happen at a fast rate, so teachers have to adapt continuously, changing their pedagogical manner of working and interpreting teaching, learning, assessment and research processes several times throughout their career. A commitment to adaptability and lifelong learning is crucial to ensure the efficiency of the educational process and to prepare students to meet the challenges of a competitive, ever-changing world where simply memorizing information will not suffice. Students must develop critical thinking skills and be able to apply their knowledge in real-world situations.

As part of this effort, fundamental disciplines establish a common language for performing tasks across other branches of engineering, enhancing the capacity for innovative thinking and problem-solving. As such, mastery of fundamental science concepts and techniques equips future marine engineers with the skills necessary to address the complex challenges of modern marine engineering, ensuring safe, efficient, and sustainable maritime operations.

Since the students at our university do not come only from high schools with a scientific profile, the authors ascertained over the years that there are wide disparities in the level of knowledge acquired in the fundamental subjects (mathematics, chemistry, computer science, etc.) in the secondary and high school years. Furthermore, many of the contents included in the university curriculum have high levels of complexity and abstraction, which implies the need for alignment between the teaching methodology and standards applied by teachers and the learning profiles presented by students.

The main objective of the introduction of remedial courses for the fundamental subjects studied at our university is to support students enrolled in the first and/or second year of bachelor studies in order to prevent them from underachievement and dropping out of school. As a result of the active participation of students in remedial courses, there has been a significant increase in the level of theoretical knowledge in the field of fundamental and humanities subjects, as well as their implementation in practice (where appropriate), which is particularly important in understanding the specific aspects of these subjects used in the maritime field.

Acknowledgements

This article is part of the research budget funded by Constanta Maritime University.

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CHALLENGES OF MARITIME ECO PORT AND ITS HUMAN RESOURCES IN INDONESIA: OVERVIEW OF CURRENT AND FUTURE ACTION

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Abstract: The largest archipelagic state in the world, Indonesia, needs to be connected by sea in order to support economic growth and logistics distribution. According to KP 432 Year 2017 JO KP 217 Year 2022, Indonesia has 1322 Location Plan for the new ports, 102 Commercial Ports, 534 Non-Commercial Ports, and 63 Public Terminals. The International Energy Agency estimates that maritime transport was responsible for 646 million metric tones of carbon dioxide (MTCO2), or around 2% of all carbon emissions, in 2020. In 2022, Indonesia will have 44.178 registered cargo vessels, 4.796 registered fishing vessels, and 49.221 registered passenger vessels. In order to reduce carbon emissions, Indonesia should build a sustainable maritime transportation infrastructure using eco ports and green shipping. The development of sustainable human resources' skills and competencies, as well as the optimization of maintenance and monitoring systems, are among the concerns that the Indonesian government must address. Other issues facing green shipping include the need to strike a balance between environmental sustainability and operational efficiency, as well as crew training and competence. This study aim is to balancing between the solution to face maritime eco port and to prepare the need of human resources to achieve the goals. This study used descriptive qualitative approaches for the literature review. The result are the keys components from human resources to face the challenges of maritime eco ports and solutions to the governments for short, mid, and long terms plans.

Keywords: eco ports, human resources; green shipping, sustainability

1. Introduction

As the world's largest archipelagic state, comprising over 17,000 islands, sea transportation plays a crucial role in connecting Indonesia and facilitating the distribution of logistics and economic growth to remote, isolated, and underdeveloped areas of the country. According to the International Energy Agency (IEA), maritime transportation accounted for 646 million metric tons of carbon dioxide (MTCO2) emissions in 2020, which is approximately 2% of global carbon emissions. Indonesia should adopt a sustainable maritime transportation system in order to decrease carbon emissions by implementing Eco Port and Green Shipping.

The issues associated with the development of eco-ports and green shipping involve mitigating the environmental consequences of maritime transportation, such as pollution and CO2 emissions, while adhering to environmental regulations. There is an increasing acknowledgement that shipping is not as ecologically sustainable as previously believed, due to concerns regarding the release of greenhouse gases and other chemicals by ships .The text provides an overview of the existing and future regulatory framework aimed at enhancing the industry's impact on the environment. It emphasizes the importance of increased market regulation and technical innovation. Ports play a crucial role in assisting the maritime industry's endeavours to minimize its environmental footprint, but they must extend their activities outside their conventional operational sphere. Efforts to attain sustainability in ports have primarily concentrated on the development of sustainable ports, eco-ports, and green ports. However, in order to effectively accomplish sustainability, it is necessary to integrate these efforts and adopt a broader viewpoint that encompasses the entire marine supply chain. Constructing green ports is seen as a crucial approach to tackle the issues arising from climate change and advance sustainable development in the port sector.

2. Eco Port

According to KP 432 Year 2017 JO KP 217 Year 2022 about the Blueprint of Indonesia National Ports (Rencana Induk Pelabuhan Nasional), Indonesia has 636 Existing Ports (consist of 534 non-commercial ports and 102 commercial ports), 63 Public Terminals, and 1322 Location Plan for the new ports. Considering the enormous number of Ports in Indonesia, the implementation of Eco Port would give a significant impact in reduction of carbon emission.

2.1 Definition, General Concept, and Four Pillars of Eco Port

Eco Port, as an environmental management initiative, has garnered substantial attention in recent years. This prominence reflects the growing global awareness of the pressing need to address the intricate and multifaceted environmental challenges intrinsic to port operations. This approach represents a sophisticated and comprehensive framework characterized by a meticulous delineation of prioritized criteria meticulously designed for the precise evaluation of port authorities' environmental performance. These criteria provide a meticulously structured and methodical approach that empowers ports to harmonize their operational activities with the exacting standards and best practices stipulated on the international stage, thereby contributing meaningfully to the overarching global endeavour of advancing sustainability in maritime transportation (Puig et al., 2022).

Ecological Port (Eco Port) is a Port within the scope of sustainable development (sustainable development port), which is not only considering environmental aspects, but also economical aspects. The general concept of Eco Port is to establish a port that is environmentally friendly through the Implementation of: (a) Environmental management program in Environmental Financial Activities, Technical and Operational Aspects, Institutional and Personal Aspects, and Rule of Law as well as Legal Provision; (b) Standard Measurement (Goal) in certain indicators such as the reduction of environmental impacts at Ports, improvement of cleanliness, comfort, health, and safety, improvement of institutional capacity in environmental aspects, and improvement of stakeholder participation in environmental management.

Moreover, the implementation of Eco Port should fulfil four pillars that consist of :

2.1.1. Fulfilment of all regulatory requirements in the environmental field (compliance).

The environmental aspect takes the shape of environmental sustainability. Sustainable transportation is expected to be able to integrate intra and intermodal, connectivity between transportation infrastructure, the shipping industry, human resources, and stakeholder integration, allowing sea transportation to be multidimensional and non-egotistical through Industry 4.0-based technological innovation. The highest level of implementation (95.7%) is observed in the presence of an environmental policy, followed by the inventory of environmental legislation (96.7%). The primary environmental concern remains air quality, with noise and energy use following closely after. Waste is the primary environmental concern under close scrutiny. Ports are increasingly adopting ecologically conscious practices and recognizing the impacts of climate change.

Over the past few years, there has been a notable rise in public consciousness regarding environmental preservation. The significance of maintaining the sustainability of port operations is increasing due to the potential adverse environmental impact they can have, despite their positive contributions to employment and economic growth in port communities. The port authority's choice and implementation of sustainable practices are significantly shaped by port-specific elements such as its financial resources, competitive areas, legislation, and environmental concerns. The variability of these parameters might differ significantly among ports and areas.

The political rhetoric of international maritime organizations led to the emergence of the notion of "green ports," which primarily aims to clarify the economic advantages and consequences of adopting environmental policies and establishing green standards and codes of conduct for port authorities. Therefore, in order to achieve a strong level of environmental competitiveness, it is necessary for all parties involved in seaports, such as port authorities, policymakers, port users, and local communities, to make substantial investments in resources.

A model of the quantities of carbon dioxide (CO2), NOx, and PM2.5 released at sea and at ports in Norwegian seas was built and utilized by Simonsen et al. They discovered that around 14.6% of these pollutants are deposited in ports, particularly in Bergen, Oslo, and Stavanger. These results attest to the notable variations in cruise ships' environmental performance. These results might be used to create maritime regulations that compel cruise lines to use greener technology and reconsider their operational procedures.

2.1.2. Fulfilment of all regulatory requirements in the environmental field (compliance).

Implementing an environmental management system can be achieved by adhering to a sequence of steps. Prior to proceeding, it is essential to carry out an initial assessment of the environment to ascertain the root causes and consequences, comprehend the legislative and regulatory concerns, and formulate a set of policies and objectives. Subsequently, it is imperative to develop and execute an environmental management program that centers on the allocation of activities and resources in order to enhance efficiency and save costs. It is important to regularly conduct audits and reviews in order to assess environmental performance and guarantee ongoing enhancement. Furthermore, it is imperative to promote public participation in order to engage local populations and legal entities in the formulation and execution of environmental initiatives. Organizations can attain various advantages by adopting an environmental management system, including adherence to environmental regulations, client satisfaction, conservation of resources and energy, and enhancement of their reputation. In order to successfully establish an environmental management system, it is crucial to engage in meticulous planning, monitoring, and collaboration with stakeholders.

2.1.3. Implementing of Green initiative

Implementing sustainable development initiatives at the Port can involve practices such as energy management, water conservation, utilization of environmentally friendly technologies, protection of habitats, and preservation of biodiversity.

2.1.4. Stakeholder's involvement to support fulfilment regulation in the Environmental Sector and Implementation Green Initiative Ports

The primary stakeholders in the implementation of green initiatives in ports involve port authorities, shippers, carriers, terminals, and port users. These stakeholders have an essential role in promoting sustainable growth and ensuring environmental protection in port operations. This signifies the active participation of port authorities and other stakeholders in the implementation of environmentally friendly activities. the Green Port idea is being implemented at specific ports in Turkey, Europe, and the US. This involves multiple stakeholders, including port authorities, shipping corporations, and workers, who follow rigorous waste management and environmental policies.

2.2 Technical Guidelines of Eco Port

The Technical Guidelines for Eco Port contain guidelines for the Implementation of Environmentally Friendly Port Management, which includes 10 clusters below:

a. Eco port Cultural and Institutional Development

Implementing effective strategies for the development of eco ports with a specific emphasis on cultural and institutional growth necessitates the use of several exemplary methods. First and foremost, it is crucial to recognize and integrate societal and environmental factors into port development. Furthermore, it is imperative to embrace sustainable development policies and practices that take into account the distinct environmental factors, including air pollution, water quality, waste management, and land/resource utilization. Furthermore, the promotion of port sustainability can be achieved through the establishment of public-private partnerships and the implementation of policies that are collaboratively developed with all relevant stakeholders. In addition, an ecosystem-based approach to port design can be employed, which entails comprehending the system, devising alternative solutions, modeling and assessing them, and ultimately completing the design. Additionally, the successful implementation of eco ports relies on the meticulous planning and establishment of logistical centers, the advancement of information technology, and the implementation of regulatory and administrative procedures. By adhering to these optimal methodologies, ecological harbors can be established with a specific emphasis on cultural and institutional advancement.

b. Air Quality Management

Air quality has always been an important concern in the field of ports, and it continues to be a crucial factor in the Eco Port evaluation framework. The significant impact of the maritime industry on the release of greenhouse gases highlights the urgent need to implement a comprehensive set of measures to effectively reduce air pollution (Wan et al., 2018). Port authorities are increasingly responsible for incorporating sustainable practices into all aspects of their operations. This encompasses, but is not limited to, the crucial necessity of substantially decreasing emissions resulting from ship operations, the careful management of cargo, and additional activities that are present throughout the port's operational framework.

c. Ship and Port Waste Management

The Eco Port framework focuses on ship-generated garbage, which is crucial due to its potential impact on port habitats. Ship-generated waste refers to the waste and byproducts that come from vessels when they arrive at port facilities. This criterion exemplifies the significant role that ports play in reducing ship-source pollution, which is a complex problem involving the unintentional release of harmful biological things, such as plants, animals, or bacteria, into port waters. In addition to its biological consequences, ship-source pollution presents clear risks to human health, the stability of marine ecosystems, and the integrity of economic assets (Jeevan et al., 2022). The efficient and responsible handling of garbage produced by ships is crucial, as it perfectly aligns with the core values of Eco Port, which aims to promote sustainable management of ports.

Port waste management is a significant concern in the Eco Port paradigm. Ports, which are vital hubs in the worldwide transportation network, naturally produce pollution. These include emissions from exhaust gases and the disposal of various waste products that result from operations related with ports (Chang and Wang, 2012). In this context, "port waste" refers to the waste streams that are produced as a result of port operations. The noticeable rise in the reputation of port waste, moving from tenth place to ninth in 2022, highlights the growing focus on promoting careful and effective waste management procedures inside ports. This increase in importance symbolizes the increasing awareness among port officials about the complex environmental consequences and the corresponding necessity to closely adhere to the sustainability goals advocated by Eco Port.

Port development, which involves the complex interconnection of economic, sociological, and environmental aspects within port ecosystems (Salsas et al., 2022). Ports are highly dynamic and transformational structures that play a crucial role as central nodes in the global trade network. Port development refers to the construction and expansion projects carried out inside the port area. These ports require developmental projects due to the increasing amount of goods they handle. Nevertheless, the negative aspect of port expansion frequently involves unintentional ecological repercussions, such as the deterioration of habitats and disruption of ecosystems (Darbra et al., 2004). The consequences can extend to include the release of small particles into the air, disturbances to wildlife, the presence of excessive noise, and even the presence of excessive artificial light. The ongoing need to improve or expand port infrastructure highlights the enduring importance of this requirement, prompting port authorities to advocate for methods based on sustainable development principles that prioritize environmental conservation and societal welfare.

d. Quality and Consumption Water Management

The Eco Port framework cogently underscores the intrinsic and indissoluble nexus between ports and water quality. The preservation of optimal water quality stands as an ontological imperative in sustaining aquatic habitats and fostering ecological equilibrium (Lam and Li, 2019). Within the Eco Port paradigm, water management and pollution abatement constitute cardinal pillars of environmental stewardship. This connotes a profound and non-negotiable responsibility incumbent upon port authorities to safeguard the immaculate quality of adjacent water bodies. In this regard, stringent adherence to environmental norms assumes paramount significance (Puig et al., 2022).

e. Energy and Climate Change Management

Energy efficiency is a crucial aspect of port operations and plays a major role in Eco Port's environmental strategy. This principle aligns with the wider recognition in the sector of the urgent need to reduce energy usage and, consequently, improve the problem of greenhouse gas emissions (Di Vaio et al., 2018). Improving energy efficiency in several aspects of port operations not only reduces emissions but also promotes significant progress in environmental conservation. Efficiently managing energy usage in ship operations, port equipment functionality, and industrial processes is crucial for achieving these overall goals.

Climate change mitigation is a top priority in Eco Port's environmental management strategy. The escalating influence of climate change on worldwide sustainability emphasizes the urgent necessity for ports to actively reduce their carbon emissions, as stated by Konstantinos et al. (2022). The capacity of maritime transport to worsen the inevitable advancement of climate change highlights the unavoidable necessity for port authorities to decrease emissions originating from their diverse activities. The complex aspects of this undertaking require a careful analysis of factors including local environmental conditions, the complexities of transportation systems, the intricate network of policies, and the necessary measures to effectively reduce carbon emissions in port operations (UNCTAD, 2009).

f. Hazardous and toxic Materials (B3) Contaminated Land Management

An efficient management of contaminated land necessitates the consideration of various aspects, including the hazards to human health and the environment, the financial expenses involved, the technical feasibility of remedial actions, and the societal importance put on the clean-up and re-use of polluted areas. Decision-making in this situation is intricate and necessitates the use of standardized methods and tools to guarantee that the process can be replicated and understood by others. Land-use planning is essential for effectively managing contaminated land, and it is imperative to have access to guidance and support from environmental health professionals. Remediation procedures play a crucial role in dealing with polluted land, namely by employing methods that may efficiently purify and transform contaminated sites for alternative purposes. Furthermore, the significance of sustainability factors has increased in the management of polluted land, including the environmental, social, and economic impacts of risk mitigation measures. In order to successfully manage contaminated land, it is necessary to use a multidisciplinary strategy that incorporates a range of different fields, including environmental health, toxicology, ecology, land use planning, economics, and risk communication.

g. Traffic and Noise Management

Within the Eco Port paradigm, the issue of noise pollution assumes an elevated stature. Noise pollution, a multi-dimensional concern encompassing environmental and underwater acoustical dynamics, is significantly accentuated by cargo handling activities that hold a pivotal place within port operations (Lam and Notteboom, 2014). The imperative to reduce noise pollution resonates beyond the immediate benefits to port personnel, reverberating profoundly in its salutary impact on the well-being of local communities and the preservation of local wildlife populations. This underscores the ineluctable need for port authorities to innovate and implement cutting-edge noise reduction strategies as a central tenet of their operational ethos.

h. Relationship with Local Communities Management

Several crucial variables determine the success of connections with local communities. The factors encompassed in this list are environmental conservation, community welfare, self-confidence, and organizational efficiency. Furthermore, the establishment and enhancement of social networks within communities can significantly contribute to the development of effective partnerships. Gaining a comprehensive understanding of and establishing fruitful collaborations with communities is essential for the efficacy and long-term viability of initiatives aiming at attaining worldwide environmental advantages. Integration and successful interactions within the local community rely on familiarity, functional interdependence, and consensus among individuals and groups. Finally, managing size and variety, resolving coalition conflict, and understanding life cycles are characteristics that distinguish good community health partnerships from those that are poor.

i. Native Habitat, Valuable Sites and Green Open Space Management

In order to effectively safeguard and oversee indigenous ecosystems, significant locations, and environmentally friendly areas, it is crucial to take into account the advantages offered by these regions and tackle the obstacles they encounter. Protected areas are essential for the production of natural food, the preservation of biodiversity, the regulation of climate, and the provision of cultural services. Furthermore, the administration of these regions can actively contribute to the advancement of rural development, the mitigation and adaption of climate change, and the involvement of the private sector in the preservation of biodiversity and ecosystem services. It is imperative to acknowledge the dynamic nature of conservation and the significance of human-dominated ecosystems in supporting animal and plant populations. It is crucial to comprehend the specific needs of endangered species' habitats and to develop strategies for managing suitable habitats in areas where they have been eradicated in order to ensure the long-term survival of interconnected populations. Ultimately, it is crucial to preserve and safeguard natural places in order to ensure the long-term survival of species, vital habitats, and biological processes.

j. Dredging, Reclamation, Development Management

The tenth and last criterion in the Eco Port matrix focuses on dredging operations, which are highly relevant to many ports. Underwater dredging is essential for maintaining shipping channels and ensuring smooth port operations. However, these activities have environmental consequences, particularly in terms of causing disruptive noise that can greatly damage local species and the fragile maritime ecosystems and habitats (Sugrue and Adriaens, 2022). Dredging is a complex activity that involves various factors such as underwater depth, tidal flow, currents, velocity, and wave dynamics. These factors combine to produce a wide range of negative outcomes, including the reduction of fishing resources, the spreading of contaminants, and changes to local water conditions. Therefore, it is necessary to carry out dredging operations with great care and diligence. This requires implementing strict control measures to reduce their impact on the environment and protect the delicate ecological balance of the surrounding area.

To summarize, these 10 Eco Port criteria enhance the comprehensive and multifaceted nature of its environmental management system. The text highlights the numerous difficulties that port authorities face as they strive to achieve sustainability and responsible environmental management. These characteristics indicate a strong need for proactive planning, ethical behaviors, and creative solutions within the complex and diverse operational environment of ports.

2.3 Function and Responsibility of Related Parties of Related Parties in Port.

To implement Environmentally Friendly Port Management, related parties in Port such as Harbour Master, Port Authorities, and Port Operator should perform their functions and responsibilities:

2.3.1. Harbour Master.

The function and responsibilities consist of: (a) To perform supervision and law enforcement in the protection of the maritime environment in port, (b) To perform coordination with the Environmental Supervisory Officer and/or Regional Environmental Supervisory Officer.

2.3.2. Port Authority.

The function and responsibilities consist of: (a) To approve the agreement and doing cooperate the construction and provision of waste storage and management facilities at ports provided by the Business Entity, (b) To conduct construction of shelter facilities and waste management if not doing by Business Entity and report periodically to Minister of the Environment every 3 (three) months about Scale Waste, Number of delivery waste certificates that have been issued with their code, and serial numbers, (c) To report implementation of environmentally port to the Director General of Sea Transportation with a copy to Director Sea Port, Director Shipping and Maritime, and Director Marine and Coastal Guard, according to the format in the attachment of this Technical Guide every June and December every year, (d) To ensure the suitability of the location of the shelter facilities and waste management to build in accordance with the Port Master Plan.

2.3.3 Port Operator.

The function and responsibilities consist of : (a) To perform construction shelter facilities and waste management, (b) To fill out and sign the waste certificate, (c) To report receipt of waste to the port operator before issuing a certificate of delivery of waste, (d) To give certificate of delivery waste to the owner and/or operator of the ship who has submitted the waste, (e) To report to Minister of Environment every 3 (three) months regarding scale waste and number of delivery waste certificate that have been issued with their code and serial numbers.

2.4 Implementation of Eco Port in Foreign Countries and in Indonesia

Eco Port has been implemented in various countries. The implementation of Eco Port in Port of Long Beach California is considered as the best practice of Eco Port in which it successfully reduced the diesel dependency by 75%. The other success story of Eco Port also could be found in Sydney Port that implement the concept of equilibrium between resource consumption and environmental quality. Meanwhile, Shanghai Green Port also manage to establish integrated port amidst agricultural area.

On the other hand, Eco Port in Indonesia has been applied in Teluk Lamong Terminal, East Java in which it reduces the carbon emission without using fossil energy and replace it with electric power and gas engine power plant. Energy saving is also performed by using solar cell system, Light Emitting Diode (LED), and Gas Exhaust for AC System. Teluk Lamong Port also has Management Trash, Incinerator, and Oily Water Separator. In addition, Teluk Lamong is also the first semi-automatic port in Indonesia thus its operational is much more safety. Until 2023, there are only a few port that already implement of Eco Port in Indonesia. Panjang Port and Pangkal Balam have been chosen as a port with green and smart port in Regional 2 area of Indonesian port.New Priok Port also going to implement of full green port in Jakarta. Currently, the level of electricity at 125 ports under the management of Pelindo ranges from 41 to 59 percent. The number of loading and unloading equipment is approximately 310. Out of the total number of tools, 126 have been converted to electric power, while 184 are still powered by diesel.

3. Green Shipping

Green shipping practices in the marine industry encompass several tactics, including speed reduction, fuel switching, and the adoption of alternative fuels. These measures aim to minimize harmful emissions and enhance environmental sustainability. Shipping enterprises are motivated to implement green shipping practices (GSP) due to factors such as adherence to industry standards, customer demand for environmental sustainability, and the aspiration to cultivate a favorable reputation. Implementing the Global Sulfur Cap (GSP) can enhance the ecological and operational efficiency of maritime companies. There has been a significant increase in public apprehension around environmental problems resulting from shipping activities, including air pollution and the depletion of resources. The shipping industry, which enables international trade, produces environmental degradation such as carbon dioxide emissions and oil spills. It is crucial to comprehend the rationale for adopting green management practices (GMPs) in the shipping business for multiple reasons.

Based on the data provided by the Ministry of Transportation, the total number of registered vessels in Indonesia in 2022 includes 4,796 passenger vessels, 49,221 fishing vessels, and 44,178 cargo vessels. Hence, given the abundance of vessels in Indonesia, it is imperative to implement green shipping practices in order to mitigate carbon emissions.

IMO Recommendation to Reduce Carbon Emission

According to the IMO, three ways that could be performed to reduce carbon emission consist of:

Energy Efficiency Design Index (EEDI). EEDI stands for Energy Efficiency Design Index, which is an index that measures the energy efficiency of a ship based on its fuel consumption per unit of tonnage and distance travelled. EEDI is set by the International Maritime Organization (IMO) as part of its efforts to reduce greenhouse gas emissions from ships. IMO's EEDI targets 30%, 40%, and 50% from the improvement of baseline EEDI efficiency in 2025, 2030, and 2035 respectively.

Energy Efficiency Operational and Ship Energy Efficiency Management Plant. Mandatory requirement for all ships 400 gross tonnage (GT) and above engaged in international voyages. Structured approach to improving energy efficiency and SEEMP through Voyage planning and optimization, Weather routing, Speed optimization, Hull and propeller maintenance, Engine management, and Waste heat recovery.

Market-based Measurement That Considers Carbon Markets Operational Measures. It is a cost-effective, flexible, and innovative approach that can create incentives for shipping companies to invest in new technologies and practices that reduce emissions For example, Maersk Line, the world's largest container shipping company, has committed to reducing its CO2 emissions per container-moved by 40% by 2030, compared to 2019 levels.

International Cooperation on Shipping Coordination

Glo Fouling Partnership. This IMO-initiated activity, in collaboration with the Global Environment Facility (GEF) and the United Nations Development Program (UNDP), aims to minimise the transfer of aquatic species through biofouling, or to minimise the development of aquatic organism assemblages on the underside of hulls and ship

On Shore Power Supply. An electrical system to connect a ship at berth with the onshore power grid to enable the ship to continue to receive electricity to power cooling, heating, lighting and other equipment and to shut down the ship's auxiliary engines while the ship is loading and unloading at the harbour.

3.3 Mitigation Action Steps Implemented

3.3.1 *Energy Efficiency.*

There are some actions that can be taken for energy efficiency such as : (a) Ship modernization and ship recycle. A structured analysis of the most pivotal innovations in green shipping technologies are Hull Optimization, ship coatings, air lubrication technologies. The focal point here has been the optimization of hull designs to ameliorate hydrodynamic efficiency and attenuate resistance. Computational Fluid Dynamics (CFD) has emerged as the vanguard tool in this endeavor (Chang et al., 2023). Progress in ship coatings, particularly the development of bio-coatings impervious to deleterious organisms and corrosion, is a linchpin of energy efficiency enhancement (Ravenna et al., 2022; Hakim et al., 2023). Air lubrication systems, by minimizing the interaction between the vessel's hull and water, exhibit promise in reducing resistance (Tadros et al., 2022e). ; (b) Implementation Ship Energy Efficiency Management Plan (SEEMP). The Ship Energy Efficiency Management Plan (SEEMP), introduced in 2013 by the IMO and further improved in 2023, is a systematic, useful instrument for assisting ship owners in managing their environmental performance and enhancing operational efficiency. The SEEMP is divided into three sections e.g Ship management plan to improve energy efficiency, Ship fuel oil consumption data collection plan, Ship operational carbon intensity plan. All ships over 400 GT must have Part I of the SEEMP on board at all times. All ships above 5,000 GT must have a certified Part II as part of the Data Collection System. All ships subject to the Carbon Intensity Indicator (CII), including cargo, Ro-Pax, and cruise passenger ships exceeding 5,000 GT, must have a validated Part III. In order to maximize the performance of the ship, the SEEMP mandates that owners and operators take into account and put innovative technology and methods into operation. Examples of operational efficiency and carbon intensity improvements include: Optimization of speed, climate planning, Monitoring and upkeep of hulls, installing heat recovery equipment. ; (c) Implementation Certification of Anti Fouling System. The use of harmful organotin compounds in anti-fouling paints used on ships will be prohibited by the international convention on the control of harmful anti-fouling systems on ships, which was adopted on October 5, 2001. The convention will also establish a mechanism to stop the potential use of other harmful substances in anti-fouling systems in the future. The Convention becomes effective on September 17, 2008.

According to the provisions of the Convention, Parties are required to forbid and/or restrict the use of harmful anti-fouling systems on ships flying their flag, as well as on ships that are not authorized to fly their flag but are under their control and on all ships that enter a Party's port, shipyard, or offshore terminal.

3.3.2. Utilisation of Renewable Energy

Implementation Onshore Power Supply (OPS), Electrification loading unloading port facilities, Utilization of Solar Panel system (Street Lighting) in Ports, Utilization of Biofuel for ships using FAME (Fatty Acid Methyl Ester), and Aid to Navigation renewable energy power

Challenges

The development of eco-ports is hampered by power requirements, investment costs, and electricity costs. Furthermore, the preservation of the environment is a vital aspect in the advancement of eco-friendly ports, with a specific emphasis on reducing carbon dioxide emissions. In addition, both organizational and technological constraints impede the conversion of conventional industrial areas into eco-industrial parks. Despite the potential competitive advantages and environmental benefits, the lack of use of eco-innovations is a hindrance to their widespread adoption in the economy. To overcome these obstacles, policymakers should enhance legislation, procedures, and support resources for industrial zones, promote knowledge regarding the sustainable benefits of industrial zones, and forge enduring collaborations with non-governmental organizations.

Eco Port Challenges

The issues associated with eco-ports encompass enhancing environmental performance, mitigating emissions, and managing stakeholder concerns. Port operators must prioritize the environmental interests of stakeholders, including shippers, and develop strategies for designing intermodal networks that include both port competitiveness and the decision-making patterns of shippers when choosing routes. Port authorities can promote environmental improvement through voluntary initiatives, but the complexity of execution and the exposure of the issues are important factors that facilitate this process. Port operations involving the handling of bulk goods provide challenges in terms of energy efficiency, dust emissions, noise pollution, and the management of dangerous substances. Ports must allocate resources to develop environmental infrastructure and adhere to rules that specifically target emissions of air pollutants from ships. Although there is currently no definitive evidence linking environmental performance to direct port competitiveness, improving environmental performance is crucial for satisfying present demands and promoting the growth of ports as significant participants in maritime trade.

Optimization of Maintenance and Monitoring System. The optimization of maintenance and monitoring systems for eco-friendly technology infrastructure, especially in the areas of water treatment and renewable energy systems, is crucial. This will help ensure that these systems operate optimally and effectively reduce environmental impacts.

The Development of skills and competencies of Sustainable human Resources. Through a comprehensive HR strategy includes the development of skills and competencies related to sustainable practices, such as training staff in the use of environmentally friendly technologies, environmental impact monitoring, and other efforts that support sustainable port management (Eco Port).

Green Shipping Challenges

One of the challenges in green shipping is the imperative to reduce carbon emissions in the business to align with the objectives of the Paris Agreement. Shipping operations have a substantial impact on the environment, contributing to air pollution and the depletion of resources. The globalization of economic activity has led to a significant increase in public concerns regarding these environmental challenges. Nevertheless, there is a clear correlation between implementing environmentally-friendly practices and the overall success of shipping companies, suggesting that these companies have the opportunity to enhance both their ecological and financial outcomes. In order to tackle these difficulties, it is imperative to establish a robust regulatory framework that can effectively govern shipping practices and encourage the adoption of environmentally sustainable operations. In addition, shipping companies should prioritize the environmental and financial consequences of their business operations, including company policies and procedures, shipping documentation, shipping materials, and shipping design to ensure compliance.

Operational Efficiency vs Environmental Sustainability. Balancing the need for operational efficiency with environmental sustainability can be challenging. Some green technologies, while reducing emissions, may impact the speed and efficiency of vessels, potentially affecting schedules and profitability.

Crew Training and Expertise. The adoption of green technologies often requires crew members to be trained in new equipment and practices. Ensuring that maritime professionals have the necessary skills and knowledge can be a logistical challenge.

Conclusion

The expansion of ports has experienced significant acceleration, particularly in the adoption of eco-friendly energy sources and the mitigation of emissions to promote the establishment of green ports.Therefore, it is necessary to achieve harmony in terms of training and equipping personnel to effectively execute and utilize the available technologies at the port.The keys components from human resources to face the challenges of maritime eco ports and solutions to the governments should be prepared into three section ; short, mid, and long terms plans. In short terms, the government must accelerate and enganged between the education administrator and the stakeholder, through this hopefully there will be no gap among both side. Meanwhile, the financial to support the implementation of eco port (green shipping) should be in a priority . The government may still refer to the medium term development goals which are building the environment, climate change, strengthening infrastructure to support development economy and basic services. Finally, the long term development goals are the management of natural resources, human resources, the environment and its institutions so that the Indonesian people can catch up and have an equal position and strong competitiveness in the international community.

Acknowledgements

Express gratitude to God and everyone who helped make this study possible. This study should be beneficial to the marine sector and maritime education.

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SOMETIMES CHATGPT IS AS CONFUSED AS I AM: A PRELIMINARY EXAMINATION OF THE ROLE OF AI IN MARITIME ENGLISH EDUCATION

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Abstract: Dialogue surrounding the use of artificial intelligence (AI) in English language learning and teaching, and in particular the use of Chat GPT, can be expanded to include research into how these technologies may be embedded in English for Specific Purposes (ESP), specifically in the domain of Maritime English. This paper attempts to offer a preliminary look at how students at Antwerp Maritime Academy are already successfully employing AI-driven technologies to assist them in the language learning process during Maritime English courses. By way of an initial short survey, the authors consider the inevitable integration of AI into Maritime English courses in tertiary education, the use of chatbots such as ChatGPT, and the linguistic drawbacks, benefits and pitfalls of this particular technology. The aim of the paper is to provoke discussion and reflection regarding this paradigm shift in language education.

Keywords: artificial intelligence (AI); ChatGPT; English for Specific Purposes (ESP); Maritime English

1. Introduction

Microsoft-backed OpenAI's ChatGPT ("Generative, Pre-trained Transformer") proved revolutionary when it was released in November 2022. As one of the most advanced AI-powered chatbots, ChatGPT is programmed to conduct interactive conversations with users. Its ability to simulate authentic interactions and to realistically mimic human conversation has fueled its reputation as an exciting and innovative tool, not least in the domain of language learning (Kohnke, Moorhouse & Zou, 2023).

Importantly, AI tools in general, and in language learning in particular, were researched even before the emergence of ChatGPT. Among others, Pokrivčáková (2019), Zawacki-Richter et al. (2019) Huang et al. (2021) classified the different manners in which AI is integrated in language education, while Jaleniauskienė et al. (2023) overviewed the existing body of research into the use of AI in language education by means of a bibliometric analysis. Furthermore, Fryer and Carpenter (2006) previously investigated the appeal of bots as language-learning partners. They argue that bots mitigate many factors ranging from a lack of time to shyness or limited opportunity for feedback and thus provide an attractive means of language practice for students, free from time constraints and classroom restrictions. It may be that in a multilingual, intercultural learning environment, such as exists in many Maritime Education and Training (MET) institutions, chatbots do indeed foster a more relaxed atmosphere for the tongue-tied student and also demonstrate the patience to provide, for example, endless feedback and explanation (idem., 2006). In a more niche setting, Takagi, John, Noble, Björkroth & Brooks (2016) explored the use of computer dialogue systems (aka chatbots) to assist Officers of the Watch (OOW) in acquiring maritime communication skills based on IMO (International Maritime Organization) SMCP (Standard Marine Communication Phrases). It is interesting to consider whether ChatGPT performs at the same level and has the same appeal for language learning in an ESP (English for Specific Purposes) context, in this case for Maritime English.

This AI technology, described in 2006 as "budding" (Fryer & Carpenter) has come a long way since then and has evolved into a powerful – perhaps irresistible! – language companion. Since ChatGPT took to the stage, there has naturally been prolonged and heated discussion about the appropriate and legitimate use of this indefatigable language-learning friend, especially within the ranks of higher education. One research question which has gained traction is to what extent ChatGPT can at least match, or even out-perform, students in higher education which leads to the logical issue of whether it should be allowed at all. Should ChatGPT be deemed appropriate during the trajectory of Bachelor, Master and Doctoral theses and dissertations? Kelly (2023) writes that ChatGPT proved capable of passing law exams at four courses at University of Minnesota and an additional exam at University of

Pennsylvania's Wharton School of Business. Herbold, Hautli-Janisz, Heuer, Kikteva and Trautsch (2023) assessed the quality of AI-generated content during a large-scale study which compared human-written versus ChatGPT-generated argumentative student essays. One of the main findings of the study was that writing styles between humans and generative AI models greatly differ. Questions are raised about how generative language, such as that produced by ChatGPT, might, eventually, affect and transform human-use of language in the future. This is ultimately a pertinent ethical issue.

Although there is little doubt that ChatGPT is the sophisticated language model it claims to be, capable of imitating human-like responses for every user input, it ultimately remains a 'generative' AI tool, and displays weaknesses, such as the production of inaccurate or wrong information. Moreover, ChatGPT fails in most cases to provide the source of its responses (Iorliam & Ingio, 2024).

Leading on from this brief introduction, this paper offers an initial study into the use of Chat GPT by a particular cohort at Antwerp Maritime Academy in Belgium, namely students enrolled in Maritime English courses in either BSc Nautical Sciences or BSc Marine Engineering. Following a short survey, responses were analysed to ascertain how often students use ChatGPT, their motivation for using it and how they put AI to use within the context of ESP and otherwise. The paper concludes with a discussion based on the responses collected and, importantly, offers some reflections on the future of language teaching and learning in the light of the gradual incorporation of AI.

2. Methodology

With a view to gauging the use of ChatGPT amongst students enrolled in Maritime English courses in the BSc Nautical Sciences or Marine Engineering programmes at Antwerp Maritime Academy in Belgium, a short survey consisting of eleven questions was created in Google Forms. Question content was derived from the literature and was designed to elicit information such as the role of ChatGPT, frequency of use, type of use, ethical considerations and legitimacy of use. Some questions offered respondents the opportunity to reply in more depth by providing space for comment or elaboration. In terms of sampling, only students studying Maritime English were deemed 'knowledgeable' to complete the survey (Kumar et al., 1993). The survey was distributed via the institution's online learning platform, Blackboard, which facilitates the option to target students enrolled in specific courses and was thus sent to all students enrolled in Maritime English 1 (MarEng1), Maritime English 2 (MarEng2) and Maritime English 3 (MarEng3). Of a total of 264 students who would have received the survey details, 91 – just under a third of the potential sample – went on to participate. Respondents and comments were subsequently assigned codes to facilitate categorization and analysis of data.

3. Data analysis

This section assesses the data collected from the responses by offering a simple quantitative analysis. It is followed by a qualitative exploration of the comments provided.

Q1 Which Maritime English course are you currently following (or have followed this year)?

Q2 In which programme are you enrolled?

As stated, a total of 91 students participated in the survey. The first two questions of the survey deal with the profile of the respondents in terms of the degree programme being followed and the specific Maritime English course. The majority of the respondents are enrolled in MarEng3 (42.7%), followed by students in MarEng 1 (34.8%) and MarEng 2 (21.3%). The majority of the respondents are enrolled in BSc Nautical Sciences (94.4%) compared to a mere 5,6% students in BSc Marine Engineering. This reflects clearly the student population at Antwerp Maritime Academy.

Q3 When did you first start exploring/using Chat GPT?[1]

The majority of respondents started exploring ChatGPT between November and December 2022 (30%), followed chronologically by 27.8% from January to June 2023. Fewer students started between July and June 2023 (18.9%),

[1] Quotes pertaining to respondents are, mostly, reproduced in their original form and thus may contain spelling errors or grammatical inaccuracies.

succeeded by only 7.8% in 2024. These late adapters, however, were outnumbered by a substantial 15.6% that report not yet having used ChatGPT.

Q4 How often would you say you use Chat GPT in general?

44.4% of the respondents claim to use ChatGPT for general purposes several times a month as opposed to 22.2% who say they never use it. This is a similar percentage to the 21.1% who state they use AI several times a week. No respondent reports using the chatbot every day but chooses the option 'other' (12.2%).

Respondents who are rather opposed to the use of ChatGPT say it is not helpful (e.g. "*I don't think it's handy*" 76ME1NS). Another student indicates it is rather awkward because "*you do not get a global overview on the topics, nor does it give any sources*" (91ME1NS). Student 22 claims not to be interested because "*it was not a thing back then* [secondary school in 2017] *so I never learned to use it*" (22ME1NS). Finally, respondent 12 protests:

> *I don't use Chat GPT at all. The one time I did was on the teacher's demand here at the AMA. I don't like the concept of AI and it makes professors useless when THEY decide to make US use it*(12ME1NS).

The reasons given as to why students use ChatGPT are to look up the meaning of a word, for speaking assistance (e.g. "*I use Chat GPT as a help and a speaking buddy. It can correct my sentences, and enhance them to make them sound native. It is especially useful for professional communications*" 05ME3NS), to help with tasks (such as portfolio work, presentations or summaries) but also for every aspect in life, as a source of inspiration for the likes of recipes, history and other miscellaneous reasons. It is consulted when another view of a particular subject is needed or "*if I can't find a specific topic on my own*" (33ME1NS) or when "*Google doesn't give me a good answer*" (80ME1NS).

Q5 For which type of course would you say you use Chat GPT the most?

Languages (Maritime English, Spanish, French, Dutch) are given as the type of course for which students most often use ChatGPT (62%). The reasons for this are multiple and range from double checking important or official emails to avoiding "*stupid mistakes*" (04ME2NS) or to "*rewriting or summarising a text*" (72ME2NS). Consulting ChatGPT might also be related to the "*structuration*" (20ME1NS) of useful sentences. It is allegedly the "*best translator for languages because it has a bigger database to use*", states 74ME1NS. Apparently it can write "*proper English texts in a matter of seconds*" (50ME2NS) or "*create texts, even in French*" (60ME3NS).

The outcome is then followed by 22.5% for Exact Sciences (Mathematics, Physics, Chemistry, etc.). Two students mention that ChatGPT explains formulae or integrals for them or helps them to understand the theory in general. 9.9% of the participants use the application for Navigational and/or Engineering Sciences (Stability, Electronics, Propulsion, etc.) because that type of knowledge is "*quite restricted in its nature*" and mostly published by professional and experienced seafarers in "*official publications, regulations, guidelines, books(…) This is not the kind of data chat GPT can extract, and it results in poor performances when challenged on nautical content*", according to respondent 05ME3NS. Somebody else mentioned:

> *I wouldn't ask specific questions, for example: Is gross tonnage of a ship dimensionless? Then it explains itself with some blabla. Then, when you simply ask: Are you sure of that? It says completely the opposite. Which one is the correct answer then?* (53ME3NS).

Finally, a mere 5.6% indicate that they use ChatGPT for Social Sciences (Psychology, Law, Economics, etc.).

Some answers to optional questions also mention that ChatGPT can help with the quest for sources of articles or to generate summaries of larger texts. The chatbot is also used for intermediate steps, says 25ME1NS, and another states that it helps to "*break the exercises down*" (26ME3NS) in order to diminish confusion. Again here, one student confirms the general use of ChatGPT because it "*comes in handy for any personal inquiries or random questions. Utilizing the platform for school assignments is only secondary*" (91ME1NS). One last student noted an absence of the reflex to use it for class work (39ME3NS).

Q6 How often do you use ChatGPT for your studies in Maritime English?

Responses to the question on how often ChatGPT is used for studies in Maritime English show that the majority of students use the application from time to time (28.9%), followed by never (23.3%). One student mentions dissuading him/herself from using it because

> *I prefer to find everything myself, it's a better way to learn because you have to search and work for it. Asking an AI is too easy and you just pick the information for a special moment without learning it.* (Q7-33ME1NS).

In descending order the rest of the students use the app very infrequently (18.9%), infrequently (13.3%), frequently (12.2%), and very frequently (3.3%).

Q7 How do you use ChatGPT to assist you with Maritime English?

In order of the most requested instruction, students use the application to generate ideas for a written text (56.8%), to correct a text one has written (43.2%), to generate ideas to give a presentation (40.5%), to generate vocabulary (27%), and in order to write a text (23%). 21.6% of the respondents equally state that they use the tool to explain grammar, to translate a text, and for 'other' purposes respectively. Finally, 9.5% use Chat GPT to write a critical reflection and a mere 1.4% to create slides for a presentation.

The 'other' is further explained in the comments section: one student points out that *"there are already other tools on the digital market that enhance student's skills and that Chat GPT even has a spoken tool for help with dictation and pronunciation"* (05ME3NS).

Another student mentions the workload as the main reason for using Chat GPT in order to meet deadlines, because *"the given tasks required an in-depth and nuanced knowledge, in order for us to complete them correctly. If we would have worked on them without any help from AI-services, we would have missed the deadlines numerous times"* (91ME1NS).

Q8 Do you ask Chat GPT for assistance BEFORE forming your own ideas/writing your own text for the Maritime English course?

The majority answer negatively (65.9%) as opposed to positively (15.9%) while others (18.2%) indicate that it depends. The latter tend to use the application for miscellaneous reasons. Some students mention the importance of the task, the quality ("*I try to do it myself, but when I think it is nor good enough I use AI.*" 72ME2NS) or the limited amount of time before a deadline ("*How much time is left for the assignment." 16NS*) as determining factors but the majority of those who answered the open question refer to inspiration as a key factor:

> "*If I do have spontaneous ideas I will not use ChatGPT as soon as I would when the assignement is too vague and I have no ideas what to do.*" (07ME2NS) or "*I really try not to, but sometimes when I hit a roadblock I could ask chat GPT to give me directional ideas.*" (26ME3NS) or "*When we had essays to write it was useful to add maybe another perspective or have some ideas given to elaborate the essay*" (42ME3NS) or "*Sometimes, I don't really know how to start writing. Then I let it generate a text for inspiration, but I also do it for other languages*" (53ME3NS).

Related to inspiration is the '*how-to*' factor': "*50% of the time it's before, this is when I have zero clue on how to begin. The other 50% of the time it's when I have an idea but don't know exactly how to proceed*" (32ME1NS). For other students the stage at which you use ChatGPT is important: "*At the creative stage, Chat GPT can be a reliable tool for brainstorming*" (05ME3NS) or "*if a particular assignment had to be completed in a matter of days, I did use AI as a starting point. Doing the research, reading and collecting usable sources, like one is supposed to do, would take an inappropriate of time, in comparison with the actual importance of the assignment*" (91ME1NS).

One last respondent refers to the acceptability of using Chat GPT at all: "*If the topic is not entirely clear (English 1 where the assignment is to write an essay of a certain amount of words about a certain topic), I ask ChatGPT to write an essay which is a bit longer and then I write my own essay based on the information it has provided me with. I consider this acceptable as I still write my own essy, which is the main objective, but I don't lose a lot of time on doing research*" (04ME2NS). This leads to the next question.

Q9 To what extent do you agree with this statement?

Students who use ChatGPT for Maritime English tasks are cheating because A1 provides an unfair advantage.

The majority of respondents claim to be neutral (37.8%) about this, followed by respondents who disagree (32.2%) and then those that agree (15.6%). Those who strongly disagree (12.2%) are more numerous than those who strongly agree (2.2%).

Q10 Are you aware of Antwerp Maritime Academy's guidelines regarding the use of A1 (ChatGPT)?

Q11 If you have read Antwerp Maritime Academy's guidelines regarding the use of A1 (ChatGPT), is it clear to you how you may or may not use it during your course work?

76.4% answer negatively to question 10 and 23.6% positively. Elaborating on the issue in question 11, 18% say they have read the guidelines and clearly understand the rules for using AI (ChatGPT) during course work as opposed to 7.9% who claim they do not (yet) fully grasp it. Astonishingly (or not), the majority (74.2%) admit to not having read the guidelines at all. It is worth noting that one respondent states: "*I'd like to know where to find the AMA's guidelines regarding the use of AI because I can't find it on BlackBoard*" (33ME1NS).

Q12 To what extent do you agree with this statement?

In the future language learning will become obsolete as a result of ChatGPT and other forms of AI.

The majority (40%) of the respondents do not think that language learning will become obsolete in the future as a result of ChatGPT and other forms of AI. Those who are 'neutral' follow (21.1%). 20% strongly disagree and 15.6% agree with the statement. A mere 3.3% strongly agrees.

3. Discussion

The present exploratory study was conducted to gain insight into how students enrolled in Maritime English courses at Antwerp Maritime Academy in Belgium use ChatGPT. More specifically, the questions presented in the survey focused on aspects related to how the students use ChatGPT within the context of ESP and elsewhere as well as their motivation for using it.

The analysis revealed a mixed view of how the participants use and perceive this chatbot. While the majority of the participants (84.4%) are familiar with using ChatGPT, it should be noted that 15.6% reported never having used it. Moreover, when asked about the frequency of using ChatGPT, an even more substantial number of the respondents, almost a quarter, said that they had never used it. This finding illustrates that, despite the alleged overwhelming use and popularity of the tool among students, there are also those who have not (yet) started exploring its potential. Notably, some students also very unequivocally stated their lack of interest in using ChatGPT (e.g., 22ME1NS) and not liking the idea of AI as such (e.g., 12ME1NS).

In terms of using ChatGPT for educational purposes, most of the respondents (62%) indicated that they use it in language classes, while a considerably smaller part of the participants reported relying on the chatbot when it comes to Exact Sciences (Mathematics, Physics, Chemistry, etc.) or Navigational and/or Engineering Sciences (Stability, Electronics, Propulsion, etc.). The main reason for this seems to be the perceived capacity of ChatGPT to assist when addressing different stages of writing tasks, i.e. ChatGPT is seen as a useful tool while aiming to eliminate spelling mistakes, rewrite, summarise or structure texts. However, the participants appeared to be much more cautious of using ChatGPT for the purposes of Exact Sciences and Navigational and/or Engineering Sciences: on the one hand, the responses some of the participants provided point at a high awareness of the fact that the body of knowledge related to Nautical Sciences tends to be published in sources that are restricted. Therefore, the confidence that ChatGPT would be able to access and share this information appears to be relatively low. On the other hand, the participants also seem to be discouraged by lack of references and a tendency to provide contradictory answers to the same question, which results in its perceived relative lack of authority as a source.

Similarly, a relatively low level of enthusiasm regarding the use of ChatGPT could be noted with regard to the frequency of its use for the purposes of Maritime English. More specifically, more than one third (32.2%) of the participants indicated using the tool either very infrequently (18.9%) or infrequently (13.3%) in the context of this subject, while a slightly smaller part of the respondents (28.9%) relied on it on a time-to-time basis and only 3.3% of the participants said they used it very frequently. Notably, several students pointed out time pressure as a determining factor to rely on ChatGPT.

As far as the reasons for using ChatGPT in Maritime English are concerned, the results revealed the participants' appreciation of the tool as an idea generator, either when writing texts (56.8%) or looking for ideas for presentations (40.5%). Importantly, it should be noted that the majority of the respondents (65.9%) indicated not forming their own ideas or writing their own text(s) prior to consulting ChatGPT. Therefore, ChatGPT appears to generally be seen as a tool that offers inspiration and ideas as well as supports students at the initial stage of dealing with tasks, especially when these are not straightforward, require multiple perspectives on a topic and/or are under time constraints. In addition, the participants also used the chatbot for a range of other reasons related to comprehending and producing texts in English (e.g. to translate and write texts, generate appropriate vocabulary items, better understand grammar, improve pronunciation). Crucially, the majority of the participants (60%) did not perceive ChatGPT as the reason why (foreign) language learning might become obsolete in the future.

In terms of understanding how ChatGPT may be used, the majority of the participants (76.4%) indicated not being aware of the fact that Antwerp Maritime Academy has guidelines pertaining to the use of AI-powered tools. However, generally, the students tended not to view the reliance on ChatGPT as cheating: 44.4% said they did not perceive ChatGPT as a tool that provides an unfair advantage, while 37.8% were neutral on this aspect.

Overall, the results of the present study are in line with those of previous research into the perceptions of higher-education students of ChatGPT. For example, Dube et al.'s (2024) rapid systematic literature review showed that students' perceptions of ChatGPT are "widely varied" (p. 258). Specifically, very similarly to the results of our study, Ngo (2023) found that while students appreciate a range of benefits offered by ChatGPT (e.g. saving time, generating ideas, providing personalised feedback), they are keenly aware of the idea that the quality and reliability of the sources provided by the tool should not be taken for granted but have to be double checked. Xu et al. (2024) also established that students tend to hold reservations about the reliability of ChatGPT as a tool, and this concern is primarily linked to the students' academic level, i.e. in their study, postgraduates were less confident in the ability of ChatGPT to adequately solve content-related queries than undergraduates.

The results of the present study carry implications for the teaching practice not only in the context of the specific institution where the study was carried out, but also in other MET institutions. The results have made clear that more efforts are needed to disseminate the institutional policy on the use of AI. In addition, more focus should be given to familiarising students both with (1) how to leverage the use of AI tools in an efficient way and (2) how AI-powered tools can be ethically used in an academic context. These ideas have been highlighted in recent literature too: for example, Saari et al. (2024) underscore that both students and teachers tend to have difficulties grasping how AI tools should be used efficiently; moreover, they stress that university teachers play a crucial role in guiding students on how to integrate appropriately the assistance of AI in their assigments. Next to providing a relevant set of guidelines for creating an institutional policy on the use of AI, Holm et al. emphasise the importance of honing not only students' but also teachers' skills of using AI tools and thus building AI literacy (2024, p. 2). Crucially, without a proper understanding of how AI technology functions, users are highly likely to use "prompts that resemble search strings for web searches, but (...) this is equivalent to just shouting the query in a crowd" (ibid., p. 4). Importantly, a lack of knowledge and skills in terms of how AI tools should be used could be at the root of the perception that the results generated by AI tools are "not handy"(77ME1NS), "awkward"(92ME1NS) or can be summed up as merely "some blabla" (53ME3NS). Becoming more expert at employing AI tools is therefore likely to improve experience and certainly help the user – if not ChatGPT itself – to become less confused.

In conclusion, our preliminary study of a sample of students at Antwerp Maritime Academy has revealed a snapshot of the attitudes they hold towards ChatGPT and its integration in an educational context. Being aware of the benefits and limitations of AI technology as perceived by students is instrumental to educators who are trying to reflect on and/or reconsider their teaching practices, specifically as far as language education in MET institutions is concerned. The finding that the participants were eager to rely on ChatGPT when addressing written production in English can hopefully also encourage educators to integrate the tool in language classes in an explicit and critical manner, with a specific focus on using it ethically. Possible avenues for future research could include a more in-depth investigation of student production generated with the help of AI tools as well as teachers' perceptions and patterns of integrating AI technology in their teaching practice.

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LEARNER VIEWPOINT OF MARITIME A.I. AND AUTONOMOUS SHIPS

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Abstract: This study examines maritime students' knowledge of Artificial Intelligence (AI) in relation to Maritime Autonomous Surface Ships (MASS) and delves into their particular worries about incorporating AI into maritime activities. The research intends to offer understanding about the readiness of the upcoming workforce for upcoming technological changes in the maritime industry. A study was carried out on maritime students to assess their knowledge of AI technologies, their feelings, and their beliefs on how it could impact their future careers. The results show that although there is strong interest in the possibility of AI improving effectiveness, safety, and sustainability in maritime activities, there are also widespread worries about the loss of jobs, cyber threats, and the decline of traditional maritime expertise. Numerous students were unsure about the impact of AI on their future positions and the kinds of skills that would be required. Drawing from these observations, the researchers proposed modifications to the existing maritime educational program to adequately equip students for a future dominated by artificial intelligence and autonomous machines. Suggestions involve incorporating modules on AI literacy, data analytics, and human-machine collaboration, along with hands-on training in autonomous systems utilization. The research emphasizes the importance of constantly updating curricula and conducting more practical tests to ensure educational programs keep up with changes in the maritime industry and adequately prepare students with necessary skills. These improvements seek to promote a forward-thinking strategy in dealing with the issues and possibilities brought about by AI and autonomous technologies in maritime operations.

Keywords: *Artificial Intelligence, MASS, Remote Control Operator*

1. Introduction

MASS stands for Maritime Autonomous Surface Ships, a breakthrough technology in the shipping industry. It describes a type of ship that can perform independent operations without human interaction to different degrees, from automated processes with decision support to fully autonomous operation. MASS will drive a global paradigm shift in the maritime industry (Aiello et al., 2020). Technology such as this would bring along benefits associated with improved safety through reduced human error, productivity through optimized operations, and cost savings through the absence of any onboard crew. However, Kontaxaki and Alexandropoulou (2023) stated that MASS also gives rise to new risks related to system failure, cyber-attacks, and difficulties in ensuring the safety of life at sea without seafarers on board.Fenton and Chapsos (2023) disclosed that the IMO has initiated a regulatory scoping exercise to determine how existing international regulations should be applied to MASS operations. The exercise would clarify the different degrees of autonomy, explain the roles and responsibilities of the remote operators, and develop new standards for the training and certification of seafarers.

As the shipping industry embarks on this digital transformation journey, countries are channeling money into research that could ascertain what MASS means for domestic shipping sectors: how this change will affect the maritime workforce, what future competencies and training needs for the workforce will be required, and what kind of strategies will ensure competitive performance throughout an autonomous shipping age. In other words, while MASS presents an exciting advancement in maritime technology, its successful implementation will require close collaboration between industry stakeholders, policymakers, and the research community to address the broad range of complex regulatory, operational, and workforce challenges that remain. Consequently, the successful trip of the Soleil signals the arrival of autonomous ships, ushering forth a new era in marine transportation (Schwartz, 2020). In January 2022, a Japanese car ferry, the Soleil, became the first large vessel to navigate without human intervention. The 220-metre-long ship automatically berthed and unberthed, turned, reversed and steered itself for

240 kilometers across the Iyonada Sea from Shinmoji in northern Kyushu - maneuvers that even skilled human operators find challenging. This technical breakthrough has piqued the curiosity of marine students, who are keen to investigate the consequences and prospects of this paradigm change.

Simmons (2020) mentioned that a recent survey of maritime students sought to uncover their perspectives and thoughts on autonomous ships and the use of artificial intelligence (AI) in the maritime industry. The study found a variety of viewpoints, ranging from excitement about AI's potential to automate processes and improve safety to concerns about job displacement and the influence of AI on human expertise. Maritime students foresee a future in which Kim et al. (2020) emphasize that autonomous ships integrate smoothly into existing maritime operations, improving efficiency, lowering costs, and reducing environmental effects. They realize the potential of artificial intelligence to improve decision-making, provide real-time data analysis, and automate repetitive work, freeing up sailors to focus on higher-level strategic and analytical jobs (Shneiderman, 2022). On the other hand, students are aware of the hardships that lie ahead. Concerns about job displacement and human skills and expertise degradation remain prominent. They see a need for maritime education to adapt to this changing landscape, emphasizing adaptability, lifelong learning, and the development of new skill sets to flourish in the age of self-driving ships.

The study emphasizes the importance of proactive initiatives to address maritime students' concerns and prepare them for the changing maritime scene. Maritime education must adapt to provide future seafarers with the skills and knowledge required to operate, manage, and oversee autonomous shipping systems. AI literacy, data analysis, and human-machine collaboration are all priorities. Maritime AI and Ship Autonomy are intertwined concepts and represent the transformational application of artificial intelligence (AI) in the maritime industry. Munim (2020) stated that AI refers to using AI in numerous maritime sectors, such as ship navigation, operational management, port administration, and logistics activities. Ventikos et al. (2020) described ship Autonomy as a vessel's ability to function independently without the direct intervention of human operators.

By harnessing AI's capacity to automate and optimize many aspects of the industry, maritime AI introduces a paradigm shift in maritime operations. Sensor data can be analyzed by AI-powered systems, enabling autonomous navigation and collision avoidance methods. Furthermore, AI systems can optimize route planning, lowering fuel consumption and journey times. Similarly, Bratić et al. (2019) emphasized that ship autonomy is the apex of marine automation, with vessels operating autonomously and making decisions about navigation, propulsion, and other operational factors. This advanced level of autonomy includes a range of human involvement, from supported decision-making to remote control and entirely autonomous operation.

Maritime AI and ship autonomy have enormous potential to alter the maritime sector by enabling increased safety, efficiency, and reduced environmental impact (Ghaderi, 2020). Indeed, artificial intelligence-powered solutions can reduce human error, improve decision-making, and streamline operations, resulting in safer and more efficient maritime transportation. However, integrating AI and autonomous technology into the maritime sector poses issues that must be carefully considered. Regulatory structures must be modified to accommodate the innovative characteristics of autonomous shipping practices. Accidents involving autonomous vessels necessitate precise demarcation of liability problems. Gunduz et al. (2020) reiterated that cybersecurity measures must be strong to protect against cyberattacks that could jeopardize operational integrity. Thus, acceptance from seafarers, port authorities, and other stakeholders is also critical for the widespread deployment of autonomous shipping technologies. Regardless of the challenges ahead, the transformative potential of Maritime AI and Ship Autonomy cannot be underestimated. As AI technology advances, we may expect autonomous ships to navigate our waters flawlessly, transforming maritime transportation and crafting a more sustainable and efficient marine landscape. We can pave the way for a future where Maritime AI and Ship Autonomy lead the maritime industry toward more excellent safety, efficiency, and sustainability by proactively addressing its challenges and encouraging stakeholder

collaboration. Conversely, maritime education and training institutes must reinvent their curricula to incorporate cutting-edge Maritime AI and Ship Autonomy concepts. This necessitates a fundamental transformation in the delivery of maritime education, going beyond traditional classroom-based training and toward experiential learning and simulation technologies. Maritime education institutes may train future seafarers on the difficulties and potential of autonomous shipping by including Maritime AI and Ship Autonomy concepts in their curricula.

Martelli et al. (2021) revealed that the maritime industry is ever-changing, and the pace of innovation in Maritime AI and Ship Autonomy is only speeding up. Maritime education and training institutions must promote a culture of lifelong learning in order to educate prospective mariners for a lifetime of success in this dynamic business. This includes encouraging students to stay current on the latest breakthroughs in Maritime AI and Ship Autonomy and providing them with the resources and support they require to continue studying throughout their careers. The incorporation of Maritime AI and Ship Autonomy into maritime education and training represents a paradigm shift in preparing future seafarers. Seafarers develop critical skills in controlling and navigating autonomous vessels by combining these modern technologies, ensuring they are well-equipped to operate in an increasingly digitized maritime environment. This enables them to adapt to technology changes, improving maritime safety and efficiency.

Integrating Maritime AI and Ship Autonomy into maritime education and training necessitates active stakeholder coordination. Maritime academies, industry leaders, technology developers, and regulatory authorities work together to provide complete curricula and training programs. The maritime industry can address the increasing needs and issues connected with autonomous shipping by developing this collaborative approach, enabling a harmonized and successful deployment of these technologies in education and training efforts. The existing literature corresponds with the objectives of the current study, which intends to measure students' awareness of ship automation and the practical applications of artificial intelligence in the maritime industry. Furthermore, the literature analysis lends credence to the second aspect of our inquiry, which involves examining the perceived benefits, adversities, and consequences of incorporating AI and automation concepts into the nautical field. By addressing these concerns and adapting to the changing needs of the maritime industry, maritime education and training can equip future seafarers to handle the complexity of autonomous shipping while also embracing the opportunities it provides. Incorporating AI and autonomous technology into the maritime industry has enormous potential to change maritime transportation, and maritime students will play an important part in determining this future.

With this, the researchers envisioned laying a solid platform for offering a maritime preparatory course in MASS by conducting a comprehensive needs analysis, which will allow educators to identify knowledge gaps and skill requirements of maritime students relating to Maritime AI and Ship Autonomy. A needs analysis can also assist in identifying any concerns or apprehensions that maritime students may have about Maritime AI and Ship Autonomy. This includes evaluating students' knowledge of AI principles, data analysis methodologies, human-machine collaboration, and practical implementations of these technologies in the maritime setting. Understanding the special demands of maritime students allows educational institutions to modify their curricula and training programs to meet these needs successfully. Modules on AI literacy, data analysis, human-machine interaction, and hands-on experience with Maritime AI and Ship Autonomy systems may be included.

The study sought to address the following questions: How may the demographic profile of the students be described in terms of academic program, year level, age, sex, residence by region, and scholastic profile? What is the student's background in ship automation and the maritime application of artificial intelligence regarding familiarity, emotional response (feelings), inclination to work preference, and the academy's preparation? What are the perceived effects of integrating AI and automation concepts in the educational and professional aspects? Is there a significant relationship between the student's demographic profile and the student's background in ship automation and the maritime application of artificial intelligence? What are your concerns about ship automation and the maritime application of artificial intelligence toward MAAP, shipping companies, and government agencies?

2. Methods

The study employed a sequential explanatory mixed methods design. In this approach, there were two different phases. The sequential explanatory approach, together with the needs analysis framework, made it possible to have an in-depth understanding of the research problem from both numeric and narrative approaches.

The sample included 480 students under the BSMT, BSMarE and BSMEE courses, which was chosen through a purposive sampling method.

The study utilized a mixed-method approach where it surveyed first to quantify the background information, familiarity, feelings, work preference, perceptions towards AI and automation concepts among the students, then followed up with qualitative interviews to elaborate further on the results of the survey. Needs analysis was an integral part since the preliminary questionnaire identified and assessed the existing knowledge and perceived needs of the midshipmen in this area. The survey questionnaire was distributed to gather quantitative data on background information, familiarity, feelings, work preference, perceptions towards AI and automation concepts among the students via Google Form.

IBM SPSS 25 was employed to examine the data. The sample distribution was assessed using descriptive statistics such as frequency and percentage, while the Pearson Chi-Square test was used to evaluate potential correlations between variables.

3. Results

Table 1. Students' Background Information

Profile		Frequency	Percent
Academic Program	BSMEE	14	2.9
	BSMarE	219	45.6
	BSMT	247	51.5
year level	1st	171	35.6
	2nd	253	52.7
	3rd	52	10.8
	4th	4	.8
Age	18-19	199	41.5
	20-21	237	49.4
	22-25	44	9.2
Sex	Male	459	95.6
	Female	21	4.4
Residence by region	Central Luzon	94	19.6
	NCR	45	9.4
	Central Visayas	56	11.7
	CALABARZON	50	10.4
	Western Visayas	52	10.8
	SOCCSKSARGEN	94	19.6
	Bicol Region	21	4.4
	Cagayan Valley	19	4.0
	MIMAROPA	20	4.2
	Eastern Visayas	5	1.0
	Northern Mindanao	2	.4
	CAR	5	1.0
	Ilocos Region	12	2.5
	BANGSAMORO	2	.4
	CARAGA	1	.2
	Davao Region	1	.2
	Zamboanga	1	.2
Scholastic Profile	Public School with Honors	225	46.9
	Private School with Honors	101	21.0
	Technical, Trade, Science High School with Honors	19	4.0
	Public School Graduate	65	13.5
	Private School Graduate	68	14.2
	Technical, Trade, Science High School Graduate	2	.4
	Total	480	100.0

Table 1 shows the demographic information of the respondents in terms of academic program, year level, age, sex, region of residence and scholastic profile. Predominantly, the students in the survey were students of BSMT, followed by BSMarE, and a very small percentage of BSMEE—this shows the present composition of the student body. The most significant number of students came from the second year, followed by the first year, the third year, and a few graduating students. The age range of the majority is 20-21 years, though 18-19 and 22-25-year-old individuals were also present. The respondents were predominantly males, with a very small percentage of females. The most significant representation is from Central Luzon, SOCCSKSARGEN, West and Central Visayas, and the National Capital Region, while the rest of the regions have smaller responses. 72% of the respondents are honor students from public, private, and science/technical school students.

Table 2. Students' familiarity with AI and smart vehicles

Familiarity	Not at al familiar	Slightly familiar	Moderately familiar	Very familiar	Extremely familiar	Median	Mean	SD
AI	31 (6.5%)	82 (17.1%)	155 (32.3%)	106 (22.1%)	106 (22.1%)	3.00	3.36	1.19
Smart vehicles	12 (2.5%)	95 (19.8%)	218 (45.4%)	132 (27.5%)	23 (4.8%)	3.00	3.12	0.87

Table 2 illustrates the students' overall level of familiarity with AI and smart vehicles. The respondents' understanding of AI and smart vehicles is, therefore, moderate, as most of their knowledge on these subjects has been sourced from popular culture rather than technical education or knowledge in the industry.

" We saw a lot (of them) from Marvel movies, like Ultron or Iron Man."

"Sa (Japanese) Manga Sir, like Gundam." [In Japanese Manga, like Gundam.]

Some learners, influenced by sensationalized media, know the real-world contributors to AI and robotics, like Tesla and Boston Dynamics. At the same time, remote learning allows them to know very little about any AI concept in substantial depth or practice.

"Self-driving cars from Elon Musk"

"Yung frequent Sir, na featured robot sa mga action movies na high-tech." [Robots frequently featured in high-tech action movies]

" We have subjects (courses) that included Robotics and basic programming, kaso Sir, via module lang because of the lockdowns."

[We have courses that includes Robotics and basic programming via modules because of (Covid) lockdowns.]

The respondents have sufficient knowledge of the existing AI applications based on first-hand use of applications such as ChatGPT and Google Gemini. Even as entertainment media remains their first point of familiarity with AI, their awareness of its applications and implications continues to grow.

"Yung alam ko lang na A.I. is Chat GPT", [The only A.I. I am aware of is Chat GPT.]

" Sa Google, Sir, may image at video generator, pang deep fake."[In Google, there is an image and video generator for making deep fakes.]

Table 3. Respondents' Familiarity with AI and Smart Vehicles

Category	Program/Year Level/Region	Familiarity of AI	Familiarity of Smart Vehicles
Academic Program			
BSMarE Students	Marine Engineering	3.46	2.87
BSMT Students	Marine Transportation	3.30	2.87
BSMEE Students	Mechanical Engineering	2.93	2.71
Year Level		Familiarity with AI	Familiarity with Smart Vehicles
1st-year Students		3.47	2.11
2nd-year Students		3.30	2.10
3rd-year Students		3.31	2.25
4th-year Students		3.36	2.07
Regional Origin		Familiarity with AI	Familiarity with Smart Vehicles
Davao Region		5.00	2.00
Caraga		4.00	2.00
Soccsksargen		3.28	2.15
Ilocos		2.83	1.75
Bangsamoro		3.5	2.00
Central Luzon		3.32	1.96
NCR		3.47	2.07
Central Visayas		3.32	1.96
CALABARZON		3.34	2.1
Western Visayas		3.13	2.23
Bicol Region		3.86	1.86
Cagayan Valley		3.74	2.26
Zamboanga		2.00	1.00

It can be gleaned on Table 3 the respondents' level of familiarity with AI and Smart Vehicles when grouped according to academic program, year level and regional origin. BSMarE students show the highest familiarity with AI at 3.46, probably due to the inclusion of technical content within their curriculum on the applications of AI in maritime technologies. For students majoring in BSMT, the familiarity rating was at 3.3, which suggests a fair amount of awareness about AI, influenced by technology and automation in their studies. The average for mechanical engineering students was 2.93, reflecting a reasonable understanding of AI but less pronounced than the first two groups. In the case of smart vehicles, both BSMarE and BSMT have very similar ratings for familiarity, while the BSMEE ranked it with a slightly lower 2.71, indicating that smart vehicles are less represented in their curriculum.

Table 4. Emotional response of the respondents with regards to Intelligent Ships

	Not Excited at All	Slightly Excited	Moderately Excited	Very Excited	Extremely Excited	Median	Mean	SD
Feelings towards intelligent ships	25 (5.2%)	96 (20.0%)	202 (42.1%)	117 (24.4%)	40(8.3%)	3.00	3.11	0.99

Table 4. presents the emotional response of the respondents with regards to Intelligent Ships. Their emotional response towards Intelligent Ships may be attributed to the present level of understanding and familiarity with artificial intelligence and smart vehicle technologies. But more than that, it expresses a general lack of interest or unease about implementing such advanced technology in maritime activities.

Consequently, some participants realize that Intelligent Ships could decrease workload by automatic execution of routine operations, reduce physical strain, and create greater operational efficiency, mainly in the engine room; this they judge as positive.

“kasi automated na yung mga processes lalo na sa engine room”[Because intelligent ships will have automated processes especially in the engine room.]

“Pwede na siguro i-voice command yung steering Sir”[I’m hopeful it will possible to steer the ship by voice command.]

Despite the respondents' appreciation of the workload benefit that can be reaped from an automated system, it was felt that more personnel would have to be added to monitor the systems incessantly so they are reliable and working properly.

“ Sir, eventhough automatic na yung process, someone still has to check.”[Though convenient, someone has to check the automated processes.]

“ I think matagal pa yan ma fully implement, saka may transition period pa na man”[I think, it will be a long wait until full implementation, and there is a transition period prior.]

“ Till hindi pa perfect yung concept sir, I think may need pa to hire people on board, to check, for recording.”[Until the concept have not been perfected, I think there is still a need to hire people onboard for check-ups and record keeping.]

Several respondents express discontent about the integration of AI, fearing it might reduce the need for manual labor. They are worried that the shift to automation could lead to fewer job openings, particularly for roles that rely on hands-on abilities.

“Less opportunities for manual labor”

“Sir, pag na-automate yung process, like sa McDonalds, binabawasan din yung service crew.”[If a process is automated, companies like McDonalds tend to let go most of the service personnel.

There is a huge concern that, with intelligent systems aboard, traditional maritime skills will be superseded, making manual skills irrelevant and giving rise to concerns regarding job prospects in the future and reskilling or upskilling.

“ Sir, pang IT nay an eh.” [That is a job for IT Technicians.]

“Paano po kami mag deck maintenance? Remote din ba?”[How should we perform deck maintenance? Remotely as well?]

"Yung makina sir, paano naming malaman kung running condition pa?"[How will we know if the engine is still in running condition?]

"Need ba naming mag shift (ng course) na agad Sir?"[Do we need to immediately change academic degrees right now?]

A substantial number of respondents view work with robots and AI as potentially hazardous. They raise safety issues when working with advanced machines, especially in a dynamic setting like the maritime sector.

"Working with robots is dangerous."

"What if they went rogue? Skynet IRL (in real life)?"

Some respondents need to be more cautious about AI disrupting established maritime rules like the COLREGS. They fear Intelligent Ships might not adhere adequately to these regulations, posing safety risks.

"A threatening scenario with regards to COLREGS"

" Paano yung fishing boats Sir, unpredictable na man kasi movement nila and minsan wala pang ilaw pag gabi."[What about fishing boats? Their maneuvers are a bit unpredictable, and sometimes, even unlit at night?]

Table 5. Perceived Effects of Integrating AI and Automation Concepts on Education and Training

Aspect	**Response Options**	**Strongly Negative**	**Negative**	**Neutral**	**Positive**	**Strongly Positive**	**Median**	**Mean**	**SD**
Effect on Training and Education	How will the concept of automated ships affect your study/training program?	5 (1.0%)	4(9.6%)	186(38.8%)	205(42.7%)	38(7.9%)	4.00	3.47	0.81
Preparation for Ship Autonomy	How is MAAP preparing you for Ship Autonomy?	23(4.8%)	68(14.2%)	201(41.9%)	143(29.8%)	45 (9.4%)	3.00	3.0	0.97

Table 5 depicts the perceived effects of integrating AI and automation concepts on education and training. Most students got excited about the prospect of self-navigating ships and predicted considerable changes in their studies once more advanced topics were introduced. They expect much more emphasis on communication technologies and computer networks, advanced math, and robotic engineering, with a foreboding that adding all these new topics might bring additional academic stress and challenges in time management.

Table 6. Inclination to Work Preference and Career Prospects Enthusiasm
in the Age of Autonomous Ships

Career Prospects Enthusiasm	Strongly Negative	Negative	Neutral	Positive	Strongly Positive	Median	Mean	SD
How will automated ships affect your prospects as a maritime professional?	12 (2.5%)	85 (17.7%)	175 (36.5%)	168 (35.0%)	40 (8.3%)	3.00	3.29	0.94
Inclination to work preference				No	Undecided		Yes	
Will you work with a remotely controlled vessel?				42 (8.8%)	184 (38.3%)		254 (52.9%)	
Will you work with an autonomous vessel?				40 (8.3%)	163 (34.0%)		277 (57.7%)	

It can be seen on Table 6 the students' inclination to work preference and career prospects enthusiasm in the age of autonomous ships. Meanwhile, the indication toward the career opportunity aspect by the automated ships was mixed with 2.5% strongly negative, 17.7% negative, and 35% positive, and 8.3% strongly positive, showing the resultant skew median = 3.00 and mean: 3.29. Looking into work preferences, 52.9% of the respondents preferred to work with remotely controlled vessels, while 57.7% are open to working with automated vessels, so that general interest toward the two emerging technologies was indicated among most of the respondents.

Table 7 relationship of students' Demographic Profile and Background in autonomous ships and maritime application of AI.

Profile	Background in Ship Automation	X^2	Sig.	Remarks (relationship)
Academic Program	Familiarity with AI	4.70	.195	Not significant
	Familiarity with Smart Vehicles	1.24	.743	Not significant
	Feeling About Intelligent Ships	1.15	.766	Not significant
	Willingness to work in RCV	1.87	.393	Not significant
	Willingness to work with an autonomous vessel	0.99	.609	Not significant
	MAAP Preparation	2.39	.495	Not significant
Year Level	Familiarity with AI	3.19	.784	Not significant
	Familiarity with Smart Vehicles	1.83	.934	Not significant
	Feeling About Intelligent Ships	**15.39**	**.017**	**Significant**
	Willingness to work in RCV	0.95	.918	Not significant
	Willingness to work with an autonomous vessel	2.74	.602	Not significant
	MAAP Preparation	5.33	.502	Not significant
Age	**Familiarity with AI**	**13.21**	**.040**	**Significant**
	Familiarity with Smart Vehicles	3.35	.763	Not significant
	Feeling About Intelligent Ships	9.22	.162	Not significant
	Willingness to work in RCV	3.00	.557	Not significant
	Willingness to work with an autonomous vessel	**15.34**	**.004**	**Significant**
	MAAP Preparation	7.23	.300	Not significant
Sex	Familiarity with AI	2.51	.473	Not significant
	Familiarity with Smart Vehicles	.447	.930	Not significant
	Feeling About Intelligent Ships	2.56	.464	Not significant
	Willingness to work in RCV	0.88	.645	Not significant
	Willingness to work with an autonomous vessel	0.83	.661	Not significant
	MAAP Preparation	6.15	.104	Not significant
Regional Group	Familiarity with AI	3.73	.713	Not significant
	Familiarity with Smart Vehicles	3.72	.714	Not significant
	Feeling About Intelligent Ships	2.82	.832	Not significant
	Willingness to work in RCV	3.22	.522	Not significant
	Willingness to work with an autonomous vessel	6.50	.165	Not significant
	MAAP Preparation	22.72	.001	Not significant
High School Type	Familiarity with AI	10.24	.115	Not significant
	Familiarity with Smart Vehicles	**14.91**	**.021**	**Significant**
	Feeling About Intelligent Ships	2.11	.909	Not significant
	Willingness to work in RCV	8.81	.066	Not significant
	Willingness to work with an autonomous vessel	4.11	.391	Not significant
	MAAP Preparation	3.80	.704	Not significant

Table 7 outlines the relationship of students' Demographic Profile and Background in autonomous ships and maritime application of AI. Analysis of the relationships between students' demographic profiles and background in autonomous ships and maritime applications of AI shows that only "Feeling About Intelligent Ships" by year level and "Familiarity with AI" by age had a significant relationship. Moreover, familiarity with smart vehicles is high and dependent on the type of high school ($X^2 = 14.91$, $p = 0.021$), whereas all other variables, including the willingness to work with remotely controlled or autonomous vessels, do not show any significant dependencies.

Figure 1: Generated Themes

There are important concerns expressed by students toward MASS from a number of different aspects. At an academic level, they were concerned about the adequacy of training received to handle advanced technologies and possible job loss as a result of the increased use of autonomous technology. They also showed concerns regarding the safety and reliability of autonomous systems and that their curriculum needs to be updated to be better prepared for the requirements in the industry in the near future. From the viewpoint for the shipping industry, students are well aware of the problems related to MASS integration: cybersecurity and adaptation to new conditions at work. Moreover, governmental agencies are perceived as critical for dealing with those concerns through the development of regulations that handle employment implications and provide guidelines on transition towards a changing maritime workforce.

4. Discussion

Demographics and Characteristics of Respondents

The questionnaires were mostly distributed to students taking up Bachelor of Science in Marine Transportation (BSMT) and Bachelor of Science in Marine Engineering (BSMarE), while a scaled-down number was from graduates who took up Bachelor of Science in Marine Engineering and Electro Technology (BSMEE). Then, with respect to distribution, most of the respondents were second and prior first years, then third years, while a very small fraction represented graduating students. Regarding their age, the highest number of respondents was 20-21 years old, followed by 18-19 years old, which would seem to correspond with their respective year levels. Most of the respondents were men, the general trend of gender bias usually found within maritime education.

Geographically, the greatest number of the respondents came from Central Luzon and SOCCSKSARGEN, with strong representations coming from Visayas, NCR, and CALABARZON. This regional distribution may indicate varying levels of exposures and educational resources found across the breadth of the Philippines.

Familiarity with AI and Smart Vehicles

In general, there was the presence of a medium level of exposure to AI and smart vehicles among the respondents. Their notion and understanding have been mostly inculcated by popular culture—for example, movies like Marvel, Japanese manga Gundam—as opposed to formal educational sources. Some of them had received theoretical education on AI through modules, but its practical application had brought a difference in learning due to the disruption caused by remote learning. In terms of familiarity with AI, BSMarE students demonstrated the highest level compared with those pursuing the BSMT and BSMarE programs. This hierarchy may very well be indicative of variable integration and/or emphasis towards AI within maritime-related programs.

Significantly, the data reveals significant regional differences in AI/smart vehicle familiarity in the Philippines, with urban areas showing greater familiarity due to better access to technology. Economic development and educational resources contribute to disparities, as well-funded regions offer better technology education, while resource-limited areas struggle to keep pace (Villanueva, 2022; Lorenzo, 2021).

Regional Variability in Knowledge

The level of familiarity with AI and smart vehicles scored significantly different between the regions. For regions like Davao, the familiarity scores are high, indicating a better presentation and focused education on these technologies compared to others. On the other hand, regions like SOCCSKSARGEN and Ilocos scored a bit lower, showing that the educational resources in these regions should be strengthened.

Regional variations in AI familiarity are influenced by economic development and access to quality education, with better-funded systems enhancing student awareness of technology, (De Castro, 2020). In contrast, areas with limited resources often struggle to keep up with technological education, leading to gaps in knowledge and preparedness among students (Reyes, 2023).

Attitudes Towards MASS

The respondents have mixed opinions when asked about the introduction of MASS. Some showed a keen interest in potential efficiency gains and reduced physical strain from automation, whereas others were apprehensive due to fears of job loss, possible safety issues, and the continuous human supervision that would thus be needed. There was also some concern about how it may disrupt the traditional role of mariners and impact job opportunities. Respondents' knowledge of AI and smart vehicles primarily comes from media and academic sources, limiting their understanding of Intelligent Ships' practical benefits and challenges. This restricted exposure, combined with the complexity of AI technologies, contributes to their apathy and preference for traditional manual maritime procedures. (Santos, 2022).

In the Philippines, there is a strong reliance on popular media and academic curricula for AI information, often prioritizing theoretical knowledge over practical applications. (Garcia, 2021). Many students learn about AI through movies and online platforms, focusing on sensational rather than realistic applications, (Tan & Cruz, 2020). Limited understanding of AI from media sources may result in misunderstandings and resistance to the adoption of new technologies in professional settings, (Villanueva, 2022). Furthermore, the complexity and rapid evolution of AI can overwhelm those lacking a strong technical foundation, leading to a preference for familiar manual methods over intelligent systems. (Reyes, 2023). Such preferences are influenced by a combination of inadequate exposure to hands-on technological applications and the fear of obsolescence in the face of automation (Lorenzo, 2021).

Educational Preparedness and Future Outlook

However, generally speaking, most of the respondents believed that their current education was sufficient to prepare them for the future developments regarding autonomous shipping. Advanced communication systems, computer networks, robotics, and mathematical modeling were stressed as vital components for the future of maritime education. Reflecting the proactive attitude of embracing technology, continuous learning would be a must for the full adaptations. Safety concerns extend beyond operations to cybersecurity, with respondents fearing that increased reliance on AI and digital systems may expose intelligent ships to cyber-attacks, jeopardizing maritime safety. This skepticism about AI's reliability and decision-making abilities in complex scenarios influences their overall perception of intelligent ships and hinders full acceptance of the technology.

Smith, (2020) mentioned that respondents' attitudes stem from educational and experiential backgrounds that lack coverage of AI's practical applications and benefits in maritime environments, fostering a cautious or indifferent mindset. Furthermore, popular media often portray AI through futuristic or dystopian scenarios, shaping perceptions and fostering fear or misunderstanding of its real-world implications. (Johnson & Wang, 2019). Brown, (2021) identified one of these negative influences is respondents fear job displacement due to automation, reflecting broader economic anxieties about the future of work amidst technological advancements, particularly in industries valuing manual skills. Ironically, the belief that more personnel will be needed for monitoring reflects an awareness of the importance of human oversight in ensuring the safe operation of intelligent systems despite automation. (Davis, 2018). Jones & Baker, (2022) disclosed the emphasis on operational safety and adherence to regulations underscores a practical concern for maintaining maritime operations' integrity and safety. This perspective is essential for addressing risks associated with new technologies, emphasizing the need for ethical considerations in deploying intelligent systems amid concerns about AI's impact on regulations, (Nguyen, 2021). Ensuring that these technologies align with safety standards and ethical guidelines is crucial for garnering broader acceptance (Wilson, 2020).

Psychological and Motivational Factors

The motivations that emerged as to why people wanted to work with autonomous vessels were both intrinsic. Also, a strong motivating factor among the respondents was fear of missing out on a career—it underpins a concern about staying relevant within an industry in rapid evolution. Data indicates that over 50% of the participants are open to collaborating with autonomous and remotely operated ships, with over 30% unsure. A small fraction of people is unwilling to work on or with such vessels. Those who are willing to participate expressed interest in the idea of working on autonomous or remotely controlled ships, likening the experience to being in a movie or a role-playing game that they are already very accustomed to. This growing interest in innovative technology mirrors a larger pattern in the maritime sector, where younger individuals are increasingly open to adopting digital improvements and automation (Andersen, Bø & Roe, 2017; Wright, 2021). Conversely, undecided participants believe they require further details on the idea and are hesitant to make a decision because they are not familiar with it. This underscores a major obstacle in the acceptance of autonomous ships: the lack of understanding and awareness regarding the operational features and possible advantages of this technology (Porathe, 2020).

5. Conclusion and Recommendations

The study identified that the awareness level of students concerning Maritime Autonomous Surface Ships (MASS) is notably low or otherwise misled, resulting to significant anxieties regarding various facets of its integration and utilization in the industry.

Students expressed substantial concerns about the safety and reliability of MASS, highlighting the perceived risks and reservations associated with their employment in maritime profession. Moreover, there were notable apprehensions regarding the likely impact of MASS on future job placement and training in the maritime sector, with students worried about skill obsolescence and the changing requirements for skills and competencies.

The study also highlighted concerns related to the technical and operational aspects of MASS, such as the complexities involved in their operation, maintenance, and the implications for traditional maritime disciplines. Students expressed uncertainty about the future implementation of MASS, reflecting a need for more comprehensive knowledge and understanding of the technology and the consequences of its evident emergence.

Thereby, the researchers recommend that technical skill sets in AI, network technology, and digital computing should be assessed with a view to better prepare students for MASS through the proposed Digital Skills Diagnostic Tool: Assessing IT, Computing, and Digital Communication Aptitude as well as the developed MASS Outline. Infusion of these learning objectives should be done into the maritime curricula at all levels in order to expose students to relevant technologies and set the foundation to keep up with further developments in the future. Furthermore, that there are developed and focused awareness and training programs related to MASS operations, while the institution collaborates with the industry and regulatory bodies in ensuring the curriculum relevance of students moving forward towards the evolving maritime technology.

Acknowledgement

This work is highly indebted to all those individuals and MAAP Departments whose immense help and support made the research possible.

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EXPLORING CADET'S ENGAGEMENT AND CADET'S RESPONSE IN USING MARLINS SYNCHRONOUS MODEL IN AN INDONESIAN MARITIME HIGHER EDUCATION

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Abstract: The aim of this study was to explore the cadet's engagement and cadet's response in teaching maritime English for seafarers based synchronous Model of Marlins. This study used qualitative research, with a case study design. Data collection used observation, questionnaire, in-depth interview and documentation to collect data on current teaching practices and approaches used in Maritime English. The research sample was 3 experienced lecturers and 24 cadets in Nautical study program. Analysis of interview data used Atlas.ti Software version 9 in 2021. Technique of data analysis used Miles and Hubberman with the step of collecting data, reduction of data, presentation of data and the last was conclusion. The findings found that the engagements of cadets can be seen from three aspects, namely emotional, behavioural and cognitive engagement. Emotional engagement focuses on cadets' emotional reaction in learning, cadet's affective reaction including interest enjoy without any boredom, sadness, afraid and anxiety. Cognitive engagement focuses on material acceptance in learning and self-regulation strategies used. Behavioural engagement can be seen from the readiness, participation and activeness of cadets in receiving learning. The cadets' response can be seen from the changes in cadet' behaviour to become more interactive and motivated to learn.

Keywords: *Maritime English, Engagement, Response, Synchronous Model, Marlins*

INTRODUCTION

Amidst the COVID-19 pandemic, students faced the challenge of adapting to online lessons conducted to technical issues such as distorted audio, frozen screens, and unreliable internet connection (Sasabone et al., 2022). These problems resulted in disruptions in the transmission of facial expressions and eye contact. Autonomous involvement during video became crucial for achieving excellent learning outcomes due to these factors (Almusharraf & Bailey, 2021).

In response to the COVID-19 pandemic, educational systems worldwide were compelled to implement remote instruction using internet platforms in order to cater to students, as lockdown measures were implemented to contain the spread of the virus. Subsequently, researchers in the field of English language acquisition have examined the impact of modifications on language learners' performance, attitudes, trajectories, and overall progress in both Second Language (ESL) and Foreign Language (EFL) settings (Shahabadi & Uplane, 2015).

The learning system used by educators can be said to be appropriate (good) if the implementation of the learning program meets three criteria, namely attractiveness, usability (effectiveness), and usability (efficiency). This shows that the learning system requires a process that is designed in such a way that the interaction between teachers and students occurs in an interesting, effective, and efficient manner. So that with this combination will give birth to educative interactions by utilizing media as teaching materials (Friska, 2021). In the learning system, teachers and students influence each other so that learning activities can live and have class goals.

Maritime school is a school specifically focused on technical skills that can be used on sailing on the ocean or working in industries related to the ocean (Ahmmed et al., 2020). It offers such a combination of classroom and hands-on experiences, which are vocational education programs in the maritime field (Sari & Aprizawati, 2019). As the world today has been facing a global pandemic, many sectors have to transform from the conventional into the digitalized one. Such change includes in educational sectors (Limbong, 2021; Pathirana, 2021). It is a happiness and pride to state that the teaching and learning activities in Polytechnic of Makassar Merchant Marine (PIP) have been implementing e-learning systems, especially during this pandemic. It should be noted that it has been one of the requirements of cadets to complete their courses and pass the standard test required by their institution, which is Indonesian maritime higher education. In a similar word, to graduate, the cadets will be taking a competency test, which measures their understanding of the practical and technical skills related to their profession (Shi, 2018).

Synchronous learning model means that teachers and students learn at the same time virtually through zoom meetings. In other words, Synchronous learning is live, real-time (and usually scheduled), facilitated instruction and learning-oriented interaction (Warden et al., 2013). So, lecturers can deliver material in class directly to their students (Limbong, 2021a). Thus, even though it is done online, lecturers can still do virtual learning through online class media (Kessler et al., 2021). Distance is eliminated because the content of online learning is designed with media that can be accessed from a computer terminal that has the appropriate equipment and other technological means that can access the network or the Internet (Van Deursen & Van Diepen, 2013).

As a result of international public concern about the increased number of maritime casualties which have affected human lives, properties, and the environment, the International Maritime Organization (IMO) had to take steps on an international level to try solving and to control the stated problems which were mainly caused as a result of human error. The establishment of detailed mandatory competence standards, according to the STCW code, is designed to ensure that all seafarers are adequately educated, trained, experienced, skilled, and competent to fulfill their tasks in a way that ensures the safety of life, property, and security at sea, as well as the protection of the marine environment (Ye, 2015; Ivasiuk, 2020).

Because proficiency in English is a requirement for the Standards for Training, Certification, and Watchkeeping (STCW) 1995 code, the 2010 Manila Amendments, and the SOLAS (Safety of Life at Sea) requirements, maritime cadets must achieve proficiency in Maritime English (M.E.). Lack of English proficiency leads to miscommunication, which frequently results in maritime mishaps, endangering life and property (Ahmmed et al., 2020). In addition, it should also be underlined that the quality of the learning process, which includes how it is implemented in language teaching for maritime, must be fulfilling the national standard.

This current study investigates the application of Marlins English for Seafarer in a synchronous learning model. This platform model for language education will, of course, be based on the STCW code's rules and regulations. Furthermore, it will be based on the curriculum developed by the internal institution, especially the existing curriculum used in the D-IV program specializing in Technical and Nautical science. This is mainly objected to improving the competence and skills of seafarers for the promotion of safer shipping and cleaner oceans by using online Marlins. The learning and teaching activities will be developed and elaborated following the guideline of the STCW Code. It should be underlined that the actions of e-learning composition will be based on the targeted competency of English for Maritime.

Based on the researcher's observation in terms of what has been commonly happening over Maritime higher institutions in Indonesia, the researcher found some crucial issues with regard to the application of online learning in Indonesian maritime higher education as follows. First, it was considered that there were only a few merchant institutions or schools which have not yet implemented Marlins English in English teaching and learning activities, although many Seafarer industries and companies require Marlin's test competency in order to enable cadets working at ships. Second, there are still a number of teachers delivering English materials that are not suitable and relevant to Maritime English content. The third, most lecturers still teach through the traditional (conventional) method, they only teach English in the classroom without using new media.

The objective of this study is to explore the cadet's engagement and cadet's response in teaching maritime English for seafarers based synchronous Model of Marlins. Regarding to the teaching and learning activities in Polytechnic of Makassar Merchant Marine (PIP) have been implementing e-learning systems, especially during this pandemic, resulting in the continuous teaching activity at the universities or schools.

METHOD

The proposed research employed a qualitative research study, specifically case study design on the Synchronous Learning Model of Marlins for Seafarer to support Maritime English in Indonesian post- pandemic maritime higher education (New Normal). A case study is a research approach that is used to generate an in-depth, multi-faceted understanding of a complex issue in its real-life context (Creswell, 2014). This research took place in Politeknik Ilmu Pelayaran (PIP) Makassar.

This research was carried out in the third semester of odd semester in 2021/2022 academic year. This research took place in Politeknik Ilmu Pelayaran Makassar. Observation and interviews were carried out to gather data on the current teaching practices and approach used in the Maritime English classes of PIP Makassar specifically in using Marlins English for Seafarer based synchronous learning. The samples of the interview were 3 lecturers and 7 cadets and observations were 3 experienced lecturers and 24 cadets from PIP Makassar particular majoring from Engine respectively.

The researcher gathered the data through observations, interview, and documentation. After gathering and analysing the data from the first round, another round of interview would then be carried out to gather data on the integration of Online Marlins for Seafarer based Synchronous Model. This round of interview was in essence an informal, open-ended interview.

The data gathered from the interview were analyzed to ascertain the participants' perceptions on Syncronous learning environment.

There were several kinds of instruments that has been been used in this research. The followings were the kinds of instruments: Interview Guideline for lecturers, Open Questionnaire for Lecturers, Checklist of Observation for Lecturers, Documentation, Checklist of Observation for Cadets, Interview Guideline for Cadets and Open Questionnaire for Cadets. Technique of Analysis Data Qualitative (Miles and Hubbernman in (Elliott, 2018). An analysis of interview data using Atlas.ti Software version 9 in 2021. Atlas.ti Software version 9 was software created by Thomas Muhr, he came from Germany. Atlas ti is software that was used to analyze qualitative data in the form of text, graphics, audio, and video in large quantities. ATLAS.ti is used in qualitative research. This software including the type of CAQDAS program (Computer-Aided Qualitative Data Analysis Software) or similar with QDA software (Qualitative Data Analysis Software).

RESULTS AND DISCUSSION

Cadet's engagement

Based on the findings of the cadets' engagement among behavior, emotion and cognitive. Behavioral involvement focuses on cadets' participation such as trying, being serious, concentrating, paying attention, obeying rules, contributing to discussions, asking questions, and paying attention. Emotional involvement focuses on cadets' emotional reactions which include interest, boredom, joy, sadness, and anxiety. Cognitive engagement that focuses on the cadets' investment in learning and the self-regulation strategies used. Cadets cognitively had engaged a desire to be involved in learning and have a desire to master knowledge.

Dealing with the cadets' engagement on Syncronous Model of Marlins For Seafarers For Maritime English, the data from the in-depth interview with the participants indicated that :

Extract 42: Cadets' Engagement

Keterlibatan saya, saya harus masuk sebelum dosen hadir di zoom itu aktif juga kalau ada pertanyaan, terus saya juga ketua kelas dalam ,,juga yang memanggil dosen kadang. Terus juga memanage kelompok saya dalam mengerjakan tugas-tugas,, itu maam. (Script record from YUS, LINE 207, Interview data)

My involvement (engagement), I have to join before the lecturer is present at the zoom, it's also active if there are questions, then I'm also the head of class, also the one who sometimes calls the lecturer, to continue to manage my group in doing the tasks, that's all maam. (Script record from YUS, LINE 207, Interview data)

This participant said that during the learning process, all cadets were active by giving opinions that they have previously found in the ZOOM Meetings, thus making all students active in learning and participating in expressing their opinions or ideas from each of them in the class room activities (Students' behavioral engagement and Students' emotional engagement).

Extract 43: Cadets' Engagement

Apalagi ya?....oh iya mem…kalo quiz quiz di aplikasi Marlins online itu kan banyak mem….berlomba lomba menjawab dan saya usahakan juga ikut menjawab…(Script record from AFR, LINE 218, Interview data)

What's again?...oh yes, mam...There are some quizzes at Marlins online application. Marlins has a lot of contests in answering questions and I try to participate in answering too...(Script record from AFR, LINE 218, Interview data).

This participant said that there are some quizzes at Marlins online application. Marlins has a lot of contests in answering questions and He tried to participate in answering the questions in Marlins online application (Students' cognitive engagement).

Cadet's response

Based on the findings found that the level of cadets' response for lecturers teaching. Response here relates to emotions, attitudes and someone's assessment of something around them. This response will appear automatically if there is a change that they like.

Dealing with the cadets' response on syncronous model for lecturers teaching for maritime English, the data from the in-depth interview with the participants indicated through some interview results from the three lecturers as below:

Extract 47: Cadet's Response to lecturer (MUT)

NUR: Respon saya tentang pengajaran dosen MUT… sangat bagus sehingga jadi termotivasi belajar Bahasa inggris maritim karena jadi banyak tau istilah pelayaran yang nantinya saya pake kerja di kapal maam. ….(Script record from NUR, LINE 265, Data interview).

NUR: My response about the lecturer's teaching of MUT….. is very good so that I know a lot about shipping terms which I will later use to work on the maam ship. ….(Script record from NUR, LINE 265, Data interview).

The participant said that the lecturer's teaching of MUT was able to explain or deliver the teaching material well and relaxed and cadets were motivated in joining the teaching and learning process, especially in learning Marlins online in martime English.

Extract 48: Cadet's Response to lecturer (RIA)

So far so good pengajaran dosen RIA… bagus Saya menjadi semangat, termotivasi lagi mem…karena ternyata belajar itu menyenangkan…
Iya mem….dengan pembelajaran online bisa memperbanyak ilmu saya tentang bahasa Inggris maritime…sebagai bekal saya nanti kalau sudah bekerja di kapal pesiar kah……..(Script record from KYW, LINE 269, Data interview).
So far so good for lecturers teaching…Mrs. RIA…. excited, motivated again…because Marlins online turns out that learning is fun…
Yes, I…. using the online learning, I can increase my knowledge of maritime English… as a provision for me later when I work on a cruise ship later….(Script record from KYW, LINE 269, Data interview).

The participant said that the lecturer teaching was excited, it can increase cadet's knowledge of maritime English because the material is designed based on cadets needs and cadets were motivated in joining the teaching and learning process, especially in learning Marlins online in martime English. Furthermore, most of cadets are easy to get jobs in the ships.

Extract 49: Cadet's response to lecturer (ADE)

Respon saya mem….tentang pengajaran Sir ADE…. Bagus saya jadi semangat dan bisa belajar mandiri juga setelah dosen mengajar Bahasa Inggris……..(Script record from AFR, LINE 271, Data interview).
My response for lecturer ADE was teaching….so excited and able to learn independently too after lecturer teaching English…..(Script record from AFR, LINE 271, Data interview).

The participant said that in learning maritime English was enjoyable and antusiastics, it can increase cadet's knowledge of maritime English because the material is designed based on cadets needs. This teaching method made cadets study independently after lecturer teaching continuously. Furthermore, most of cadets are not difficult to get jobs in the yacht or cruiser.

Moreover, the researcher did interview to lecturers with the aim to provide any confirmation for the results of study especially the cadets' response on syncronous learning model of Marlins for Seafarers. Dealing with the cadets' response on syncronous learning model of Marlins for Maritime English, the data from the in-depth interview with the participants from lecturer indicated through some interview results below:

Extract 50: Cadet's response based on lecturer statement

LINE 272
Respon sekali mereka dalam artian positiv, mereka sangat antusias dan termotivasi belajar terutama di speaking practicenya……….(Script record from ADE, Data interview).
Their response was very positive, they were very enthusiastic and motivated to learn, especially in their speaking practice.
…..(Script record from ADE, Data interview).

The participant said that the cadets were very positive, they were very enthusiastic and motivated to learn, especially in their speaking practice when they learning maritime English because the material is designed based on cadets needs and cadets were antusiastics in joining the teaching and learning process, especially in practicing cadets' skills especially speaking skill in martime English.

Extract 51: Cadet's response based on lecturer statement

LINE 273
Taruna rata rata memiliki positive response selama ini pada saat pembelajaran maritime English. Then antusias sekali itu taruna, mungkin karena zaman serba teknologi, pola interaksi mereka bagus dan dosen juga bisa berkolaborasi……(Script record from MUT, Data interview).

The cadets mostly have a positive response so far, especially when learning maritime English. Then the cadets were very enthusiastic, maybe because of the technological era, their interaction patterns were good and lecturers could collaborate in teaching…..(Script record from MUT, Data interview).

The participant said that cadets were mostly enjoyable and antusiastics in learning maritime English. The material is designed based on cadets needs. Moreover, Teaching material is designed according to the technological era, their interaction patterns were good and lecturers could adapt their teaching methods and collaborate with peer teaching in teaching maritime English.

From the transcribed data, it is found that the primary data source of this research is one of the lecturers at PIP Makassar who had given his class through synchronous learning with the initial ADE. This observation also involved the cadets of PIP Makassar who had been taught maritime English. The way the cadets' participate in synchronous class taught by the lecturer can be seen in the following analysis.

In the following extract, the lecturer was entering the online class through zoom application and the cadets were paying attention to the given material through Marlins maritime English website. The lecturer ADE started to explain the material about Marlins Maritime English and the cadets participated in the learning process. All of the recording activities, both the researcher and the primary data source were using full English.

The extract shows the field notes of classroom observation. All of the activities had been noted by the researcher. It was found that the lecturer had conducted his classroom through synchronous learning. It was also found that there had been interaction between the lecturer and all cadets in classroom. The interaction can be seen in cadets' participation in answering all the questions. It is barely indicated that the cadets are actively participating in the synchronous learning.

DISCUSSION

The Cadets' Engagement on Learning Maritime English subject in Synchronous learning model of Marlins for Maritime English Subject in an Indonesian Maritime Higher Education

The third question of this research is "How are the cadets' engagement in learning Maritime English subject under Synchronous learning modelof Marlins for Maritime English Subject in an Indonesian Maritime Higher Education?" The researcher has formulated field notes for classroom observations to answer this research question. The researcher observed the classroom interactions while cadets' participated in a synchronous class taught by an EFL lecturer. In that situation, all cadets actively pay attention to the given materials through Marlins maritime English website. The EFL lecturer starts to explain the material about Marlins Maritime English and all cadets participate in the learning process.

Based the results of interview found that the cadets and lecturers gave statements related to their engagement or involvement of cadets in the learning process in the Maritime English class using Marlins with the synchronous learning model. In terms of cadets' involvement in learning, it was found that cadets were involved in an emotional form where cadets liked and were happy with the Marlins media used. It was also found that the behavior of cadets was active in the learning process, submit tasks on time, like to ask questions, often gave presentations and could collaborate well and interactively. Then, the three lecturers got cadets with cognitive involvement where the cadets quickly understood and the quality of questions from the cadets was quite good.

There are several ways the cadets engaged in synchronous class taught by the lecturer. Based on the result of study stated that the student engagement in learning process are if they actively pay attention to the teacher's explanation, they conduct direct dialogue with the teacher in the discussion, and students' sentiments towards their educational experience, including class material, teachers, and the institution are referred to as emotional engagement (Giesbers et al., 2014). The situation in this research indicates that in which the lecturer asks to students or cadets to keep the camera on to make sure that all of them are still in there and attended the class (Limbong, 2021a). The researcher also finds that there has been a discussion between an EFL lecturer with the cadets about the benefits of online Marlins platform. The EFL lecturer believes that online Marlins platform can engage the cadets to the lesson. It is also proved by the cadets' interaction and participation in answering every question.

There are several ways the cadets play the role in question and answer section in synchronous class taught by EFL lecturer ADE to engage the cadets in the lesson. A way that the lecturer apply that giving an open-question discussion with the cadets about the materials that has been given. The cadets are asked to give some questions and the lecturer answers the questions directly in the synchronous learning. From both interaction the cadets are engaged to the lesson through giving the questions, and actively participate in the synchronous learning process. Those are the Online Marlins platform promotes student interaction via discussions and collaborative assignments; the students actively participate in learning activities and engage to one another (Limbong et al., 2022), and the lecturer encourages all students to participate and asks open-ended questions to prompt engagement and draw out shyer students (Aprizawati et al., 2022).

Also this study said that online learning during a pandemic is not only limited to using website-based e-learning or providing online assignments to students, but also the varied use of digital media that influences student engagement and interest in online learning process. This is supported by the other result of study found that Health professional educators can use these tips to enhance student engagement in online synchronous classes and Increased student engagement in online sessions, means better learning. The authors as being satisfactory for increasing student interest in synchronous sessions and hence providing an optimal online learning experience (Suranto, 2009)

These are all just media so that students get as much information/knowledge as possible, but all of them are more important, namely the motivation of the students and the feeling of need from the students which is called student engagement or Student involvement occurs when "students make a psychological investment in learning They try hard to learn what the school has to offer. In this session, the researcher did interview to cadets with the aim to provide any confirmation for the results of study especially the lecturers' engagement on Synchronous Learning Model of Marlins for Seafarers. Regarding the lecturers' engagement in learning by implementing the online Marlins in a synchronous online class.

Referring to the results of interviews, questionnaires and observations of researcher, the researcher found that lecturers had a high engagement of Maritime English learning which was carried out synchronously and using marlins. The researcher categorized into highly engage because this category refers to teachers' involvement in terms of behaviour, emotion and cognitive. Behavioural involvement focuses on student participation such as trying, being serious, concentrating, paying attention, obeying rules, contributing to discussions, asking questions, and paying attention. Emotional involvement focuses on students' emotional reactions which include interest and really enjoy.

The Cadets' Responses on Synchronous Learning Model in Teaching Maritime English

This sub chapter widely interpret the analysis result of cadets' responses on Synchronous learning model in teaching Maritime English Subject. Through this study, the researcher wants to know the response of students regarding the use of the Synchronous learning model in teaching Maritime English. Therefore, the researcher devised a set of questionnaire questions and guidelines for PIP Makassar cadets' address this research questions. From the questionnaire, the researcher encountered the responses from the cadets.

From the result of data analysis, the researcher finds the degree that students feel it is important to know Maritime English performance. In teaching maritime English is useful for a person who wants to become cadets and after graduate. Maritime English is also needed or used for cadets and after graduation. Through this research, it is also found that the use of *teaching maritime English is useful* which is easy for cadets to learn. All cadets are getting easier to understand maritime English through Synchronous learning model in teaching Maritime English Subject. As a result, all cadets enjoy the study with this Synchronous learning model. Based on that condition, it is also found that *learning maritime English leads students to have high motivation in learning* (Conrad et al., 2022).

From the data analysis, the researcher also finds factors that encourage students in practicing Maritime English by using Synchronous learning model. *This learning media encourages cadets to practice Maritime English. In addition, using* Synchronous learning model *enable them to understand maritime English and finally they can reach their dream of sailing around the world.*

Based on the results of interview found that the cadets gave statements regarding their responses after participating in the learning process in the synchronous learning class in Maritime English learning. In terms of cadet responses, a positive response was obtained in the sense that there was a change in cadet behavior, namely: cadets were more enthusiastic, diligent, able to learn independently, motivated to learn, happy so that they could interact with each other and collaborate well with each other.

This is in line with the previous research findings show that features of online learning develop students' knowledge through the internet interface (Lakhal et al., 2021). The more courses they take, the more comfortable and confident they are. Positive perceptions of participation in discussions and quality of discussions increased with additional synchronous virtual course enrolment (Flynn-Wilson & Reynolds, 2020). The students were significantly more willing to participate in online discussions and had less participation apprehension than in a face-to-face environment (Nurhilaliah et al., 2023). However, the aspect of culture may have been a factor in these students' responses as well as the age range of most undergraduate students.

Referring to the results of interviews, questionnaires and observations of researcher, the researcher concluded that lecturers and cadets had a positive response of Maritime English learning which was carried out synchronously and using marlins. The researcher categorized into respond positively because this category refers to the level of student response to learning. Response here relates to emotions, attitudes and someone's assessment of something around them. This response will appear automatically if there is a change they like.

Based on the interview results, the respondents gave statements related to the response after participating in the learning process in the synchronous learning class. In terms of cadet responses, the three lecturers received positive responses in the sense that there was a change in cadet behavior, namely: enthusiastic, motivated to learn, able to interact with each other and collaborate well with each other.

Based on the results of the questionnaire, the respondents gave related statements *with online Marlins, English maritime skills are better than before. Encourages them to practice Maritime English using online Marlins was to enable to understand maritime English and fulfil my dream of sailing around the world. It really motivates them to know more about English Maritime. Moreover, many cadets who pass the marlins test and are accepted to carry out sea practices in foreign companies with overseas shipping lines.*

CONCLUSION

The cadets' engagement in learning maritime English subject under the synchronous based model of marlins for maritime English is highly engaged which is refers to 1) behavioral engagement is proved through cadets are actively participating in synchronous learning model of Marlins. 2) Emotional engagement which focuses on students' emotional reactions including interest enjoy without any boredom, sadness, afraid and anxiety. 3) cognitive engagement that focuses on students' investment in learning and the self-regulation strategies used. Cognitively engaged students have a desire to be involved in learning and have a desire to master knowledge. The interaction can be seen in cadets' participation in answering all the questions. It is barely indicated that the cadets are actively participating in the synchronous learning. Moreover, the cadets have a positive response towards the use of Synchronous learning model of Marlins. The respondents received positive responses that there is a change in cadet behavior, namely: enthusiastic, motivated to learn, able to interact with each other and collaborate well with each other. *Cadet's English maritime skills are better than before. Encourages them to practice Maritime English using online Marlins was to enable to understand maritime.* Online Marlins surely gave a positive respond for them as lecturers. They generally stated that the Online Marlins produced a positive change because providing online Marlin's course to the students/cadets made them easy to explain the lessons based on the materials what they want to achieve in lesson plan. Online Marlins created a more fun atmosphere during classroom discussion because it offers an audio-visual practice with a useful vocabulary, structure, and technical knowledge.

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USERS' EVALUATION ON THE EFFECTIVENESS OF THE INNOVATIVE LEARNING RESOURCE ONLINE PLATFORM IN A DEVELOPING COUNTRY

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Abstract: This study aimed to determine the effectiveness of John B. Lacson Foundation Maritime University E-Learning Management System (JeLMS) in terms of course content/materials, technological capability, students' quality of outputs, and quality of modules of faculty. The respondents of this study were Grade 11, Grade 12, BS Crim 1 BS Crim 2 students, faculty of Senior High School (SHS) and BS Criminology (Crim) departments. Respondents were selected through stratified and cluster random sampling. A questionnaire was sent to the respondents through google forms. Results showed that the effectiveness of JeLMS in terms of course content/materials was moderately effective from the perspective of faculty, while it was highly effective from the students' point of view. The technological capability of JeLMS was described as very good, and the quality of outputs was labeled as very satisfactory. Moreover, a significant difference was observed between the effectiveness of JeLMS from the perspective of faculty and students of SHS department in terms of course content/materials. However, no significant difference was found in the effectiveness of JeLMS from the students' perspective. The feedback from faculty and students was classified according to themes. For faculty, the specific problems and difficulties encountered in using the JeLMS were errors and limitations of JeLMS and downtime of server and connection issues. The students identified technological knowledge and skills as their specific problem. They experience challenges in creating or editing visual image, having basic technological knowledge in computer, difficulties in using Microsoft excel, Microsoft word, powerpoint, and other applications, and confidence in utilizing the platform. The students' recommended to improve the modules uploaded in JeLMS specifically to have more emphasis on topics for quality education, stable connection for ease of access, improved appearance and lay out of JeLMS, satisfaction with the way JeLMS is presented and its content, and sustainability during synchronized utilization. This study concludes that the specific problems and difficulties of faculty from senior high school and BS Crim departments vary in using JeLMS, and the students' technological knowledge and skills also vary.

Keywords: effectiveness; JeLMS; technological capability; JBLFMU (Arevalo), Inc.

Introduction

The study aims to evaluate the effectiveness of the John B. Lacson Foundation Maritime University e-learning Management System (JeLMS) in Senior High School and Bachelor of Science in Criminology departments. This study was conceptualized to evaluate the quality of learning the students achieved and how online learning like JeLMS can be managed to be more effective as provided and implemented by the institution. The study uses the Connectivism Learning Theory to assess the effectiveness of the system in terms of course content/materials, technological capability, and quality of outputs and modules. The research will also investigate the differences in effectiveness between faculty and students in terms of course content/materials, technological capability, and quality of outputs. The study will also gather feedback from faculty and students on the use of JeLMS and its potential improvements. The study is anchored in the Connectivism Learning Theory, which recognizes the importance of technology in the learning process.

Methods

This research used a survey to gather feedback from faculty and SHS and Criminology students on the effectiveness of JeLMS. The survey was distributed on paper and was conducted through complete enumeration and stratified proportional and cluster random sampling. Both faculty and students were selected to determine the level of effectiveness of JeLMS use. Table 1 shows the distribution of respondents.

Table 1. Distribution of Respondents

Category	N	n
A. Entire Group	684	252
B. Faculty		
C. Students		
Grade 11	353	130
Grade 12	294	108
BS Crim 1	11	4
BS Crim 2	26	10

Instrument

The Research and Development Council (2022) of John B. Lacson Foundation Maritime University (JBLFMU) used a questionnaire to gather feedback on the use of JeLMS. The instrument was validated by experts and tested using Cronbach alpha. It consists of three parts: course content/materials, technological capability, and the quality of outputs for faculty and modules for students. The results provide valuable insights into the effectiveness of JeLMS in education. Table 2 shows the reliability coefficients of the instrument.

Table 2. Reliability Coefficients of the Instrument

Parts of the Instrument	Faculty	Students
Entire Questionnaire	0.99	0.98
Course Content/ Materials	0.98	0.96
Technological Capability	0.98	0.98
Quality of Outputs/Modules	0.96	0.95

This researcher-made questionnaire was validated by three experts in research and grammar. It underwent reliability-testing through Cronbach alpha set at .05 level of probability.

Data Collection and Analysis

The researcher used an online questionnaire to gather data on the effectiveness of the use of JeLMS in SHS and BS Crim departments. The questionnaire was distributed via email, Facebook messenger, and group chats. Data was collected and analyzed using statistical tools such as mean, standard deviation, t-test of independent samples, and One-way ANOVA at a .05 level of significance. The study aimed to determine the effectiveness of using JeLMS from the perspectives of faculty and students of SHS and BS Crim departments. Table 3 shows the mean scale, descriptive rating, and indicators to be used to interpret the level of effectiveness on the use of JeLMS in terms of course content/materials.

Table 3. *Mean Scale, Descriptive Rating, and Indicators to Interpret the Level of Effectiveness on the Use of JeLMS in terms of Course Content/Materials*

Mean Scale	Descriptive Rating	Indicators
4.51-5.0	Very Highly Effective	Fully functional with rare minor problems/issues
3.51-4.50	Highly Effective	Fully functional with more frequent minor problems/issues
2.51-3.50	Moderately Effective	Fully functional with occasional major and more frequent minor problems/issues
1.51-2.50	Somewhat Effective	Functional but with major and minor problems/issues most of the time
1.0-1.50	Not Effective	All functions are problematic/ensue major and minor problems each time it is used

Table 4 shows the mean scale, descriptive rating, and indicators to be used to interpret the level of effectiveness of the use of JeLMS in terms of technological capability from the perspectives of faculty and students of SHS and BS Crim departments.

Table 4. Mean Scale, Descriptive Rating, and Indicators to Interpret the Level of Effectiveness of the Use of JeLMS in terms of Technological Capability

Mean Scale	Descriptive Rating	Indicators
4.51-5.0	Excellent	Fully capable; can perform the task independently
3.51-4.50	Very Good	Capable but occasionally needs some technical assistance
2.51-3.50	Good	Capable but needs to be guided/ supervised most of the time
1.51-2.50	Poor	Somewhat capable and needs to be guided/ supervised all the time
1.0-1.50	Very Poor	Cannot perform the task and needs someone to help doing it

Table 5 shows the mean scale, descriptive rating, and indicators to be used to interpret the level of effectiveness of the use of JeLMS in terms of quality of outputs and modules from the perspectives of faculty and students of SHS and BS Crim departments.

Table 5. Mean Scale, Descriptive Rating, and Indicators to Interpret the Level of Effectiveness of the Use of JeLMS in terms of Quality of Outputs and Modules

Mean Scale	Descriptive Rating	Indicators
4.51-5.0	Excellent	Outputs - Fully met the standard described in the item Modules - Carefully prepared and written; met the standards described in the item
3.51-4.50	Very Satisfactory	Outputs - Partially met the standard described in the item Modules - Well-prepared and written and met most of the standards described in the item but need to be further reviewed and edited
2.51-3.50	Fairly Satisfactory	Outputs - Met half of the standards described in the item Modules - Met at least half of the standards described in the item but needs thorough review and editing
1.51-2.50	Somewhat Satisfactory	Outputs - Some portions do not meet the standard described in the item Modules - Met some of the standards described in the item but need improvement in most aspects
1.0-1.50	Needs Improvement	Outputs - Students' effort is not evident; work is entirely not by the students Modules - Poorly prepared and written and need to be overhauled and improved in all aspects

The study utilized t-test for independents samples and One-way ANOVA to determine the effectiveness of JeLMS among faculty and students of SHS and BS Crim departments. The t-test for independents samples aimed to identify differences in course content/materials, technological capability, and quality of outputs among two groups, while the One-way ANOVA aimed to determine differences in the perspectives of students. The significance level was set at .05. Themes were generated to categorize similar feedback of faculty and students of SHS and BS Crim departments.

Results and Discussion

The study found that faculty have a high level of technological capability, which is considered very good, but occasionally requires technical assistance. The effectiveness of JeLMS in course content and materials is moderately effective, with a grand mean of 3.10, indicating full functionality with occasional minor issues. Students have a high level of technological capability, with a grand mean of 4.12, highly effective, and a grand mean of 4.27, indicating they are capable but occasionally need technical assistance. The quality of modules is very satisfactory, with a grand mean of 4.17, indicating they are well-prepared but need further review and editing.

Table 6. Level of Effectiveness of the use of JeLMS from the Perspectives of Faculty and Students of Senior High School and Criminology Departments in terms of Course Content/Materials, Technological Capability, and Quality of Outputs and Modules

Category	Course Content/Materials			Technological Capability			Quality of Outputs and Modules		
	Mean	Descriptive Rating	SD	Mean	Descriptive Rating	SD	Mean	Descriptive Rating	SD
A. Faculty									
SHS	3.55	Highly Effective	0.92	4.38	Very Good	0.57	3.69	Very Satisfactory	0.62
BS Crim	4.44	Highly Effective	0.55	4.30	Very Good	0.55	4.10	Very Satisfactory	0.55
Over-all	3.10	Moderately Effective	0.74	4.34	Very Good	0.56	3.90	Very Satisfactory	0.59
B. Students									
Grade 11	3.93	Highly Effective	0.86	4.13	Very Good	0.85	4.04	Very Satisfactory	0.89
Grade 12	4.12	Highly Effective	0.81	4.34	Very Good	0.73	4.22	Very Satisfactory	0.78
BS Crim 1	3.93	Highly Effective	1.15	4.21	Very Good	0.80	3.97	Very Satisfactory	0.97
BS Crim 2	4.48	Highly Effective	0.69	4.40	Very Good	1.01	4.43	Very Satisfactory	1.13
Over-all	4.12	Highly Effective	0.88	4.27	Very Good	0.85	4.17	Very Satisfactory	0.94

The study found significant differences in the effectiveness of JeLMS among faculty and students in Senior High School and Criminology departments, with no significant difference observed in their course content/materials.

Table 7. t-test of Independent Samples Results in the Effectiveness of the Use of JeLMS from the Perspectives of Faculty and Students of SHS and Criminology Departments in terms of Course Content/Materials

Sources of Variation	t	df	Sig.
A. SHS (Faculty & Students)	-2.803*	278	.005
B. BS Crim (Faculty & Students)	.654	40	.517

Note. Asterisk (*) means significant at .05 level of probability.

The study reveals a significant difference in the effectiveness of JeLMS among faculty and students in SHS and BS Crim departments, as shown in Table 8.4.

Table 8. t-test of Independent Samples Results for the Effectiveness of the Use of JeLMS from the Perspectives of Faculty and Students in terms of Course Content/Materials

Sources of Variation	t	df	Sig.
Course Content/Materials (Faculty & Students)	-1.967*	320	.050

Note. Asterisk (*) means significant at .05 level of probability.

Table 9 reveals that faculty of SHS and BS Crim departments' effectiveness of JeLMS is similar in terms of course content/materials, technological capability, and output quality.

Table 9. t-test of Independent Samples Results in the Effectiveness of the Use of JeLMS from the Perspectives of Faculty of SHS and Criminology Departments in terms of Course Content/Materials, Technological Capability, and Quality of Outputs

Sources of Variation	t	df	Sig.
Course Content/Materials	-2.921*	21	.008
Technological Capability	.345	21	.733
Quality of Outputs	-1.777	21	.090

Note: Asterisk (*) means significant at .05 level of probability.

Table 10 reveals no significant differences in the effectiveness of JeLMS for students in SHS and BS Crim departments in terms of course content, technological capability, and output quality.

Table 10. t-test of Independent Samples Results in the Effectiveness of the Use of JeLMS from the Perspectives of Students in SHS and Criminology Departments in terms of Course Content/Materials, Technological Capability, and Quality of Modules

Sources of Variation	t	df	Sig.
Course Content/Materials	-1.472	297	.142
Technological Capability	-.620	297	.536
Quality of Modules	-.185	297	.854

The study reveals significant differences in the effectiveness of JeLMS among students in terms of course content and technological capability, but no significant difference in module quality.

Table 11. One-way ANOVA Results in the Effectiveness of the Use of JeLMS from the Perspectives of All Students in terms of Course Content/Materials, Technological Capability, and Quality of Modules

Sources of Variation		SS	df	MS	F	Sig.
Course Content/Materials	Between Groups	6.19	3	2.06	4.20*	.006
	Within Groups	145.14	295	0.49		
	Total	151.32	298			
Technological Capability	Between Groups	3.48	3	1.16		
	Within Groups	123.98	295	0.42	2.76*	.043
	Total	127.46	298			
Quality of Modules	Between Groups	3.39	3	1.13		
	Within Groups	141.79	295	0.48	2.35	.073
	Total	145.18	298			

Note. Asterisk (*) means significant at .05 level of probability.

Table 12 reveals that BS Crim 2 and Grade 12 students have a higher perception of the effectiveness of JeLMS in course content/materials compared to BS Crim 1 and Grade 11.

Table 12. Scheffe Test for the Comparison of Means in terms of Course Content/Modules

Grade Level	Mean
Grade 11	3.94[a]
Grade 12	4.12[ab]
BS Crim 1	3.92[a]
BS Crim 2	4.48[b]

Note. Same superscript means not significant while significant if otherwise.

Table 13 reveals that BS Crim 2 and Grade 12 students have a higher perspective on the effectiveness of using JeLMS in terms of technological capability.

Table 13. LSD Test for the Comparison of Means in terms of Technological Capability

Grade Level	Mean
Grade 11	3.94[a]
Grade 12	4.12[b]
BS Crim 1	3.92[ab]
BS Crim 2	4.48[ab]

Note. Same superscript means not significant while significant if otherwise.

Specific problems and difficulties encountered by the faculty in using JeLMS

Faculty are experiencing errors and limitations in using JeLMS, including difficulty accommodating a wide range of users, sharing course shells, and uploading supplementary tools. Server and connection issues are also causing frequent downtime and poor internet connection. Students face challenges in creating visual images, having basic technological knowledge in computers, and using Microsoft Excel, Word, and PowerPoint applications. Despite these challenges, students are confident in using JeLMS and have no specific recommendations for improvement.

The study focuses on improving the modules uploaded in JeLMS, focusing on quality education, stable internet connection for ease of access, and improving the appearance and layout of the platform. The students suggest a more emphasis on quality education topics, ensuring more comprehensible learning materials, and updating modules regularly. They also emphasize the importance of stable internet connections for continuous access and the need for better communication and user interface. The students also suggest improvements in the presentation and content of JeLMS, with eleven students satisfied with the features. They also suggest ensuring JeLMS can sustain satisfactory performance during synchronized utilization, accommodating multiple users and ensuring fast loading times.

Conclusions and Recommendations

The study found that both students and faculty from the SHS and BS Crim departments perceive JeLMS as effective for delivering lessons and assessments. Respondents actively used JeLMS and were satisfied with its features for remote learning. The researcher recommends a follow-up study involving other units of JBLFMU to validate the findings and suggests enhancing JeLMS features to ensure reliable results at the end of the semester.

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EVALUATION OF ENGLISH MARITIME DOCUMENT TRANSLATION ACCURACY INTO JAPANESE BY CHATGPT, GOOGLE TRANSLATE AND DEEPL

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Abstract: The purpose of the present paper is to evaluate the translation accuracy of English Maritime documents into Japanese by ChatGPT 4.0, Google Translate, and DeepL. A total of 10 short passages (2612 words in total) were chosen from various sources such as SOLAS, COLREGs, sailing directions, accidents reports, articles available on the Internet, etc., and they were translated into Japanese by the above applications. The output Japanese translations contained lexical errors resulting from the mistranslation of Maritime words and phrases (A-1), those from the mistranslation of non-Maritime English words and phrases (A-2), and those from ignoring original English words and phrases (A-3). Also identified were grammatical errors (B) that stemmed from misinterpreting the grammatical structure of the original sentences. In some limited cases, there were ungrammatical or unnatural Japanese sentences (C). Type A, that is, lexical level errors were by far the most common and this was the case for each translation application evaluated. Averaging across the 3 applications, Type A errors accounted for 87.3% of the total number of errors (292). Type B and C errors accounted for only about 9 and 3 percent, respectively. Looking into the translation error rate, the 3 applications were almost the same and there were about 3.7, 3.5, and 3.9 translation errors for every 100 words translated by ChatGPT, Google Translate, and DeepL, respectively.

Keywords: AI translation; Maritime English; Translation into Japanese

1. Introduction

When free Internet translation applications became first available, many English teachers, like the first author of the present paper, must have tested them and felt somewhat relieved every time some computer program made somewhat “stupid” mistakes. For example, when prompted to translate into Japanese the sentence “I was staring through the window at the girl on the stage,” many free applications failed to assign the proper grammatical function to the three prepositional phrases, and came up with totally meaningless translations such as “私はステージで女の子でウインドウでじっと見つめていた” where all of the prepositional phrases were interpreted as modifying “was staring.” However, the AI translation technologies appear to have reached a totally new stage roughly by the end of 2023. All of the 3 translation applications to be evaluated in the present paper, namely, ChatGPT, Google Translate, and DeepL, now give perfect translations to the above English sentence.

The goal of the present paper is to evaluate how accurate these 3 applications are when translating English Maritime documents into Japanese and to determine what types of translation errors occur. Many of us may have heard phrases such as “neural machine translation (NMT)” and “large language mode (LLM) by now, but the technological side of AI translation is not the present authors’ expertise and goes outside the scope of this paper, although some errors, for example, ignoring original English words and phrases, may be attributable to the NMT method [7].

2. Method

A total of 10 short passages (2612 words in total) were chosen from various sources such as COLREGs (Rules 15-17, crossing situation) [1], SOLAS (Ship’s Manning, Master’s Discretion) [2], an engineering article available on the Internet (Scavenging) [3], accidents report and a safety bulletin by MAIB (Safety Warning after an Explosion, Dragging Anchor, Collision) [4],[5],[6], sailing directions (Kurushima Strait) [8] and a textbook (Lubrication) [9]. COLREGs and SOLAS were chosen since there are official Japanese translations by the Ministry of Land, Infrastructure and Transport and Tourism. Other documents were chosen in order to represent a wide range of Maritime topics covering both deck and engine matters.

Each passage was translated into Japanese by the 3 applications. When prompting translation for ChatGPT 4.0, the following phrase was used and the translation was done only once: "Translate the following into Japanese." The output Japanese sentences were carefully evaluated for translation errors.

3. Results

The errors found in Japanese translations can be classified into 3 main categories, that is, lexical errors (A), grammatical errors (B) and ungrammatical/unnatural Japanese sentences (C). Lexical errors can be further divided into 3 types: errors in translating Maritime English words/phrases into Japanese (A-1); errors in translating non-Maritime English words/phrases into Japanese (A-2), and ignoring original English words and phrases (A-3). The following Table shows the number of errors for each error type for the 3 applications.

Table 1. Number of Errors

Type	ChatGPT	GoogleT	DeepL	Total	%
A-1	60	55	65	180	61.6
A-2	12	18	17	47	16.1
A-3	12	4	12	28	9.6
B	8	12	7	27	9.2
C	5	3	2	10	3.4
Sum	97	92	103	292	100.0

As shown in the table, Type A errors were by far the most common errors, accounting for 87.3 (61.6 + 16.1 + 9.6) percent of the total numbers of errors and this tendency was the same across the 3 translation applications. Of the 3 subcategories of Type A errors, Type A-1 errors were the largest in number, followed by Type A-2 and Type A-3 errors. There seems to be little difference among the 3 applications in terms of the total number of errors: 97, 92, and 103 for ChatGPT, Google Translate, and DeepL, respectively. Since there were 2612 words in total, these applications had the error rates of 3.7, 3.5, and 3.9 per 100 words, respectively. In the following sections, each of the error types will be explained with actual translation error examples.

3.1. Type A-1 Errors (Mistranslation of Maritime English words and phrases)

This was the most common error type. Presented below are some of the words/phrases that were mistranslated by all of the three applications, their correct Japanese translation, their incorrect Japanese translations by the three applications and what they literally mean in English.

Example 1

vessel not under commands 運転不自由船

ChatGPT 操縦不能船 vessel that cannot maneuver

Google Translate 指揮下にない船舶 literal translation, vessel that is not under command

DeepL 指揮下にない船舶 literal translation, vessel that is not under command

Example 2

stand-on vessel 保持船

ChatGPT 進路を維持する船 vessel that keeps her course

Google Translate 待機船 vessel that is supposed to wait

DeepL スタンドオン船舶 sound (katakana) translation (スタンドオン) + vessel

In the Japanese law that corresponds to COLREGs, the term "vessel not under command" is defined as 運転不自由船 and "stand-on vessel" as 保持船, and these Japanese words must be used. Not a single application gave the correct Japanese translations.

Example 3

watchkeeper 当直者

All 3 applications used 監視者, which means “someone who watches/monitors something” in general, but this word is not used for a “watchkeeper” on the bridge.

Maritime words/phrases that were mistranslated included the following:

all *plans* and lists required to be posted, class condition, classification society, close-quarters situation,

cold filter plugging point, crossing situation, give-way vessel, incoming fresh charge, local vessels, pilot, sailing directions, superintendent, the States whose flag the ship is entitled to fly

The above examples involved nouns or noun phrases only, but maritime phrases involving verbs were also mistranslated as in the following example.

Example 4

Celtic Spirit dragged its anchor.

セルティック・スピリットは走錨した。

ChatGPT and DeepL translated the phrase “to drag anchor” literally into Japanese as 錨を引きずった, which means “to pull the anchor along the ground.”

3.2. Type A-2 Errors (Mistranslation of non-Maritime English words and phrases)

This error type often involved non-Maritime English words that correspond to multiple Japanese words depending on the context.

Example 5

communications on board between the pilot and bridge watchkeeping personnel

パイロットと船橋の当直要員との間の、船上でのやりとり（会話）

All 3 applications translated the word “communication” as 通信, which means “radio communication,” but of course, the pilot and bridge watchkeepers do not communicate by radio, and so “communication” should be translated as either やりとり, or 会話, both of which mean “conversation” in Japanese.

Example 6

gas exchange control elements ガス交換制御部品

All 3 applications translated the word “elements” as 要素, but in this context, the word “elements” means “parts” and should be translated as 部品.

3.3. Type A-3 Errors (Ignoring English words/phrases in the original, or omission)

There were cases where original English words/phrases were ignored or omitted in translation. See the following examples.

Example 7

The filter system can be complex. In a small engine it is only a filter, to be exchanged every so many hours. フィルタシステムは複雑になりうる。小型のエンジンでは、それは、一定の運転時間ごとに交換されるフィルタ１つだけである。

Here the pronoun “it” refers to the filter system and this must be explicitly translated into Japanese, but all 3 applications failed to do so.

The pronoun “it” should not be translated at all in such sentences as below:

It is easy for me to solve the problem.

I found it difficult to solve the problem.

It was his manners that bothered me.

This fact may have something to do with the present omission. However, the pronoun “it” definitely refers to “the filter system” in the previous sentence, and ignoring this pronoun in the Japanese translation fails to capture the meaning of the original English sentence. The output of Google Translate, for example, was as follows: フィルターシステムは複雑になることがあります。小型エンジンでは、数時間ごとに交換するフィルターのみです。As mentioned above, the other 2 applications also did not translate the pronoun explicitly.

Example 8

with a steady bearing and decreasing range to Happy Falcon

ハッピーファルコンに対するベアリングは一定のまま、距離が縮まり続けた。

Here ChatGPT and DeepL ignored the word "bearing" and translated only the "decreasing range" part. Google Translate did translate the word "bearing" but it failed to interpret the conjunction "and" correctly as shown below.

Other omission cases involved the following words/phrases (ignored words are in italics): Happy Falcon had overtaken Scot Explorer *overnight* (ChatGPT); *fine* on Scot Explorer's port bow (ChatGPT, DeepL); by her manoeuvre *alone* (ChatGPT); environmental conditions *experienced* (all 3 applications), with the *out-going* (N) stream (ChatGPT); *course should be altered* if it is safe and practical to do so (DeepL), etc.

These ignored words are mostly either adverbs or adjectives, but there were cases where nouns (the word "bearing" in Example 2), and even a whole sentence, were ignored as in the last example above. Predicting what words/phrases are ignored was found to be difficult.

3.4. Type B Errors (grammatical errors)

This error type involves misinterpretation of the grammatical structure of original English sentences. One might think that an apparently non-problematic conjunction "and" pauses no challenge, but indeed the 3 applications tested here sometimes misinterpreted what words/phrases this conjunction juxtaposes.

Example 9

Scot Explorer maintained its course and speed, with a steady bearing <u>and</u> decreasing range to Happy Falcon.

スコットエクスプローラは、針路と速力を一定に保ち、ハッピーファルコンに対するベアリングは一定のまま、距離が縮まり続けた。

In this sentence, the conjunction "and" juxtaposes "a steady bearing" and "decreasing range", and the prepositional phrases "to Happy Falcon" modifies both "steady bearing" and "decreasing range" as shown below.

with a { steady bearing
and
decreasing range } to Happy Falcon

As mentioned in Example 8, both ChatGPT and DeepL ignored the word "bearing" and did not translate this word into Japanese. Google Translate, on the other hand, did translate it as 方位は安定し、ハッピー ファルコンまでの距離は減少しました. However, it failed to use the correct Japanese word for "bearing" (ベアリング, rather than 方位). It also failed to capture the grammatical structure as well, and the original English was interpreted as follows:

with a and { steady bearing
decreasing range to Happy Falcon

Example 10

Celtic Spirit was unable to manoeuvre in sufficient time to remedy the situation because its engine was not on immediate readiness, <u>and</u> class conditions relating to engine readiness while operating with only one anchor were not followed or understood.

セルティック・スピリットは、エンジンが直ちに使える状態になく、錨が一つしかない状態で運航する場合の、エンジンの準備に関する船級条件が理解されていなかったために、十分な時間の余裕をもって操船し、状況を改善することができなかった。

Here the last sentence following the underlined "and" should be interpreted as part of the adverbial clause that starts with the conjunction "because," but Google Translate and DeepL failed to capture this and interpreted the last sentence as an independent one outside the scope of the conjunction "because" as shown below:

Google Translate:セルティック スピリット号は、エンジンがすぐに準備できる状態ではなかったため、状況を改善するのに十分な時間内に操縦することができませんでした。また、アンカー 1 個のみで運航中のエンジン準備に関するクラス条件が遵守または理解されていませんでした。

DeepL: セルティック・スピリットは、エンジンが即座に準備態勢に入らなかったため、状況を改善するのに十分な時間内に操船することができず、また、1つのアンカーだけで操船する際のエンジン準備態勢に関するクラス条件が守られていなかったか、理解されていなかった。

Example 11

In big ships the oil is pumped through a very complicated micro-filter which has a built-in self-cleaning system via back-flushing.

大型船において、潤滑油は、逆洗による自己洗浄システムが組み込まれた、とても複雑なマイクロフィルタを通して、ポンプで送られる。

ChatGPT and DeepL translated the above sentence as if "the oil" were the antecedent of the relative pronoun phrase, which is not correct. The following is the mistranslation by ChatGPT: 大型船舶では、オイルは非常に複雑なマイクロフィルターを通過し、バックフラッシングによる自己洗浄システムが内蔵されています。

Example 12

Navigation through Kurushima Kaikyo Traffic Routes is determined by the flow of the tidal streams and may be summarised as keeping to the starboard side of the traffic route with the out-going (N) stream and keeping to the port side of the traffic route with the in-going (S) stream.

来島海峡航路の航行は潮流の流れによって決められ、上げ潮（北流）の場合には航路の右舷側を航行し、引き潮（南流）の場合には航路の左舷側を航行すると要約される。

DeepL interpreted the prepositional phrases "with the out-going (N) stream" and "with the in-going (S) stream" as modifying "the traffic route" and came up with the following incorrect translation:

来島海峡の航路は、潮流の流れによって決定され、要約すると、潮流（N）が出ている航路の右舷側を航行し、潮流（S）が入っている航路の左舷側を航行することである。

3.5. Type C Errors (ungrammatical/unnatural Japanese)

The output from the translation applications sometimes contained ungrammatical or unnatural Japanese sentences, although such cases were rather limited in number. There were only 10 such cases in total, as shown in Table 1 above, and only two examples will be presented here. Suffice it to say that the translation applications tested does a decent job as far as producing grammatical Japanese sentences.

Example 13

When, from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the give-way vessel alone,

針路と速力を維持することを求められている船舶が、あまりに接近しすぎていて避航船の行動だけでは衝突が避けられないと、いかなる理由であれ判断した場合は、

Google Translate translated the above phrase as follows:いかなる理由により、進路と速度を維持することを要求されている船舶が、避航船の行動だけでは衝突を回避できないほど接近している場合

Here, "いかなる理由により" just sounds awkward. It should be "いかなる理由であっても" or "いかなる理由であれ."

Example 14

a crew member, who had been working on deck, ran to the bridge

デッキで作業をしていた乗組員が、ブリッジに走って行った。

Google Translate and DeepL translated "ran to the bridge" as 駆け寄った, but this Japanese verb can be used only when someone ran to somebody, not to some objects.

4. Discussion

4.1. Type A Errors (lexical errors)

By far the largest number of errors involved translating Maritime English words and phrases into appropriate Japanese Maritime ones (Type A-1 errors). In many cases, such errors occurred when original English contained composite nouns or noun-phrases with some modifiers such as *classification society, give-way vessel, stand-on vessel, vessel not under command*, where the entire phrase has a specific meaning in the maritime context. Thus, from the Japanese counterparts of "vessel" (船舶) and "not under command," (指揮下にない) one cannot reach the proper Japanese phrase for "vessel not under command" (運転不自由船) as shown in 3.1.

English words that correspond to multiple Japanese words depending on the context were also sometimes mistranslated, and when original English words have a Maritime meaning, such errors were classified as A-1 and those involving non-maritime meanings were classified as A-2. However, the root cause of these mistranslations is the same: the one-to-many correspondence between an original English word and its Japanese counterparts. As shown in 3.2, "communication" can be a conversation on the radio as well as a face-to-face conversation in Japanese. A "watchkeeper" on the bridge is always called "当直者" in Japanese, not as "監視員," which is an ordinary word for someone who watches over something.

Not only nouns but also verbs in the maritime context were mistranslated. The word "crossing" in the phrase "when two power-driven vessels are crossing" was translated as "交差している" by ChatGPT and DeepL, and as "横断を行っている" by Google Translate, but none of these translations are correct. It has to be "互いの進路を横切っている."

Phrases involving the word "anchor" was often mistranslated. Google Translate and DeepL translated "dragging anchor" as "to pull the anchor along the ground" in Japanese as shown in Example 4. The phrase "weighing anchor" was translated as "measuring the weight of anchor" by DeepL. For a vessel to "be at anchor" all 3 applications used 停泊している but this Japanese phrase is used for a vessel that is moored. The correct translation should be 錨泊している in Japanese.

Since selecting the right Japanese word from multiple candidates depends on the context, that is, the meaning of the entire phrase or sentence, this error appears to be difficult for AI to cope with, since it does not understand meaning, but instead relies on what words appear in the vicinity of the target word.

In order to reduce Type A-1 and A-2 errors, AI translation applications should learn the correspondence between English maritime words/phrases and their Japanese counterparts with context. ChatGPT 4.0 allows its users to incorporate a knowledge base created by them and our preliminary attempts to use a list of English and Japanese Maritime words and phrases have led to desired results.

Type A-3 errors accounted for slightly less than 10 percent of the entire translation errors, and these omissions appear to take place in a relatively random fashion. This may be an inevitable consequence of the underlying neural machine translation technology [7]

4.2. Type B Errors (grammatical errors)

Assigning the correct syntactic structure to a grammatically ambiguous sentence also requires proper semantic interpretation, and thus, type B errors also appear to be difficult to cope with. It is certainly true that these errors were fairly limited in number (only 10 cases accounting for 9.2% of the total errors), but these errors do exist.

The misinterpretation of the conjunction "and" was not limited to Example 9, and phrases such as "flame and ignition failures" and "the intake and exhaust ports" were mistranslated. The first example was mistranslated by all 3 applications as "flame": and "ignition failures" whereas it should be "flame failures" and "ignition failures." For the second example, Google Translate and DeepL successfully translated the phrase as 吸気ポートと排気ポート, but ChatGPT gave 吸気と排気ポート.

As discussed in the Introduction section, AI translation applications are improving very quickly and grammatically ambiguous sentences such as "I was staring through the window at the girl on the stage." can now be translated correctly by all 3 translation applications. It remains to be seen if the grammatical errors found in this study can be translated properly in the future. With ChatGPT 4.0, lexical errors can be reduced by the introduction of parallel lists of Maritime English and Japanese words/sentences. Whether this will also reduce grammatical errors or not must be empirically evaluated.

4. Summary and Future Directions

Translation accuracy of English Maritime documents (10 short passages with 2612 words in total) into Japanese by ChatGPT, Google Translate, and DeepL was evaluated. There was little difference among these 3 applications in terms of the number of overall translation errors (97, 92, and 103, respectively). On average, the applications made about 3.7 errors for every 100 words translated. By far the largest number of errors involved translating Maritime English words into Japanese (61.6%), followed by mistranslation of non-Maritime English words (16.1%). There were also cases where some parts of original English were ignored in translation (9.6%).

The AI applications tested sometimes misinterpreted the grammatical structure of English sentences when there is grammatical ambiguity, although such errors were limited in number (27 in total by 3 applications). Such errors involved misinterpreting the juxtaposition structure of the conjunction "and" (Examples 9 and 10), assigning an incorrect grammatical function to a prepositional phrase (Example 12), and failing to identify the correct antecedent of a relative pronoun clause (Example 11). Presumably, these errors will occur when translating non-Maritime English passages. Since AI applications do not understand the meaning of sentences being translated, a certain number of grammatical errors when translating sentences with grammatical ambiguity may be inevitable. This possible limitation appears to be an intriguing topic in and of itself.

A classic example of a grammatically ambiguous sentence "Flying planes can be dangerous." can be turned into a semantically unambiguous one by adding "for birds living near an airport" at the beginning. This new version was translated into Japanese and the results are presented below:

ChatGPT: 空港近くに住んでいる鳥にとって、飛行機が危険なことがあります。

Google Translate: 空港付近に生息する鳥にとって、飛行機の飛行は危険となる場合があります。

DeepL: 空港の近くに住む鳥にとって、飛行機を飛ばすことは危険である。

ChatGPT ignored "flying" in translation and the other applications interpreted "flying planes" as an "act of flying airplanes", rather than "planes that are flying", whereas just about every human being would opt for the second interpretation.

With ChatGPT, reducing the number of lexical errors is possible by incorporating a user-made knowledge base, but this option is not available with Google Translate and DeepL. Our next goal is to create a large-scale knowledge base by using international conventions such as SOLAS, MARPOL, and STCW for which official Japanese translations are available and see if its incorporation into ChatGPT will reduce the number of lexical translation

Since English and Japanese are linguistically so different both in terms of lexicon and grammar, translating Maritime documents into languages that are much closer to English, for example, French or German, may lead to lower lexical and grammatical error rates. Unfortunately, the present authors' knowledge in Maritime French, German, or for that matter any other foreign languages is virtually non-existent, we would like to invite IMEC colleagues to use the same passages used here and translate them into their native languages using the same AI translation applications. All the passages used and all the errors identified will be made available for the asking. Please contact the corresponding author.

Acknowledgements

This research was funded by a Grant-in-Aids for Scientific Research granted to the corresponding author (2024-2026). The authors would like to thank Prof. Dr. Xiangen Hu for providing technical guidance in the use of ChatGPT.

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RESHAPING MARITIME EDUCATION AND TRAINING WITH A CIRCULAR ECONOMY PERSPECTIVE

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Abstract: In today's world where limited resources are rapidly decreasing, reducing the damage to the earth and ensuring the welfare of future generations have been the main concerns of people who can foresee future challenges. One of the approaches that is increasingly accepted to fight these problems is the transition to the circular economy. This study aims to explore the steps that need to be taken in maritime education and training institutions of today to shape the maritime industry of the future with a circular economy mindset. Within this frame, steps such as integrating circular economy principles into the curriculum, providing hands-on training opportunities for maritime students to learn circular economy principles, and encouraging research and innovation in sustainable maritime practices are considered good methods to give students a mindset that prioritizes circular economy. Taking these steps will contribute to the development of a more sustainable and environmentally friendly maritime sector, as well as to the knowledge and awareness of future maritime sector professionals in the field of circular economy. The study also provides examples of international projects that aim to equip students with a sustainability and circular economy mindset and develop curricula and courses for this purpose.

Keywords: Maritime Education and Training (MET); circular economy; sustainability; environmentally friendly.

1. Introduction

Until very recently, people have been making unlimited changes and innovations by using the world's limited resources and ignoring the damage they cause to nature. However, when the effects of this indifference to nature threatened human health, the seriousness of the situation was realized, and some measures were taken to stop or at least slow down this deterioration. The scope of these measures, which were first taken slowly and in certain areas, has expanded over time and has come to cover the entire sector and even all areas and activities, whether related to maritime or not. These concepts include loop closing, eco-design, industrial ecology, industrial symbiosis, life cycle analysis, and performance (Deutz, 2020). As a result of the evolution of these concepts over the years, which aim to minimize human damage to nature, the idea of a circular economy has emerged.

Resources are never wasted, and the environment is renewed in a circular economy. Materials and products are recycled, composted, renovated, reused, and maintained. The circular economy addresses issues such as pollution, waste, and biodiversity loss in addition to climate change by severing the link between economic activity and the use of limited resources, (Ellen MacArthur Foundation, 2024). It is based on three principles:

- Getting rid of garbage and pollutants
- Distributing goods and resources (at their best value)
- Revitalizing the natural world

The circular economy has gained more and more importance and has started to be put into practice in several stages. The first step in this process was taken by the European Commission (EC), which introduced the First Circular Economy Action Plan (CEAP) (2015), "Closing the Loop - An EU Action Plan for the Circular Economy," on December 2, 2015, considering the new economic opportunities. This plan included actions to encourage the shift from the European linear economy model to a circular one, as well as measures to increase job creation, foster global competitiveness, and promote sustainable economic growth (European Commission, 2020).

One of the cornerstones of the European Green Deal, Europe's new goal for sustainable growth, was the Circular Economy Action Plan for a Cleaner and More Competitive Europe, which the European Commission adopted on March 11, 2020, following the evaluation of the first CEAP. Initiatives covering the entire product life cycle, from the design stage to the reintroduction of materials as secondary materials back into the market, are anticipated by the new CEAP. It strongly encourages sustainable design and the empowerment of public buyers and consumers to make more circular decisions (European Commission, 2020) (Valta, 2024). Studies have indicated that the circular economy model can be implemented in 6 stages. These phases are illustrated in Figure 1.

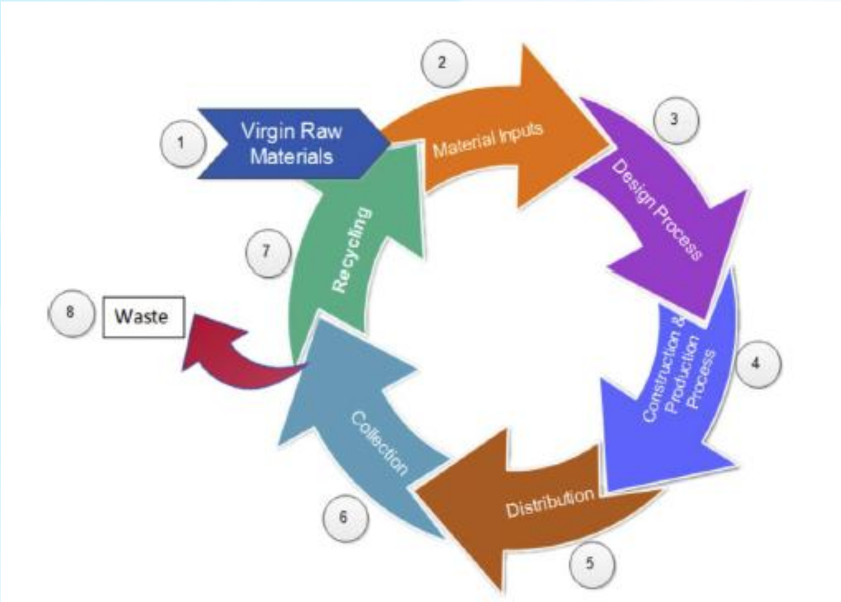

Figure 1. The phases in the circular economy model (Akanbi et.al., 2017)

The success of each stage depends on the fact that everyone who is involved in the process understands the subject very well, is aware of the tasks that fall upon him, and has received the necessary training to carry out those tasks properly. In this case, as in every field, education is important to realize a circular economy. This study will try to evaluate the steps that need to be taken for the circular economy to be understood, adopted and widely implemented by as many people as possible from the educational point of view.

2. Literature Review

Most studies on the relationship between circular economy and education emphasize the importance of activities aimed at raising circular economy awareness and knowledge in the curriculum through different methods. In addition, the benefits of getting the support of all stakeholders and cooperating with them in this process were also studied. One of these studies was conducted by Renfors (2024), who found that education for the circular economy (ECE) should be applied more broadly in the context of many industry and market scenarios to create inventive teaching and learning methodologies to incorporate the circular economy holistically into the curriculum. He also pointed out that as changing consumption is another aspect of systemic transformation, the demand side should also be addressed in lessons. Lessons promoting systems thinking should include objectives related to the circular economy and all stages of implementation. According to this research, increasing creative methods to promote real contact in the workplace is also necessary.

Another study related to the ECE was carried out by Vergani (2024), who emphasizes the key role Higher Education Institutions (HEIs) play in the transition to the circular economy and adds that they are entitled to give a circular economy mindset to the generations to come. He aims to examine HEIs comprehensively from the viewpoint of their roles in the transition periods. To this end, he studied 72 articles related to the topic and identified six topics related to CE implementation in HEIs. They are education and research; facilities on campus; everything needed to create a green campus, material flows and waste management; collaboration, stakeholder engagement, and behaviors; and frameworks for CE implementation. His research revealed the growing interest in the implementation of CE in HEIs and the potential in HEIs for the transition to CE. Muaddab (2024) approached the topic from the green skills perspective and found that students need to have a higher level of green skills to meet the demands of the sector. He also added that these skills are quantifiable through metrics that assess the technical expertise, knowledge, and mindset workers in a green economy require. It is anticipated that the study's findings will impact the vocational training process by making it greener and competency-focused. Another field where courses related to environment protection and resource management are given widely is vocational and technical education. These programs provide instruction and opportunities for skill development in key areas including waste management, renewable energy technologies, sustainable resource management, and ecologically friendly production methods (Zubir et al., 2021). All these courses help pave the way for the creation of the CE mindset. Ab Hamid et. al., (2023) studied how the CE principles can be integrated into the curriculum of vocational education to address food waste management. They found specific strategies for production methods and teaching techniques can be applied to prevent raw food waste, to use energy efficiently, or to conserve water. They also cultivate circular thinking among pupils to foster innovation (Ah Hamid et. al., 2023).

The transformation of school systems to support CE is as equally important as the creation of a mindset in the students. Yuana et. al. (2024) studied what should be done to realize the transformation of schools to the CE concept. They first tried to answer the question of how to bridge the gap between CE principles and their application to education. The second issue they studied was how and to what extent this process could facilitate the transformation of schools. They also argued that innovative solutions should be encouraged to ensure sustainability and that sector stakeholders should collaborate in this regard, emphasizing that if this happens, the potential for raising environmentally conscious educational leaders, educators, students, and families will increase. In addition, they gave an example of research covering 54 primary and secondary schools between 2022 and 2023 in Indonesia. The findings of this research underlined the need for shared decision-making by all stakeholders for the transition to a circular school and highlighted the importance of pathways and shared decision-making in bridging the gap between CE principles and practical implementation (Yuana et.al., 2024). Furthermore, employing green methods and technologies in supportive educational buildings has proved to contribute positively to the implementation of the circular economy. The practices concerning CE on the university premises encourage all stakeholders to contribute to them, thus leading to positive behavioral change. In addition to the benefits of implementing sustainability practices within the university, it has been revealed that these practices also bring some challenges such as causing feelings of restriction and frustration for employees and students during the transition period (Moghayedi, et. al., 2024)

The perspectives of young people on circular economy also emerge as an important research topic. As a result of the examination of 36 studies on the circular economy, it was concluded that young people know the importance of issues like circular economy and renewable energy and know that these issues will play an important role in their careers (Warnats, 2024). Likewise, a study conducted with the participation of 443 university students in Taiwan and Thailand on students' perspectives on the circular economy and their purchasing behavior towards circular economy products revealed that factors such as environmental awareness, trust, and care for environmental protection encourage young people to buy circular economy products (Yang et. Al., 2024).

3. Methodology

The systematic review method was used to find the necessary data for this study. Four keywords that are "maritime education and training", "circular economy", "green" and "blue" were identified as the keywords. Then the Google Scholar database was searched for studies discussing the implications of circular economy in maritime education and training institutions using these keywords. The study considered studies written in English after 2020. As a result of the search, a total of 18 studies were found to meet the criteria.

4. Results

The studies were evaluated in terms of their relation to maritime education and training. Table 1 gives them the order of their publication and shows their main theme.

Table 1. List of the articles related to MET and circular education

	TITLE	AUTHOR(S)	FINDINGS
1	Feasibility study for a hybrid renewable energy system at the International Maritime University of Panama. 2020	Quesada Juarez, Adriana Marie	Establishment of a hybrid renewable energy system at the International Maritime University of Panama and its benefits.

2	Port innovation ecosystem, a symbiosis of capital 2020	M. Jansen	Educational values are nonmaterial benefits people obtain from ecosystems. Partnerships between institutions, mainly driven by making optimal use of the maritime education and training infrastructure contributes to cultural capital.
3	Addressing Environmental Concerns in Tertiary Education 2021	Pınar Özdemir, Alaettin Sevim, Taner Albayrak	To raise a more environmentally conscious generation, maritime sustainability topics should be considered while preparing the courses' contents.
4	The Priority Areas of Innovations in the Maritime Industry: An Application to the Adriatic Marine Environment. 2021	Šekularac Ivošević, S.	The paper proposes solutions for the Adriatic region concerning its future research, innovations, and vision for development.
5	Implications of Automation and Digitalization for MET (in Sustainability in the maritime domain: Towards ocean governance and beyond) 2021.	Sharma, A., Kim, TE., Nazir, S.	Digital technologies are changing the approach toward education and training specifically in the maritime domain. Digital skills, information processing skills as well as other non-technical skills are necessary for a sustainable maritime domain.
6	Sustainability in the Maritime Domain - Towards Ocean Governance and Beyond 2021	Angela Carpenter, Tafsir M. Johansson, Jon A. Skinner	Encourages policy proposals and prescriptive thinking on topics such as: sustainability management, sustainability strategies, lifestyle changes, and regional approaches. Provides a framework for good ocean governance.
7	Maritime leadership in a changing world: The role of the future professional mariner 2022	Gordon R. C. Foot	The research suggests that current training is outdated and remains slow to react to the known future technology. Present maritime professionals are not considered adequately trained to meet the challenges of the future
8	Coastal risks and resilience learning 2022	L Runko Luttenberger, N Mandić - Pomorstvo,	The study analyzes the characteristics of education for resilience and sustainability, emphasizing that the curricula should focus on deeper learning about local knowledge, promoting local sustainability, and integrating teaching about the environment and responsible citizenship so that resilience can be strengthened.
9	Building resilience through foresight: The case of maritime container shipping firms 2022	H. Bathke, C. Münch, H. A. von der Gracht E. Hartmann,	The study contributes to the academic focus on in-depth diversity analysis in the Delphi methodology and emphasizes the relevance of incorporating multiple stakeholders and panelists in future planning
10	Green maritime practices in an emerging economy towards the achievement of sustainable development: a Ghanaian context 2023	Dacosta Essel, Zhihong Jin, Joseph Oliver Bowers, Rafiatu Abdul-Salam	Quality maritime education and training are needed for sustainable development.
11	Closing the gap between present and future through education: MINE-EMI Project 2023	Pınar Özdemir, Alaettin Sevim, Taner Albayrak	Technological developments require up-to-date approaches in maritime educational programs. Transboundary marine and coastal management methods require international postgraduate programs.
12	Maritime Society 5.0: a global transition on the human economy and civilization for maritime sustainability. 2023	Autsadee, Y., Jeevan, J., Bin Othman, M. R. Mohd Salleh, N. H. B.	Integration of advanced technologies, sustainable practices, and socio-economic considerations are necessary to shape the future needs of the maritime industry. To create a resilient and socially responsible maritime industry for the future, interdisciplinary collaboration, evidence-based strategies, informed decision-making, and sustainable growth.

13	Enhancing Sustainable Development of the Estonian Maritime Sector Through Policy-making Framework 2023	Kaidi Nõmmela	Maritime companies should be actively involved in the development of curricula for schools and higher education institutions so that the graduates will be provided with the skills they need for the labor market.
14	A strategic analysis of sustainable transportation on Lake Van 2023	İ. Karaca, Ö. Söner	It is important to improve communication among the shareholders to build cooperative connections and develop new ways to integrate the SDGs into regulatory and policy plans to innovative infrastructure planning and investment solutions. It also emphasizes that educational institutions support Inland Waterway Transportation (IWT
15	Port Systems in Global Competition 2023	C. Ducruet, TE Notteboom	The study provides information supporting decision-making processes related to the development of ports, supply chains, and transportation networks. It is useful for academics and advanced students interested in the analysis of transportation and economic systems, as well as providing effective ways to respond to complex problems in transportation and socio-economic development.
16	MSc in Maritime Logistics: A program developed in collaboration with industry 2023	Marco Sernaglia1, Augusto M.P. Carreira1, Helena M.L. Carvalho , Pedro B. Água, Armindo Frias, Manuel Carrasqueira	A new training program in maritime logistics will provide an answer to the increasing demand for skilled professionals in the maritime industry, one of the most significant and impactful industries of the blue economy.
17	Ensuring Gender Equality in Nordic Blue Economy: Results from the Salmon and Equality Project 2024	Anna Karlsdóttir, Hjördís Guðmundsdóttir,	The study deals with the absence of women from the blue bioeconomy.
18	UN General Assembly	General information on sustainability in the blue sector	The importance of sustainability in the maritime sector is discussed.

As Table 1 shows, the majority of the 18 studies accessed by using keywords emphasize that rapid technological transformation and rising awareness of environmental issues should bring changes in MET. They also point out that contemporary MET should include studies for the realization of the circular economy. They say that integrating circular economy principles into MET is crucial for preparing future maritime professionals who can address sustainability challenges and promote environmentally responsible practices in the maritime industry. Considering all these recommendations and the results of the research carried out on the topic, albeit a few, it is clear that some steps should be taken to reshape MET with a circular perspective. These steps can be given under four major subheadings that complete each other, as Figure 2 shows.

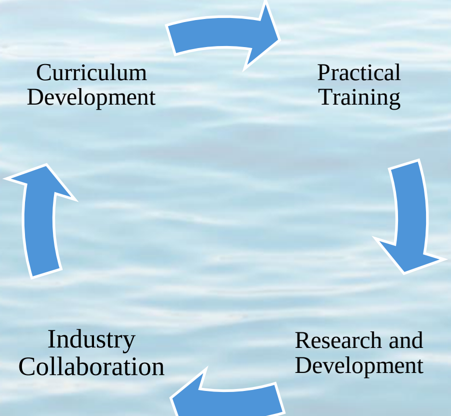

Figure 2. Major subheadings in MET for circular economy

4.1 Curriculum Development

To realize this step, MET institutions should:

- Develop specialized courses or modules within maritime education programs that focus on circular economy principles and their application to maritime operations. Topics may include sustainable ship design, eco-friendly propulsion systems, waste management strategies, and circular supply chain management.

- Integrate circular economy concepts into existing maritime courses such as maritime law, marine engineering, navigation, and port management to ensure a comprehensive understanding of sustainability issues across all aspects of the maritime sector.

- Incorporate case studies, simulations, and practical exercises that highlight real-world examples of circular economy initiatives and their impact on maritime operations (IMO, 2020; EMSA, 2021).

4.2 Practical Training

This step requires that the MET institutions concerned should:

- Provide hands-on training opportunities for students to gain practical experience with circular economy practices in maritime settings. This may involve internships, apprenticeships, or fieldwork placements with shipping companies, port authorities, marine research institutes, or environmental organizations.

- Offer simulation exercises and virtual reality training modules that simulate maritime scenarios involving circular economy challenges, such as waste reduction, energy efficiency optimization, and sustainable vessel operations (Mallam et.al., 2019).

- Equip maritime training facilities with state-of-the-art equipment and technologies that support circular economy principles, such as advanced recycling systems, energy-efficient propulsion systems, and waste-to-energy technologies (Demirel, 2020).

4.3 Industry Collaboration

To realize collaboration with industry, MET institutions are expected to:

- Foster partnerships between maritime education institutions and industry stakeholders to co-develop educational programs, research projects, and training initiatives focused on circular economy principles.

- Establish industry advisory boards or steering committees composed of representatives from shipping companies, port authorities, maritime organizations, and environmental NGOs to provide guidance and support for integrating circular economy into maritime education and training.

- Facilitate knowledge exchange and networking opportunities between students, faculty members, and industry professionals through seminars, workshops, conferences, and industry visits (European Commission, 2020; Williams, 2024).

4.4 Research and Innovation

In the frame of this step, MET institutions are to:

- Encourage research projects and thesis work that explore innovative solutions for advancing circular economy in the maritime sector. This may involve studying new technologies, best practices, policy frameworks, and business models that promote sustainability and resource efficiency in maritime operations (MINE-EMI, 2022).

- Provide funding, resources, and mentorship support for student-led research initiatives focused on circular economy topics, such as alternative fuels, green shipping technologies, waste management strategies, and environmental impact assessments (Sukiennik et. al., 2021).

By taking these steps with a special emphasis on circular economy, MET institutions will be able to effectively integrate circular economy principles into their programs and equip students with the knowledge, skills, and competencies needed to promote sustainable practices and innovation in the maritime sector.

On the other hand, achieving a circular economy, and sustainable development as a result, in the maritime sector is a global issue so it requires global collaboration. That means the realization of this goal in the best way requires forming partnerships, especially international partnerships, with other stakeholders, including governments, NGOs (Non-Governmental Organizations), industry associations, and local communities, to promote and implement sustainable maritime practices. In the following part, three examples of such partnerships are given:

SUDEMAR Project (* SUstainable Development of the European MARitime sector)*

The project aims to increase awareness of maritime sustainability through international cooperation and the creation of open resources. The project, which is being implemented by three universities and four international organizations, will carry out its activities within the framework of two main objectives:

- To increase the awareness of maritime sector stakeholders on the Sustainable Development Goals (SDGs) planned to be achieved by the United Nations member states by 2030,
- To create tools to support the implementation of practices that will realize these goals in the maritime sector.

Within the framework of the project, the main outputs will be to create a data repository containing all existing practices and regulations in the maritime sector for sustainable development goals, to create an online course on realizing sustainable development in the maritime sector, and to prepare all course materials related to the subject, to develop a user-friendly and functional mobile application that provides access to basic resources, information and tools related to Sustainable Development Goals in the maritime sector.

CULMARSkills Project (*CULMARSkills (MARitime Soft Skills for Onboard Healthy Nutrition and CULinary Arts in Seagoing Services)*

The project has five partners, four of which are universities and one of which is an NGO. Within the frame of this project, which focuses on training future ship cooks with a future mindset, courses such as waste management, green transformation, and food waste prevention will be prepared. These will both educate and train prospective cooks and give them a mindset that cares about sustainability. The project also aims to contribute to the creation of new job opportunities under the EU Blue Skills strategy.

GREENPORTS Alliances Project

This project, which is being carried out by 10 partners, including five universities and five international institutions, aims to contribute to MET from a circular economy perspective. Within the frame of the Project, needs assessment, data collection and analysis for greener port operations will be carried out. In parallel with the results of the analysis, learning outcomes and curricula will be determined for the training module for the following 3 separate groups: Higher education students (future staff), professionals, and trainers with e-learning courses.

GREENPORT Alliances aims to create and implement innovative Higher Education Institution (HEI) and Vocational Education and Training (VET) curricula targeting behavioral change in port service operations, to reduce this sector's emissions in the immediate short- to medium-term. This will be achieved through a cross-sectoral collaboration bridging academia, industry, and industry representative bodies. In doing so, GREENPORT addresses a key societal challenge: the imperative of reducing emissions within the maritime port services sector without waiting for stricter legislation, more elaborate compliance monitoring, or more environmentally friendly technologies to become available. Educational material to be designed will be supported by practical training to be implemented in Port of Aveiro, Portugal, one of the project partners. This will target prospective marine personnel studying in HEIs, current seafarers who have been working in the industry for a long time (with a special emphasis on pilots and tugboat staff), and the educators and trainers of both parties.

5. Conclusions and Discussion

The importance of the circular economy today and how indispensable it will be in the coming years is recognized by all sectors. It is important to have stakeholders with a circular economic mindset to ensure sustainability in the maritime sector, which has an active role both on land due to ports and shipyards and at sea. To raise generations equipped with such a mindset and the skills to implement circular economy principles, it is necessary to start with educational institutions and to organize education and training curricula and practices in a way to raise individuals with a circular economy perspective.

In this study, the steps to be taken for this purpose are discussed under four headings, and examples of international projects that have been implemented to realize sustainability and circular economy, which is a sub-branch of it, are given. According to the findings the following measures can be taken to provide MET with a circular economic perspective:

- Reorganizing the content of the curriculum and covering topics that enable students to understand the circular economy and take measures to put it into practice
- Transferring theoretical knowledge into practice by supporting it with hands-on training and studies
- Supporting the circular economy through continuous research and development activities in educational institutions

- Cooperating with the industry and to raise awareness of industry employees about the preventive measures that can be taken on the subject
- Showing the stakeholders in the industry how the measures can be used in a way that can provide the most benefit
- Taking incentive measures to bring the circular economy mindset not only to students but also to the sector and even to society as a whole
- Ensuring that everyone understands the danger the world faces if measures are not taken to ensure sustainability
- Organizing seminars, conferences, lectures, and public speeches to explain the importance of the subject to students and transform them into leaders who will convince other people
- Increasing the number of projects aiming to enhance maritime sustainability and provide a circular economy mindset to help achieve this
- Taking and implementing measures that will not be limited to a specific region, but will cover a wide, even international, area.

It is crucial that these measures are taken without delay and that everyone understands the challenges that can be faced without transitioning to a circular economy.

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SOFT SKILLS FOR MARITIME STUDENTS: POSSIBILITY VERSUS NECESSITY

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Abstract: Issues of soft skills significance are rightly raised by researchers and representatives of various industries worldwide. In our quickly changing world of emerging technological advances and increasing interest in ethical and psychological aspects of human relationships to possess technical skills only seems insufficient, lacking some essential meanings by perceiving coworkers as performers obliged to do certain actions. Being a popular notion currently, soft skills help manage people in more efficient way in contrast to stiff way of organizing team activities. The intent focus on the lack of efficient interpersonal interaction in numerous work environments brings forward intense discussions and profound researches on the nature of soft skills. Despite general understanding that IMO regulatory documents, among them STCW Convention, do not directly address the necessity of implementing soft skills concepts, some maritime training institutions make efforts to deliver to students the importance of building soft skills as being foundational to kind leadership and increasingly sought by employers. To do that, Maritime English teachers need to determine the soft skills sets making the process of developing study programme easier and more flexible. The paper is aimed at presenting soft skills as an inherent element of English language course for maritime students at a higher education institution.
Model Course 3.17 "Maritime English" provides some implications for the choice of soft skills required by the shipping industry nowadays. On completing a survey among teachers, the authors have grouped the selected soft skills into three sets: communicative (persuasion, negotiation, emotional intelligence), behavioural (leadership, teamwork, conflict management) and cognitive (critical thinking, problem solving, decision making). The article reveals the researchers' ideas on the sequential order and ways of presenting and discussing modernity and elitism of soft skills to be accepted by students as their potential to become advocates of effective human and professional interaction.

Keywords: soft skills; maritime education and training; Maritime English study programme

1. Introduction

Soft skills necessity at workplace has lately gained unceasing attention as the employers seek for the personnel to improve the working atmosphere that enhances productivity. Having a decisive effect on the onboard crew psychological well-being during long voyages, the "softened" interpersonal relations are of great value in the shipping industry as they lead to considerable decreasing of accidents at sea.

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) serves as the basic international convention addressing the maritime professionals' core competencies. Without a formal requirement for the seafarers to necessarily possess soft skills, it acknowledges them indirectly, together with hard skills, to be of major importance in the shipping industry, among them effective communication in different situations, ability to apply effective resource management and decision-making techniques.

International Maritime Organization (IMO) Model Course 3.17 "Maritime English" (2015) provides some implications for the choice of soft skills required by the shipping industry nowadays which can be useful for designing a course with soft skills integrated.

The annual analysis of the maritime transport industry's performance and future trends conducted by the International Chamber of Shipping emphasises the need to make changes in professional training of future seafarers to ensure stable supply of human resources for the industry. These changes primarily relate to the need for identifying soft skills to be a learning objective at the same level as technical skills (The Key Role of Seafarers 2023).

The necessity for maritime education institutions to attach more importance to developing students' soft skills dictated by current circumstances leads Maritime English teachers to becoming aware of the relevant strategy and methodology. To implement the selected skills set successfully, teachers should come to their own choices in enriching the Maritime English course with new components.

2. Literature Review

A certain number of attempts have been endeavored in trying to take practical steps of making soft skills be part of study programmes. Those are dedicated courses at some training centres, educational institutions, and companies. Scientific and methodological substantiations of them are regretfully deficient.

The most explored research areas refer to general descriptive aspects of the necessity to determine optimal soft skills sets (Malykhin et al 2024) and to reconcile them with hard skills (Lamri & Lubart 2023), while the focus of our interest lies in methods of teaching soft skills as well as in Maritime English course design incorporating soft skills development at a higher education institution.

It has become obvious that higher education cannot be considered to study hard skills only, multiple recent articles and, additionally, reviews of publications on soft skills being true evidence for it (Espina-Romero et al 2023; Touloumakos 2020; Coelho & Martins 2022). The difficulty of defining this concept is repeatedly noted and the importance of including soft skills into the content of higher education is emphasised (Spirovska Tevdovska 2015).

Fairly enough, much attention is paid to the usage of cases for developing students' soft skills. It is stated that empirical results from applying the case study method show high percentage of satisfaction among the students with a slight "mind change" through the tested methodological approach (Lutzkanova 2022). The educational tools list includes group discussions, role-plays, simulations, structured exercises, games, video reviews and self-study which enhance the impact of learning.

A group of researchers working under the guidance of the International Maritime University confirm the important role of soft skills in improving technical skills and draw attention to the underestimation of human factor in professional maritime training. To that, they emphasise the need to amend STCW Convention and suggest a list of skills required for seafarers in the short, medium and long terms, including: 1) human resources management; 2) business communication; 3) quality and safety control; 4) critical thinking and analysis; 5) application of digital technologies; 6) stress resistance and flexibility; 7) leadership and initiative; 8) active learning; 9) personal abilities. This soft skills list covers the most important aspects of seafarers' professional activities with further detailing of their content.

A thorough analysis of the importance of soft skills aboard ships and methods for soft skills development in English classes with a focus on communication reveals task-based and problem-solving learning, case studies, discussions and debates, role-playing games, oral and poster presentations, and written tasks related to the future professional activities of students to be the most appropriate methods for incorporating soft skills into the English language classes (Sirbu & Georgescu 2023).

It is further concluded that problem-based learning as an instructional approach has a significant role in the development of soft skills among students (Deep et al 2020) This method seems to be more challenging for instructors requiring much more efforts on problem refinement, student coaching, performance evaluation, data gathering, and experience analysis when compared to a traditional instructor-centered learning approach.

Using gamification has the potential to benefit in the educational field, so progress of research into gamification in the context of higher education is clearly seen (Guerrero-Alcedo et al 2022). Nevertheless, research results on implementing this method in connection with soft skills are not available, though.

Wide-scale international projects on the issue hold our attention by being reliable resources.

The Intensive Study Program within the ISOL-MET (Innovative Soft Skills to Maritime Education and Training) project (Lekakou et al 2023) brought together leading maritime education institutions in Europe to propose practical approaches to integrating soft skills into the learning process through the analysis of purposefully developed and selected real-life accidents at sea. The Maritime Case Study Handbook as one of the project outputs containing the course programme and the teaching/learning methodology involved may undoubtedly be of great value for Maritime English instructors.

The findings of the SkillSea project (2023) include current requirements for the skills of maritime professionals. It is recommended to introduce a number of separate courses for the development of soft skills in maritime education, namely: 1) digital technologies; 2) environmentally mature behaviour; 3) leadership, communication and teamwork; 4) conflict management. The project is a further attempt to identify and substantiate the soft skills that determine the sustainable development of the maritime transport industry.

Due to the specifics of working at sea, crew resource management is an extremely important skill. The Kind Leadership project implemented under the auspices of the UK Maritime Professional Council has put forward the idea of adding "Human Element, Leadership and Management" course into the curriculum with the aim of encouraging students to develop their leadership skills necessary to create positive working environment (Davis et al 2022).

All of the above-mentioned projects focus on designing a separate course. With our emphasis on incorporating soft skills into the current study programme of Maritime English, the available research deliverables provide us with the justifiable decision of continuing to explore the issue.

The purpose of this paper is to present soft skills as an inherent element of English language course for maritime students at a higher education institution.

3. Survey Analysis

In order to identify specific soft skills to be taught and effective teaching approaches, a survey has been conducted among Maritime English teachers of Kherson State Maritime Academy. The collected responses have been used for subsequent integration of soft skills into current study programmes and learning materials creation.

To gain deeper insights and provide broader access, "Teachers' Perception of Soft Skills" questionnaire has been designed on Google Form App. It comprised open- and close-ended questions. The link to the questionnaire has been shared with the survey focus group represented by those who teach Maritime English to students of different fields of study.

The findings are based on the survey data collected from 23 respondents, who teach Maritime English to deck officers (11 respondents), marine engineers (8 respondents) and electro-technical officers (4 respondents). Most interviewees (17 persons) teach students who have already had some sea-going practice and been familiarized with routine life and work on board ships in hierarchical and multicultural environment.

The following questions were included into the questionnaire:

1. Which soft skills do you believe are crucial for seafarers?
2. How do you currently integrate or plan to integrate soft skills into study programmes?
3. What approaches do you believe are most effective for soft skills development?
4. What challenges do you foresee in implementing effective soft skills development?
5. What opportunities or innovations do you see for enhancing soft skills development in maritime education?

The first question intends to specify the profession-oriented soft skills needed to be developed purposefully at Maritime English course. The respondents were suggested to select appropriate skills from the list of 13 and add their own, if available.

Figure 1 visualizes the language teachers' perspectives on the soft skills that have the potential to help students succeed in their future careers.

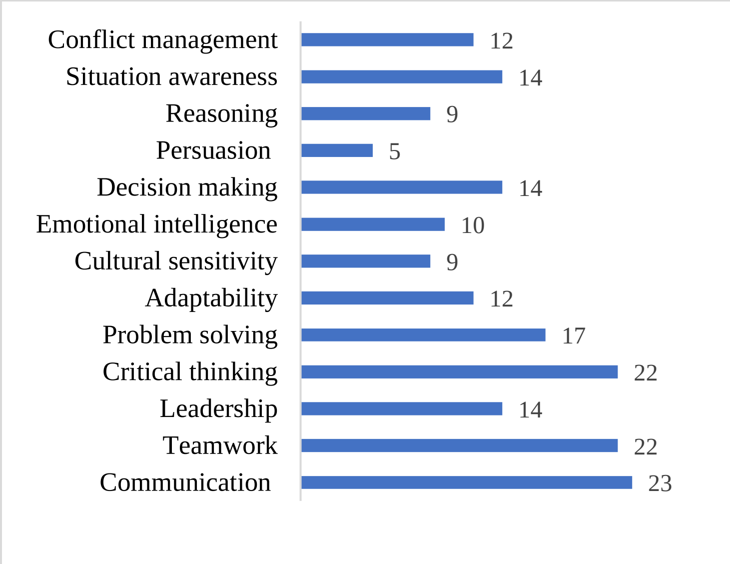

Figure 1. Soft Skills Ranging by Respondents.

The analysis shows all the teachers (100%) understand the importance of communication skills in education and ways they can help students achieve success in their professional careers. Meanwhile, ability to persuade and negotiate, being integral parts of successful communication, has been selected as significant by 5 respondents only (23%). That means that there is an essential necessity to define communication skills in general and clarify the essence of effective communication indicators.

According to the survey results, most respondents perceive higher order thinking skills as high priority for future seafarers. Critical thinking goes along with problem solving, decision making and situation awareness, but the latter has been selected by 14 respondents.

The survey illustrates that while most respondents appreciate teamwork skills (96%), conflict management and leadership skills have been chosen by 55% and 64% of the respondents respectively.

The second question focuses on the respondents' experience of teaching soft skills. Embedding soft skills into study programmes is considered by them to be essential to overcome challenges the students may face in the maritime industry. Most respondents have already taught soft skills at their classes by implementing case studies, group discussions, scenario-based simulations and group projects. The teachers have promoted collaborative learning environment by utilizing active learning strategies, such as peer-coaching and reflective writing that motivates students to provide feedback, think critically, and cultivate their leadership and teamwork abilities.

The next question proposes selecting most effective approaches to developing future seafarers' soft skills. According to our survey, 20 out of 23 respondents have reported that case studies are most effective. The authenticity of real-life situations motivates and encourages students to apply their knowledge and evaluate their attitudes. Group discussions as a widely used technique have been chosen by 18 teachers while simulations, interactive workshops, and role-plays have been chosen by 16, 15, and 11 respondents respectively. Those activities are recognized as enabling students to apply their knowledge for completing meaningful tasks. Only 4 respondents have selected mentorship as an effective method to accelerate the transfer of professional knowledge and personal skills. In their opinion, mentoring shows great promise in guiding and supporting newcomers.

The fourth question is aimed at discovering difficulties the teachers have encountered working on soft skills in their teaching practice. It has been stressed that achieving success in this process necessitates ongoing efforts from both teachers and students along with a long-term perspective on the anticipated learning outcomes. Absence of teaching materials to train particular skills discourages some teachers from participating in this initiative. Some students are described as reluctant to being engaged in active learning online. In addition, isolated learning environment, lack of live communication, and cultural differences can cause misunderstanding and discourage from utilizing innovative teaching and learning approaches.

Despite those challenges most respondents underscore the importance of soft skills development for their students. The analysis illustrates the current need to integrate soft skills into the education process of future seafarers either by dedicated courses design or embedding them into academic study programmes.

4. Soft Skills Sets

Upon completing the survey, several soft skills have been identified as essential for designing Maritime English study programme that focuses on developing 21st-century competencies for future maritime professionals. A possible taxonomy may group such soft skills into three sets: communicative, behavioural and cognitive (Figure 2).

Figure 2. Soft Skills Sets.

4.1. Communicative Set

The communicative set of soft skills includes persuasion, negotiation and emotional intelligence. Students should be taught multiple aspects of communication.

Persuasion is a valuable soft skill that can significantly contribute to safety of crew, ship and marine environment, as seafarers need to interact with each other on board as well as with various parties involved in shipping, namely, port authorities and superintendents, cargo owners and charterers. Being able to persuade others and influence their actions or performance is crucial and should be practiced regularly in English language classes. Students learn how to identify differences between facts and viewpoints, provide reasoning and persuade their groupmates to accept an idea or commence an action.

Negotiation plays an essential role in effective communication as it assists in reaching compromise and influencing another person or party to support a specific idea or behaviour. To negotiate a mutual agreement, students practise active listening skills to understand the speaker's needs and identify how to fulfill them. Mastering negotiation skills takes time and practice. It requires a high level of language proficiency to prevent students from feeling discouraged to participate actively due to their limited vocabulary or grammar.

Emotional intelligence entails an ability to understand and manage one's own emotions in addition to noticing and interpreting the emotions of others. To understand the importance of emotional intelligence, it is crucial to consider the global character of the maritime industry, where individuals from diverse cultures collaborate and communicate during emergencies. Despite emotional intelligence is perceived as one of innate personality traits, it can be consciously developed by means of self-analysis, empathy and social skill development.

4.2. Behavioural Set

The behavioural set comprises leadership, teamwork and conflict management.

Leadership as a soft skill encompasses the ability to inspire, motivate, guide, and influence others to achieve common goals. It is particularly critical in the maritime professional domain. Cultivating these skills involves developing several attributes and behaviours that enable future maritime professionals to operate and manage competently. Strong leadership can improve work productivity, enhance safety procedures, and promote high moral standards within the crew. By developing leadership as a soft skill, seafarers can navigate the complexities of their roles more adeptly, ensuring the success and well-being of their crews.

Teamwork is not just a soft skill but a fundamental component of maritime professionalism. By fostering teamwork, seafarers contribute to safer voyages, operational excellence, and supportive onboard environment. Enhancing teamwork skills among crew members is essential for ensuring sustainability of the maritime industry.

Conflict management is a crucial soft skill for seafarers who face the dynamic and often challenging environment on a regular basis. At sea, where crews live and work in small communities for long periods, conflict management can significantly impact safety, crew unity and operational efficiency. By developing conflict management skills seafarers can mitigate interpersonal challenges, contribute to harmonious working environment, and ensure the successful execution of shipboard operations.

4.3. Cognitive Set

The cognitive set is presented by critical thinking, problem solving and decision making. In sequential order, they logically follow each other.

Critical thinking is a professional ability to analyse available facts or observations about a certain situation, process, state or certain relations which require being thought about and resolved. The skill (rightly called a life-skill) is of primary importance for seafarers as they work in small crews onboard ships and frequently encounter unpredictable situations that require contending against imminent dangers.

Problem solving, as the next step, means the process of exploring possible options for coming to a rational solution of those matters. It is closely related to critical thinking because the ability of being impartial and unruffled in hazardous situations becomes worthwhile.

As the last step in this chain, decision making concerns the process of choosing the best alternative to form a judgement and communicate it. The possibility to avoid incidents, fatal in some instance, comes with the working environment where misdoings are welcomed to be reported and analysed in order to come forward with the best decision for similar processes in future and where open sharing of information is stimulated.

Thus, all those soft skills sets, being closely connected, may be addressed to separately or together depending on students' level of understanding soft skills as well as the necessity to be able to adapt to the changing circumstances in the workplace.

5. Integration into Maritime English Study Programme

Integrating soft skills into Maritime English study programme involves a strategic approach to enhance communicative, behavioural and cognitive skills alongside language proficiency.

An analysis of Maritime English study programme to assess the opportunities for incorporating sets of soft skills into thematical modules has been conducted. This effort is aimed at facilitating more comprehensive development of soft skills crucial for a successful maritime career. To obtain more reliable information, it has been decided to analyze some modules of the undergraduate (bachelor) programme, specifically the second and third years.

Table 1 outlines integration of the soft skills sets in the content of Maritime English study programme. The second year of study comprises modules "Bridge Equipment", "GMDSS Communications", "Anchoring", "Mooring" and "Ship Security". Each module is evaluated for its potential to develop specific soft skills, categorized into communicative, behavioral, and cognitive sets.

Table 1. Soft Skills in the Content of Maritime English Study Programme (Year 2).

Module	Soft Skills Sets		
	Communicative	**Behavioural**	**Cognitive**
Bridge Equipment Characterize working principles of bridge equipment			
GMDSS Communications Comprehend and participate in GMDSS communications accurately			
Anchoring Exchange information on anchoring procedure			
Mooring Exchange information on mooring procedure			
Ship Security Describe measures for ensuring ship security			

Module “**Bridge Equipment”** primarily focuses on cognitive skills, specifically understanding the working principles of bridge equipment. Enhancing communicative skills could improve the ability to convey technical details effectively. In module “**GMDSS Communications” t**he emphasis is mostly on communicative skills which are crucial for accurate participation in ship-to-ship and ship-to-shore communications. Both modules “**Anchoring”** and “**Mooring”** highlight the importance of communicative skills for clear information exchange during these shipboard operations. Additionally, incorporating behavioral skills such as teamwork would provide deeper understanding and execution of some specific orders and commands. The cognitive aspect is emphasized in module “Ship Security” focusing on understanding and describing security measures. Communicative skills for reporting and behavioral skills for proactive security measures would also enhance performance effectiveness. Table 1 shows that in the second year of study the primary emphasis is on communicative skills in all the modules with behavioural or cognitive skills addressed to secondarily in a few modules only.

Table 2 demonstrates the potential of the modules of the third year study to develop specific soft skills. In module “Bridge Procedures” the focus is mostly on behavioural skills, emphasizing teamwork on the bridge. Effective bridge operations require strong communication skills as well, so integrating communicative skills would enhance the ability to exchange information within the crew. Communicative skills are highlighted in module “VTS” as they are crucial for clear interaction between the bridge team and VTS personnel. Incorporating cognitive skills to understand VTS operations and behavioural skills for coordinated actions would provide a more comprehensive approach. Module “Pilotage” focuses on cognitive skills, ensuring that students understand the principles of collaboration between the pilot and bridge team. To enhance practical application, integrating communicative skills for interaction with pilots would be beneficial. Cognitive skills are emphasized in module “Meteorology”, focusing on the interpretation of weather data to ensure safe navigation. In Module “Navigation Challenges” the focus is on decision making process as a component of cognitive skills required for watchkeeping in challenging conditions. In addition, behavioural skills to maintain composure under stress would improve overall preparedness. Table 2 shows the primary emphasis on cognitive skills for each module, with communicative and behavioural skills addressed to only in some of them.

Table 2. Soft Skills in the Content of Maritime English Study Programme (Year 3).

Module	**Soft Skills Sets**		
	Communicative	**Behavioural**	**Cognitive**
Bridge Procedures Exchange information on effective bridge teamwork			
VTS Speak about the responsibilities of VTS and bridge team in VTS area			
Pilotage Describe basic procedures of pilotage			
Meteorology Define a safe passage for the ship by reading weather maps and NAVTEX messages			
Navigation Challenges Describe watchkeeping duties of the OOW in different challenging conditions			

Each of soft skill sets listed in Tables 1 and 2 can only be developed through interpersonal communication. Soft skills play an important role in the content of Maritime English study programme, ensuring a comprehensive approach to developing essential competencies of students. This approach would ensure that future maritime professionals are not only knowledgeable but also effective communicators and team players, capable of handling multiple operational challenges.

6. Methods

Methods of developing soft skills should generate students' motivation for in-depth understanding of interpersonal relations. Based on this research, case studies, discussions, video reviews, brainstorming sessions, job interviews, thinking hats and role-plays have been chosen as most effective. Besides those activities teachers have an ample choice of strategies to involve their students into active learning. Among them are group strategies (think-pair-share, quescussion), reasoning strategies (debate, four corners), and instructional strategies (Socratic questioning). Various types of reflection – self-assessment, feedback on groupmates' performance, reflective thinking and writing – are also meaningful and applicable techniques for this purpose (Kudryavtseva et al 2021).

Three methods are presented as an example from our experience.

Case study. To implement soft skills successfully, teachers need to be well practiced in using communicative methodology as well as triggering students' higher order thinking that requires skills of analysis, assessment and creation.

Needless to specify, cases serve as a perfect tool in the process of developing soft skills. Their major benefits are:

- detailed description of real-life situations at sea;
- presentation of interpersonal relations dynamically;
- feasibility of analyzing misdoings and correct actions;
- chance to differentiate between hard and soft skills;
- opportunity to create alternatives.

Several years of experience have led us to believe that it's beneficial to start using cases from the very first month after students' enrollment. With the four-year course of Maritime English for the bachelor degree, students are initially taught to work with sea stories during three semesters. The regular set of tasks consists of:

- introductory discussion;
- comprehension check;
- exchange of opinions on possible reasons for the behavioural tendencies, and
- extension task.

During the final three semesters, students work upon maritime accident reports (MARs). Testified by our team, the effective structure of a MAR-study lesson on soft skills is as follows:

1. Brief introductory discussion on soft skills implied;
2. Case analysis (Why could the accident have happened? What seems to be the major problem? What alternatives might be suggested?);
3. Role-play / simulation "Debriefing";
4. Flowchart "Crucial points of soft skills evidence".

Case studies require flipped classroom approach in which students read cases or maritime accident reports beyond the lesson in order to take enough time for comprehension of the text and the tasks to be discussed at the forthcoming lesson.

Video Review. It is evident that watching videos is an integral part of modern life due to the increasing accessibility of technology. Moreover, it has become a popular teaching method as it provides enthusiasm and satisfaction for students. The video review encourages reasoning, persuasion and problem solving by enabling students to process the obtained information, comprehend issues, and determine optimal solutions, thereby enhancing their understanding of professional concepts, skills and procedures.

The video review method includes several stages. To provide an example, in the course of working on the module "Pilotage" the video review may be organized in the following way:

Video Selection: Choose videos that depict proper and improper examples of interaction between pilots and bridge teams.

Pre-Watch: Before viewing, discuss the importance of clear communication and shared decision-making on the bridge.

Viewing 1: Watch videos without interruptions.

Interactive Elements: Engage students in a discussion about the observed interactions and decisions.

Viewing 2: Watch videos, pausing at key points to let students take necessary notes on important details.

Group Analysis: Divide students into small groups. Assign roles to students (Master, Pilot, OOW, Helmsman, Lookout). Provide each group with specific questions to guide their analysis. Have each group present their analysis to the class.

Assessment: Ask students to evaluate their group performance.

Reflection: Collect feedback and suggestions for improvement.

The video review method ensures comprehensive understanding of video content, encourages active participation, and reinforces soft skills through practical application.

'Thinking Hats'. This learning technique helps realize that each person may normally have differing opinions about the same situation. For a small working community as an onboard crew such circumstances require negotiations to make an appropriate decision. 'Thinking hats' require group discussion and individual thinking the type of which is indicated by different colours of hats: white – informative, red – positive, black – negative, green – creative, yellow – optimistic, blue – conclusive. By seeing a problem from multiple perspectives and resolving it students acquire skills of critical thinking, decision making, negotiation, and persuasion.

'Thinking hats' are used for discussing narrative texts containing a specific problem. Students shall read the text prior to the lesson.

At the lesson students:

1. Choose cards to be arranged in pairs or small groups depending on the size of the group; pairs/groups can have the same colour hats or different ones;
2. Discuss the text from their 'colour' perspective;
3. Share their opinions;
4. Rank the available decisions;
5. Reflect on the process of group work, focusing on students' ability to use reasoning and persuasion.

'Thinking hats' method fosters creativity and helps understand other people's logics. It stimulates critical thinking, generates new ways to solve problems and make decisions by considering risks, benefits, and alternatives in detail. Besides, this brainstorming activity develops students' soft skills in the course of their interaction.

All the methods can be utilized to engage students in language mastering, enhance their collaboration, and create more efficient learning environment to hone soft skills which help build better relations and accomplish shared tasks.

7. Conclusion

Under circumstances of uncertainty when, on the one hand, soft skills need to be developed in order to work more successfully in the modern environment, but on the other hand, there are no approved guidelines or model courses for maritime education institutions, our experience reveals the possibility to integrate their acquisition into Maritime English study programme.

The survey proves the teachers' awareness of soft skills value for seafarers to be successful in their future career. The experience shared illustrates that the process of integrating soft skills is underway, with a variety of teaching techniques being utilized in Maritime English classes.

The Maritime English study programme samples exemplify our approach to meeting the industry demands for soft skills development, ultimately enhancing the quality of education and equipping students to effectively fulfill their professional duties in the challenging conditions of the maritime world.

Implementing the above-mentioned methods and techniques to enhance higher order thinking and motivate students' meaningful interaction, deepening learners' awareness of interpersonal relations are feasible tasks to help students understand the importance and increasing significance of soft skills for their future professional careers.

Among the main tasks planned for the near future is to design Guidance Tool for English teachers. It is meant to describe methods for working with various types of tasks, as specified in the paper, and outline recommendations on assessing the learning outcomes related to soft skills.

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MARITIME EDUCATION: A CRITICAL APPROACH TO BUILD CAPACITY FOR GHG EMISSION REDUCTION IN SHIPPING INDUSTRY

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Abstract: The aim of this study was to bridge the large disparity between the urgent need for education on greenhouse gas (ghg) emission reduction and the current fragmented approach by exploring ghg emission reduction-related maritime education from an integrated perspective. Initially, a detailed analysis of international maritime organization（imo）resolutions and associated documents is conducted to define the key themes of ghg emission reduction-related education. Subsequently, the current educational landscape is evaluated, highlighting both technical and organization gaps in meeting the increasing demand for professionals proficient in ghg emission reduction knowledge and skills. On the basis of the study findings, the primary recommendations are outlined as follows: (1) world maritime institutes play a pivotal role in ghg emission reduction education, which necessitates restructuring their current curricula, enhancing trainer training, and adopting e-learning strategies. (2) the imo should continue to extend its capacity-building efforts to developing and least developed countries, specifically through regional technical cooperation centers established jointly by the imo and relevant maritime institutes.

Keywords: IMO; Maritime education; GHG emission reduction

1.Introduction

In 2023, the IMO upgraded its GHG emission reduction strategy at the 80th session of the Maritime Environment Protection Committee (MEPC). The goal of the upgraded strategy is to realize net-zero carbon emissions by or around 2050 rather than to reduce GHG emissions by at least 70% of the level in 2008 by 2050 (MEPC, 2023). This revised goal represents the IMO's ambitious commitment to GHG emission reduction (ICCT, 2018). Maritime education and training are crucial for effective implementation of the aforementioned strategy. The IMO's *Capacity-Building Decade 2021-2030 Strategy* (A.1166(32)) highlights the importance of nurturing competent professionals equipped with the necessary knowledge and skills to help the IMO's member states to effectively implement and fully comply with the IMO's regulatory maritime standards and instruments (Christodoulou et al., 2021). The resolution of A.1166(32) specifies principles and pathways for enhancing maritime-capacity-building efforts; these pathways involve measures such as close partnerships with maritime universities and training institutions, enhancing local training capacity in a practical manner.

In alignment with the IMO's goals, educational and training activities are conducted by numerous maritime education institutes. However, as highlighted by the resolution of A.1166(32), current maritime education and training have limitations such as "reactive and insufficient prospect analysis, nonthematic and integrated planning, and tactical concerns rather than strategic focus" (IMO, 2021). Moreover, a systematic review of the maritime education literature indicated that only 9 out of 1899 maritime education studies have addressed GHG emission reduction-related topics. This review was conducted using the Web of Science database by employing the following keywords: "maritime" or "seafarer," "education" or "training," and "decarbonization."

Considering the aforementioned background, the present study explored maritime education related to GHG emission reduction from an integrated perspective to bridge the gap between capacity-building requirements and current maritime education. The remainder of this paper is organized as follows. Section 2 provides a detailed analysis of the IMO resolutions and indicates the key themes of GHG emission reduction-related education. Section 3 describes the current maritime educational landscape, highlighting technical and organizational gaps in meeting the increasing demand for professionals with relevant knowledge and skills related to GHG emission reduction. Section 4 details several strategies for enhancing GHG emission reduction-related education. Finally, Section 5 provides the conclusion of this study.

2. Key themes of ghg emission reduction-related education

To address the atmospheric pollution caused by exhaust gases from ships, in 1997 the IMO added a new annex, namely the Prevention of Air Pollution from Ships, to the International Convention for the Prevention of Pollution from Ships (MARPOL), which entered into force in 1983. In particular, in 2012, the Ship Energy Efficiency Management Plan (SEEMP) was introduced through the MEPC.213(63) resolution. This resolution was subsequently amended to create MEPC.282(70) and MEPC.346(78) (MEPC 2022). The SEEMP and its amendments, which focus on the prevention and control of GHG emissions, have introduced energy efficiency indicators such as Energy Efficiency Design Index(EEDI), Energy Efficiency Design Index, Energy Efficiency Existing ship Index(EEXI), and Carbon Intensity Indicator (CII) for measuring the level of carbon emissions; recommended a wide range of GHG emission reduction technologies; and established rating, auditing, and certification procedures for compliance with IMO regulatory standards (Baldi et al., 2022; Polakis et al., 2019). In accordance with the SEEMP, the MEPC 278(70) resolution was adopted at the 70th session of the MEPC. This resolution called for establishment of the IMO Data Collection System (DCS), which requires ships to record and report their fuel oil consumption. The theoretical and actual energy efficiencies of existing ships have been assessed in terms of the EEDI, EEXI, and CII since January 1, 2023, and ships that fail to meet the assessment criteria shall not be certified. (MEPC 2022). Subsequent progress is being shifted from short-term measures aiming to increase ships' energy efficiency to medium- and long-term measures, which can be supported by more widespread usage of market-based measures and advances in alternative energy resources.Figures 1 and 2 depict the time and theme classifications of the typical activities and relevant resolutions, respectively, of the MEPC.

Figure 1. Time and theme categorizations of the MEPC's resolutions pertaining to GHG emission reduction

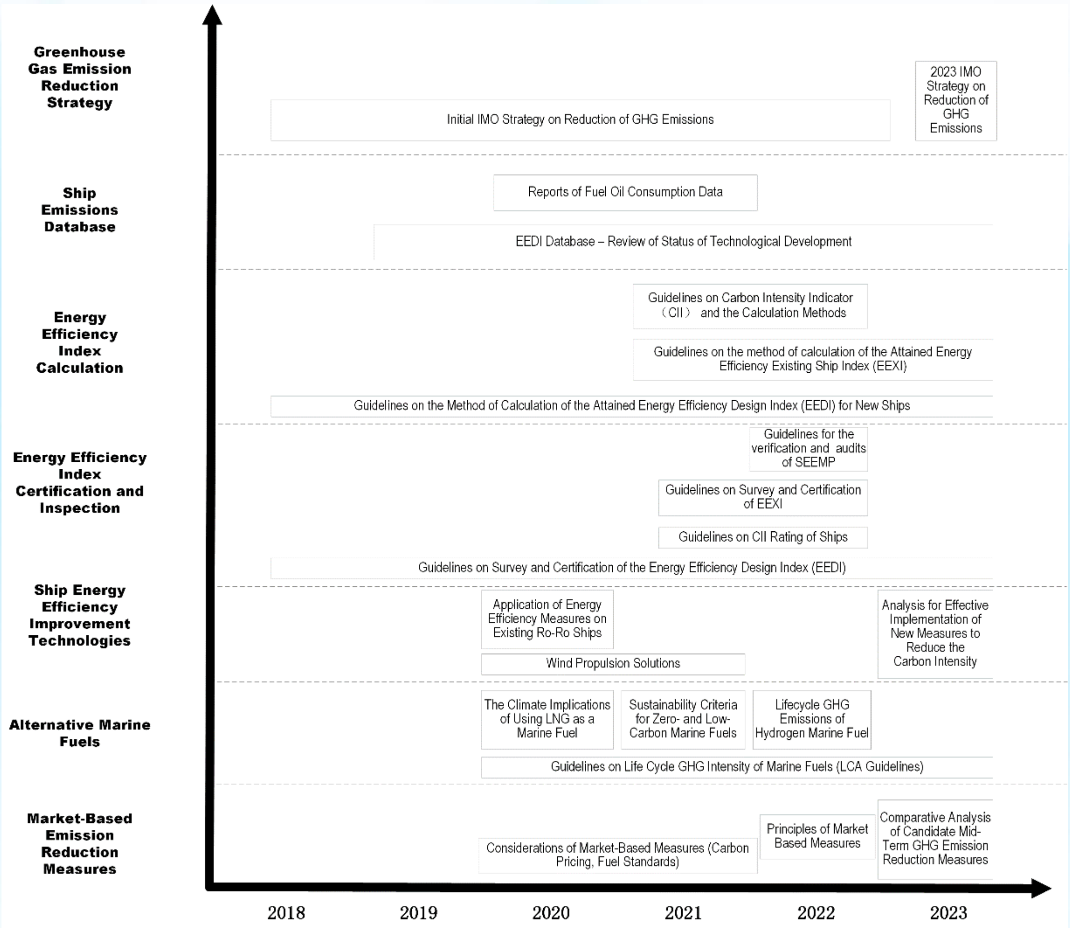

Fig. 2: Time and theme categorizations of the MEPC's activities related to GHG emission reduction (source: compiled by the author on the basis of documents from the 72nd to 80th MEPC meetings

Figures 1 and 2 indicate that the SEEMP and its amendments are the main measures adopted by the MEPC for mitigating GHG emissions from ships. To facilitate implementation of the IMO's resolutions and regulations, several key technical themes must be included in GHG emission reduction-related maritime education and training.

2.1 Monitoring and Estimation of GHG Emissions in the Shipping and Port Sectors

To maintain standards related to the energy efficiency performance of ships, the IMO approved several resolutions and circulars to require ships to report their fuel oil consumption. For instance, the MEPC.278(70) resolution and MEPC.1/Circ.871/Rev.1 circular mandate signatory and nonsignatory states of MARPOL Annex VI, respectively, to report the fuel consumption data of marine vessels in a prescribed format. Moreover, MEPC.349(78) provides guidelines for the development of a fuel oil consumption database for ships.

Relevant personnel must receive appropriate training regarding the collection of fuel consumption data so that they can collect such data accurately. Such training should include extended explanations of the resolution of the IMO DCS and the guidelines applicable in different conditions for the appropriate collection of fuel consumption data. Furthermore, training can be provided for advanced tasks, such as the accurate assessment of various GHG-emission-monitoring technologies and fuel consumption estimation models by using the empirical analysis method and the comprehensive analysis of energy efficiency by using data mining technologies.

2.2 Assessment and Promotion of GHG Emission Reduction Technologies

The IMO has recommended many ship GHG emission reduction technologies through reports, resolutions, and projects, such as the SEEMP [MEPC.282(70)] (MEPC 2022), IMO Energy Efficiency Appraisal Tool (DNV, 2016), GloMEEP Project, and IMO GHG studys (Buhaug et al., 2009; IMO, 2020). In general, technologies for reducing ship GHG emissions can be categorized into two main types: those improving energy efficiency and those improving the energy structure. The first type of technologies can be further classified into those that enhance the efficiency of ships' power equipment, hulls and other equipment, and ship operation and management. Moreover, the new type of energy refer to low- and zero-carbon fuels and alternative energy sources (DNV, 2016; IMO, 2020). Different ship GHG emission reduction technologies have differing technical features, and the effectiveness of their implementation largely depends on the application scenario. The transferability of various ship GHG emission reduction technologies to different scenarios should be considered. In particular, before new energy technologies are adopted, their technical maturity (i.e., technological readiness level) and commercial viability should be analyzed (Foretich et al., 2021).

Therefore, to enhance the understanding regarding the technical and economic features of various shipping GHG emission reduction technologies, especially their applicability and transferability in different scenarios, systematic education and training should be conducted using relevant education materials, such as application guidelines.

2.3 Roadmap of the IMO's GHG Emission Reduction Strategy and Relevant Instruments

The IMO formulated GHG emission reduction strategies in 2018 [MEPC.304(72)] and 2023 [MEPC.377(80)]. Compared with the strategy formulated in 2018, that formulated in 2023 includes upgraded GHG emission reduction goals and increased requirements for the application of zero-emission or near-zero-emission technologies, fuels, and energy sources (MEPC, 2023). Accordingly, a series of resolutions, circulars, and other instruments related to the implementation of the IMO's GHG emission reduction strategy have been introduced. These instruments are mainly based on the SEEMP and its amendments.

Relevant professionals and talent must have sufficient understanding regarding the evolution of the IMO's GHG emission reduction strategy and relevant documents. Such education can be extended to developing professionals' ability to conduct rigorous impact assessments for the effects of IMO's GHG emission reduction efforts on member states; formulate a roadmap for a sustainable, decarbonized future; and apply market-based measures employed by the IMO (MEPC, 2023).

3. Current educational landscape regarding ghg emission reduction

Maritime education is mainly provided by maritime institutes to seafarers and technical and managerial professionals from the shipping industries. Such education can be broadly categorized into three tiers: Degree-level maritime education, Diploma-level maritime education, and maritime training. Degree-level maritime education encompasses undergraduate and graduate maritime education programs. Many major institutions specializing in degree-level maritime education are affiliated with the International Association of Maritime Universities (IAMU). These institutions are often designated maritime universities or maritime academies. Some polytechnical universities also cultivate maritime talent, and a few universities are focused on educating high-end service professionals. Figures 3-1–3-4 depict the various characteristics of maritime institutes affiliated with IAMU.

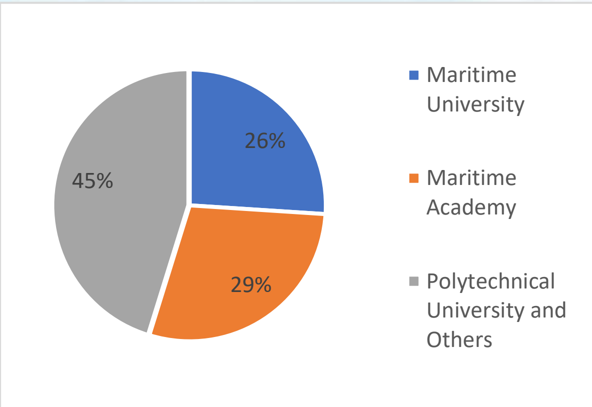

Figure 3-1: Distribution of Maritime Institutes by Type

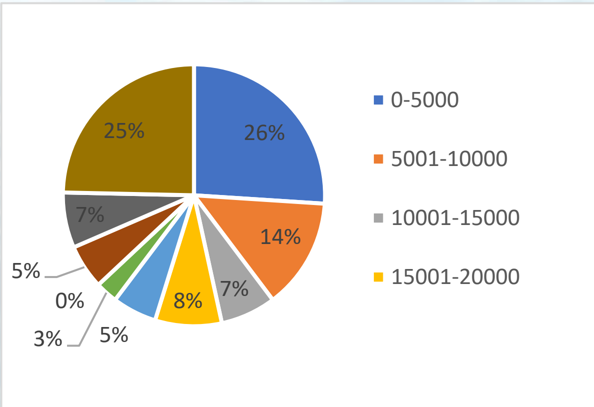

Figure 3-2: Distribution of Maritime Institutes by Student Population

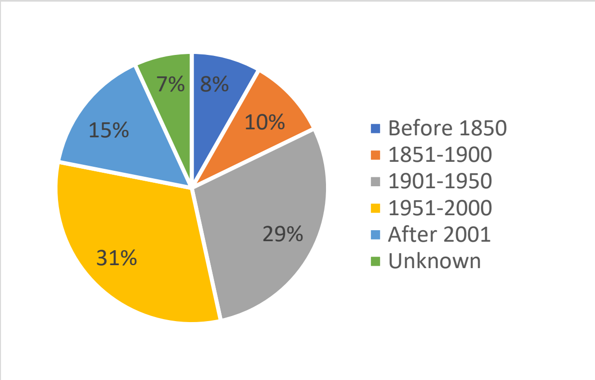

Figure 3-3: Distribution of Maritime Institutes by Year of Establishment

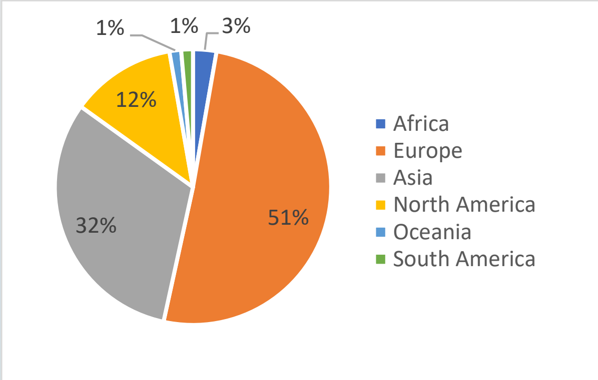

Figure 3-4: Distribution of Maritime Institutes by Region

Diploma-level maritime education involves practical education for careers in the maritime industry focusing on developing specific skills necessary for roles such as deck officer, marine engineer, and maritime technician. These institutes offer diplomas related to navigation, engineering, and management. According to incomplete statistics obtained from edumaritime.net, the number of maritime colleges worldwide is considerably higher than that of degree-level maritime education institutes.

Finally, maritime vocational training refers to the nonacademic education provided by training centers and industry associations, which do not award academic degrees or diplomas but issue relevant certificates. These organizations offer a wide range of tailored and commercially oriented training courses and programs designed to equip individuals with practical skills and knowledge essential for maritime safety, navigation, marine engineering, ship operations, and adherence to maritime regulations. Numerous professional maritime training institutions exist worldwide.

An examination of the curricula of several maritime universities and colleges affiliated to IAMU indicates a gap between the provided maritime knowledge and the maritime knowledge required in the industry. The environmental courses maritime universities and colleges incorporate into their programs mainly encompass the prevention of ship oil pollution, the prevention of ship pollution caused by toxic liquid substances, and ship ballast water management, indicating these courses focus on the water pollution caused by ships rather than the air pollution caused by the GHG emissions of ships. This gap is also observed in the programs of vocational training institutions, which often focus solely on seafarer skill development and offer no training related to the GHG emissions of ships.

Recognizing this gap, the IMO has organized various training courses on the reduction of GHG emissions from ships in the least developed countries and in Small Island Developing States. This effort of the IMO is in line with its commitment to environmental concerns and climate change. However, such training programs primarily target national authorities and policymakers to assist them in the formulation of GHG emission reduction policies and plans. Currently, no systematic, technical, and hands-on training courses focus specifically on the

reduction of GHG emissions from ships. Thus, maritime education institutes must address the pressing need for GHG emission reduction-related education and training.

4. Discussion and Suggestions

4.1 Curriculum Restructuring

The aforementioned discussion indicates that current maritime education programs do not include GHG emission reduction-related education and training. Therefore, the following courses should be included in such programs to overcome the aforementioned gap.

Course 1: Dynamics of the IMO's GHG Emission Reduction Strategies and Instruments

This course aims to provide knowledge pertaining to the GHG emission reduction strategy of the IMO and a series of instruments approved or released by the IMO for mitigating the effect of GHG emissions from the shipping industry. In addition to nurturing students' awareness of the IMO's GHG Emission Reduction Strategy and related instruments, the course will improve their abilities (1) to conduct impact assessments regarding the effects of the IMO's emission reduction efforts on both the shipping industry and member states and (2) to initiate approaches for complying with the IMO's regulatory standards.

Course 2: Monitoring of GHG Emissions from Ships

This course is designed to provide knowledge and skills regarding the management of ships' emissions in a range of scenarios, mainly covering technologies for measuring GHG emissions and in-depth analyses regarding spatial and temporal distributions of GHG emissions. Through this course, students can gain practical skills and abilities related to schematic design, equipment selection, data analysis, and emission estimation.

Course 3: Improvement and Application of Technologies for Reducing Ship GHG Emissions

This course aims to cover the various technologies that can be employed for reducing ships' GHG emissions. By gaining a comprehensive understanding of these technologies—including their technical principles, technical maturity, operational requirements, safety considerations, cost concerns, and regulatory framework—students can acquire knowledge regarding advancements in ships' power equipment, hull efficiency, and operational management as well as alternative fuels such as zero-carbon and renewable energy. Such knowledge can help students effectively assess and adopt GHG emission reduction technologies.

Course 4: Advanced Training on the SEEMP

A comprehensive course on the SEEMP can equip trainees with a thorough understanding of this plan's fundamental objectives and the regulatory landscape shaping its implementation. By exploring topics such as the Ship Fuel Oil Consumption Data Collection Plan and the use of energy efficiency indicators for evaluating ship emissions and the associated administration procedures, trainees can gain knowledge regarding the meticulous methods required for systematic collection and analysis of data and regarding integrated technical methods for optimizing energy efficiency. Moreover, with a focus on ship-specific energy efficiency management plans, trainees can learn how to navigate complex regulatory requirements.

Course 5: Roadmap to GHG Emission Reduction in Shipping and Market-Based Measures

The purpose of this course is to cultivate the ability of students, particularly future maritime administrators and other stakeholders from the shipping and port sectors, to develop tailored GHG emission reduction roadmaps. Through this course, students can obtain the basic skills needed for policy formulation as well as knowledge of multiple market-based GHG emission reduction measures. In particular, this course enables students to address complex GHG emission problems and design the most suitable roadmap for a technology promotion scheme with respect to the characteristics of specific scenarios.

4.2 Implementation of Capacity Building

Because of factors such as political, economic, and technological influences, considerable disparities are observed in the efforts made by different countries to achieve GHG emission reduction in the maritime sector. In particular, the small island developing states and least developed countries are unable to fully implement the requirements and recommendations of the IMO. Therefore, the Capacity-Building Decade 2021-2030 Strategy (A.1166(32)), the IMO suggests that the resources of shipping universities and institutions should be leveraged to help developing countries achieve capacity building for GHG emission reduction. This suggestion represents an opportunity and a challenge for maritime institutes worldwide.

Given the relatively limited quantity of high-level educational resources owned or controlled by the IMO and the loose connection between the maritime education institutes, one suggestion for coordinating international educational resources to conduct GHG emission reduction capacity-building activities involves having the Global Maritime Technology Cooperation Centers Network (GMN) function as a channel for expanding the range of resource usage from other shipping universities and institutions. The GMN, which managed by the IMO, is focused on reducing GHG emissions by enhancing energy efficiency and promoting GHG emission reduction technologies, particularly in developing countries. Under the GMN project, five Maritime Technologies Cooperation Centers (MTCCs) were established worldwide in different shipping universities. For example, MTCC-Asia is hosted by Shanghai Maritime University in China; MTCC-Caribbean is headquartered at the University of Trinidad and Tobago; and MTCC-Latin America is located at the International Maritime University of Panama. MTCCs can be utilized to pool the resources of more maritime institutions for enhancing global capacity-building efforts related to GHG emission reduction of ships. To support the sustainable development of MTCCs, funds and technical, human, and financial resources from the IMO, governments, and the shipping industry can be leveraged to conduct professional education and training activities for reducing GHG emissions from shipping (Canton, 2021).

4.3 Efficient Resource Utilization

Considering the gap between the demand and opportunities for GHG emission reduction-related education worldwide and the limited resources of maritime education institutes, traditional teaching models characterized by in-class teaching should be replaced by teaching models involving online education and training. Rapid developments in information and communication technologies have resulted in the increasing prevalence of online education, especially since the COVID-19 pandemic.

Another method of increasing education resources is to conduct teacher training programs regarding GHG emission reduction in shipping. With the standardization of such training programs in terms of theme, location, time, and participants, the establishment of a sustainable training base in several maritime education institutes like the MTCC-hosted universities with sufficient funds and facilities is highly recommended.

5. Conclusion

The conclusions and recommendations of this study are outlined as follows. First, GHG emission reduction is a critical topic in the shipping industries, and key technical topics for professional development include Monitoring and Estimation of GHG Emissions in the Shipping and Port Sectors, Assessment and Promotion of Emission Reduction Technologies, and Roadmap of the IMO's GHG Emission Reduction Strategy and Market-Based Measures to Address GHG Emissions from Ships. Second, maritime institutes worldwide must play a pivotal role in GHG emission reduction-related education. Current maritime education does not meet the demand and requirement for GHG emission reduction action. Therefore, maritime institutes should restructure their curricula to include topics related to GHG emission reduction, enhance their teacher training programs, and adopt e-learning strategies. Finally, the IMO should continue to conduct capacity-building efforts regarding GHG emission reduction in developing countries, especially the small island developing states and least developed countries, by establishing collaboration ties with suitable maritime institutes like MTCCs.

Acknowledgement

The research is supported by the International Cooperation Project (Grant No.21160710800) of Shanghai Science and Technology Committee; Scientific and Innovative Action Plan of Shanghai (Grant No.23230750300).

The core content of this article has been formulated into an IMO proposal "Proposal for Strengthening the Global Training and Development Network in Pursuit of the International Maritime Organization's Greenhouse Gas Emission Reduction Strategy" and has been submitted accordingly on May 1st, 2024.

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TECHNICAL PROGRESS IN THE MARITIME INDUSTRY AND THE CHALLENGES OF THE VOCATIONAL EDUCATION

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Abstract: The main mission of the higher education institution is to provide training of specialists with the competence, which meets the requirements of the employment market, equipped with the skills to identify and solve professional problems, on the basis of vocational and higher educational programs of modern standards and continuous education training courses. According to the survey "Survey on the requirement of skills by enterprises- 2022" conducted in Georgia, on the question: "What kind of education is the most important/required to carry out work/business in your enterprise?" more than 30% of respondents answered Vocational Education. According to the analysis of the Georgian labor market, the demand for electrical engineering specialists (both engineers and electricians) is very high. This applies to both, shore employment or employment in the maritime infrastructure. Various projects are implemented in the Battumi State Maritime Academy, the purpose of which is to improve the learning environment and introduce new programs. Among them is the projects "Introduction of Mechatronic Systems at Bachelor's, Master's and Vocational Education Levels in the BSMA Educational Programs". This project is financed by the World Bank and the Ministry of Education of Georgia (Georgia I2Q - Innovation, Inclusion and Quality in the framework of the Competitive Innovation Fund (CIF)). The preparation of the programs "Electricity" at the Vocational education level - Basic Vocational and Secondary Vocational qualifications (III and IV level) in electricity for accreditation is included in the project. Graduates of this specialty will be able to acquire skills in the management of mechatronic systems through the Academy laboratories. This grant project also includes conducting of the trainings on the management and operation of mechatronic systems. The article discusses the curriculum of Vocational Education, in which the training course of Basics of electricity and electrical technologies is strengthened with laboratory works of mechatronic system service. It is possible to train a Marine rating Electro-tecnitian by integrating Vocational qualifications in Electricity and the accredited retraining program "Marine rating Electrician" in Georgia. As a result, the Vocational Center of the BSM Academy will be able to train specialists on demand of the employment market, for both fields: shore and marine infrastructure.

Keywords: vocational education, electricity, mechatronic system.

1. Introduction

Raising the employment rate is one of the important challenges of the Georgian economy and it is the main priority of the country's economic policy. According to the "Research on Enterprise Demand for Skills - 2022" [1], vocational education is important nowadays and there is a high demand for specialists with relevant skills and knowledge (Analysis of the Georgian labor market [2]).

The demand for electricians having vocational education is increased is caused due to the rising the degree of automation of the equipment used in the energy, marine, construction, household and industrial sectors.

According to the survey related to the necessity of the personnel with the most required vocational qualifications in the Adjara region [3], 2/3 of the respondents named a highly qualified electricians. There are 4 vocational educational institutions in Adjara, and only two institutions offer electrician programs, which cannot meet the demand of the today's labor market. Taking into account the above mentioned, introducing a new vocational educational program - "Electricity" with basic and secondary qualifications - will contribute to solve the employment problems in the region.

2. Main text

The current educational programs of the Batumi State Maritime Academy, in accordance with the level of education (Bachelor's and Master's, as well as Vocational in the maritime field), discuss the issues of management, service, assembly/operation and planning of automated systems. Appropriate laboratories are functioning at the institution, where practical and research works can be carried out. From August 18, 2023, Batumi State Maritime Academy is implementing the grant project "Implementation of Mechatronic Systems Education at Bachelor's, Master's and Vocational Education Levels at the Batumi State Maritime Academy's Educational Programs", which is financed by the World Bank and the Ministry of Education of Georgia (Georgia I2Q - Innovation, Inclusivity and Quality of the Competitive Innovation Fund (CIF) framework).

The main goal of the grant project is to purchase an integrated laboratory stand that can be used for carrying out electromechanical, electropneumatic, electrohydraulic exercises. Laboratory works should include tasks on the topic of assembly and operating of circuits containing programmable logic controllers and assembly and testing of mechatronic systems (electromechanical, electrohydraulic and electropneumatic) nodes. Also, the project includes the preparation of "Electricity" programs for accreditation at the level of Vocational education - basic Vocational and secondary Vocational qualification (III and IV level) in electricity.

Basic Vocational Qualification in Electricity includes 4 general modules with a total of 10 ECTS credits, 4 general vocational modules with a total of 14 ECTS credits, 6 compulsory Vocational modules with a total of 28 ECTS credits. To be awarded a basic professional qualification in electricity, a person must accumulate 52 ECTS credits. Basic education (grade 9 education) is a prerequisite for admission to basic professional qualification. The holder of the basic vocational qualification in electricity can be employed in any organization as a service person for electrical installations and other electrical equipment: as an electrician; as an installer of electrotechnical systems; as a building electrician; as a supplier-electrician; as an electromechanic; as an installer of electrical wiring and fittings; as an installer of lighting systems; as a fire alarm installer; as an installer of security alarms; as an installer of street lighting and electrical signaling devices; as an installer of runway lighting and solar energy collectors.

Vocational educational program "Electricity" at the level of basic vocational qualification provides the teaching of such vocational modules as: electrical and electronic principles, electrical technology, properties and use of electrical machines, health and safety in electricity, electrical installation, engineering project. The issues discussed in all study modules correspond to the level of education determined by the prerequisites for admission to the program. The results of studying vocational modules are designed to develop such skills as: measuring and calculating the parameters of electric and magnetic circuits, selecting materials for electric circuits taking into account the installation environment, performing on-off and control operations of electric machines, assessing electrical hazards, installing lighting and grounding systems.

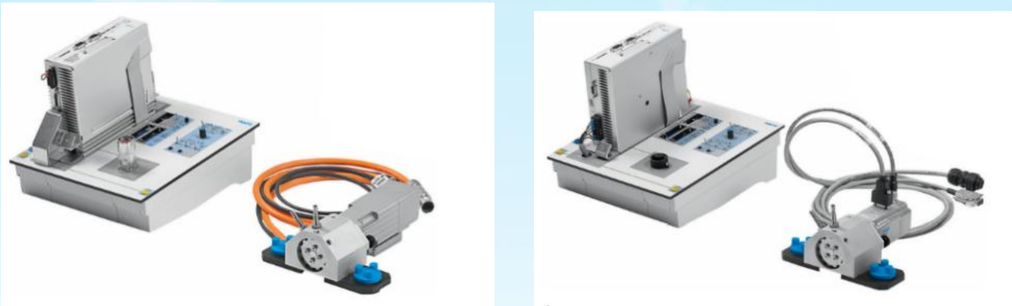
The secondary vocational qualification in electricity includes: 4 general modules with a total of 11 ECTS credits, 4 general vocational modules in the amount of 14 ECTS credits, 9 compulsory vocational modules in the amount of 45 ECTS credits in total. To be awarded a secondary vocational qualification in electricity, a person must accumulate 70 ECTS credits. Prerequisites for admission to the program are: complete general education; basic general education – if the secondary vocational educational program integrates the results of the secondary level of general education.

A holder of a secondary vocational qualification in electricity can be employed in any organization that owns or operates sub-stations and high-voltage power transmission cables, he/she can perform: operation of power transmission systems from the power station to the distribution system; operation of distribution systems (electrical cables, poles, meters) that deliver electricity from power plants, sub-stations to the user. Employment positions can be: fitter; assistant fitter and specialist in power transmission systems.

The vocational educational program "Electricity" at the level of secondary vocational qualifications provides teaching of such vocational modules as: electrotechnical materials, electrical functions and analysis, safety in high voltage electricity, construction and maintenance of high voltage power cables, installation, diagnostics and service of sub-stations, programming of programmable logic controllers.

The learning outcomes of the modules are designed to develop such skills as: correct use of electrotechnical materials, compliance with electrical and fire safety rules, proper use of electrical measuring tools, installation and maintenance of overhead and cable lines (including high voltage transmission cables), installation of power, lighting and weak current systems, configuration/programming of control systems, hardware installation of programmable logic controllers.

Various projects are functioning at the BSMA, the aim of the projects is to improve the learning environment and introduction of new programs. One of these projects is "Introduction of Mechatronic Systems at Bachelor's, Master's and Vocational Education Levels in BSMA Educational Programs", which is financed by the World Bank and the Ministry of Education of Georgia (Georgia I2Q - Innovation, Inclusion and Quality in the framework of the Competitive Innovation Fund (CIF)). The project includes the preparation of programs "Electricity" at the level of professional education - basic professional and secondary Vocational qualification (III and IV level) in electricity for accreditation. The program developed by BSMA fully includes the educational modules provided by the framework document of the Vocational educational program "Electricity", and the institution has the means to achieve the results written in the program (laboratories, workshops, installation tools and materials).



a b

Figure 1. Motors with software control. a - the servo motor system, b - the stepper motor system

In the laboratory purchased by the grant project, students will have the opportunity to master the skills of assembling/adjusting programmable systems. Taking into account the level of study, in Vocational modules it is possible to carry out such laboratory work as: software management of actuator motors / servo motors, which is carried out on the TP 1421 servo drive stand (Fig. 1a.), on the TP 1422 pitch servo drive stand (Fig. 1.b.) [5], [6].

Also, on the MPS stand (Fig. 2) for software control of liquid transfer, it is possible to perform various types of work, such as: parameter measurement, implementation of control with an open and closed system in minimal space - control of liquid level and transfer speed with P proportional, I integral and PI proportional-integral regulators.

Figure 2. liquid pumping control MPS station

After completing the vocational program "Electricity" of basic and secondary qualifications, the applicant will be able to gain skills in operation of mechatronic systems on the basis of the laboratories of BS Academy. They can also be trained in mechatronic systems, which is determined by the grant project.

Also, after completing the vocational program "Electricity" (basic/ secondary level), the applicant will be able to take the retraining program "Ship's Electro Technician" accredited by the Maritime Agency of Georgia. BSM Academy has obtained the right to implement the retraining program [4], the prerequisite for admission to which is:

- Basic vocational or equivalent qualifications in electrical engineering and/or;
- Secondary vocational or equivalent qualifications in electrical engineering;

and/or

- Qualifications of Electrician of the second and third levels according to the legislation of Georgia;

and/or

- Qualification in electrical engineering awarded by the Law on Higher Education of Georgia.

Based on the above mentioned, after obtaining the basic or secondary vocational qualifications, the applicant has the opportunity to take training program "Ship's rating Electrician" at the BSM Academy, which ensures the development of skills determined by Part A-III/7 of the International STCW Convention and Regulation III/7.

The purpose of the retraining program is to ensure the training of a rating electro technician for the international maritime transport field (cargo and passenger) in accordance with the current legislation of Georgia and international requirements.

3. Conclusion

Vocational educational training program “Electricity”, in which the training courses: the principles of electricity and electrical technologies are reinforced with laboratory works maintaining programmable systems (mechatronic system), gives opportunity to prepare well-qualified personnel. It is possible to train a ship's rating electro technician by integrating vocational qualifications in electrical engineering and the accredited retraining program "Ship's electro-technition" in Georgia.

As a result, the Vocational training center of the BSM Academy will be able to train specialists in demand of the employment market, for both shore and marine infrastructure.

Acknowledgements

The introduction of a new vocational education program is provided by the grant project "Introduction of Mechatronic Systems at Bachelor's, Master's and Vocational Education Levels in the BSMA Educational Programs", which is financed by the World Bank and the Ministry of Education of Georgia (Georgia I2Q - Innovation, Inclusion and Quality within the framework of the Competitive Innovation Fund (CIF)).

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SYSTEM DYNAMICS MODELING FOR ADDRESSING PORT CONGESTION IN GLOBAL TRADE

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Abstract: Maritime transportation, responsible for approximately 90% of global cargo movement, is acknowledged as a vital mechanism integrating port, cargo, and vessel elements to sustain the dynamics of global commerce and uphold the resilience of supply chains. However, Port congestion represents a significant challenge in the field of international supply chain management and defined as a maritime transportation issue that has a negative impact on economic stability and operational efficiency on a global scale. The primary objective of this study is to investigate the complex interactions and feedback loops that contribute to port congestion by utilizing system dynamics modeling. Therefore, a model that provides a comprehensive overview of the port structure including vessel turnaround time, vessel traffic, storage capacity, freight volume, documentation procedures and government policies is developed. The paper concludes with findings and suggestions that contribute to the academic literature by illustrating the application of the system dynamics approach in the context of port congestion. Furthermore, it offers a practical framework for decision-makers aiming to optimize port operations and enhance global supply chain resilience.

Keywords: port congestion, system dynamics modeling, supply chain management

1. Introduction

The maritime industry is a fundamental component of global trade and economic development, serving as a conduit for market connectivity, international commerce facilitation, and economic growth. However, the intricate nature of this sector poses considerable challenges in analyzing, understanding, and predicting its functions, behavior, and performance (Stopford 2008). The industry's significance extends beyond the mere transportation of goods. It encompasses a wide range of activities, including shipping, shipbuilding, port operations, and related services, which collectively contribute to global trade (Fratila et al. 2021). The International Maritime Organization (IMO) is the principal regulatory body governing the vast maritime industry, responsible for the assurance of maritime safety, the protection of the marine environment, the promotion of efficient maritime operations, the enhancement of maritime security, and the standardization of maritime practices (Knudsen and Hassler 2011).

Ports represent a crucial node in the global supply chain, facilitating the movement of goods between sea and land. Port operations encompass a multitude of activities, including terminal management, cargo handling, environmental sustainability and operational efficiency. These are indispensable for the expedient movement of goods and passengers (Moon and Woo 2014). Effective terminal management is of critical importance for the optimal functioning of port operations. As Cullinane and Wang (2006) state, the operational efficiency of terminals can be gauged by examining factors such as throughput, berth productivity, and equipment utilization. On the other hand, Dinwoodie et al. (2012) emphasize the implementation of sustainable practices in cargo operations with the objective of reducing environmental impacts, including emissions and noise pollution. Tongzon (1989) asserts that the efficiency of a port is of paramount importance for the attainment of competitive advantages. This is demonstrated by the provision of services that meet the expectations of shipowners and customers. Furthermore, it is a matter of fact that port congestion represents a significant factor to be considered when evaluating port performance (Bolat et al. 2020, Ayaz and Bucak 2024).

Port congestion results in delays to the transportation of goods, which has the potential to have a significant impact on a range of stakeholders involved in the energy supply chain. These include exporters, importers, carriers, suppliers, port operators, and many others (Bai et al. 2024). In the existing literature, port congestion is typically defined in terms of the waiting time required for vessels to berth; however, there are also studies which consider additional concerns such as the congestion of berths, work areas, vehicle gates, entry/exit routes, and cargo stacking areas (Gidado 2015). In addition to the above classification, congestion within ports can be further subdivided into three categories, which encompass the main areas of the port where congestion occurs: seaside, landside, and hinterland-side congestion (Eddrgash 2022).

Port congestion can arise from a variety of causes, whether periodic or momentary. A multitude of factors can give rise to port congestion, including port infrastructure, government policies, failure to keep pace with technological advances, labor issues, an excess of demand for port services, strikes, epidemics, a lack of allocated space or stock, adverse weather conditions, war, limited port access, a lack of cargo handling equipment, hinterland planning and port location (Nze and Onyemechi 2018). Researchers have employed a variety of methodologies to quantify port congestion. Yeo et al. (2007) quantified the extent of port congestion by calculating the number of vessels waiting to berth, along with the interval between their respective arrivals and the commencement of their respective servicing on the berth. Leachman and Jula (2011) computed container flow times through ports to provide an indication of the extent of port congestion. The databases employed in these studies are typically sourced from port authorities, and thus their findings cannot be extrapolated or compared on a global scale (Peng et al. 2023).

The direct consequences of port congestion are the queuing of vessels and an increase in waiting times. Furthermore, congestion in ports has a notable influence on the expenses associated with transportation, including the value of time, the consumption of fuel and the costs incurred due to congestion. Time loss represents the most significant contributor to congestion costs. Ship owners and charterers aim to accurately predict the waiting time at the outset of a shipping activity to reduce chartering costs and mitigate waiting losses by selecting alternative berths or ports (Meng et al. 2023). To mitigate the consequences of port congestion, a number of strategies have been developed in the literature. These include the investment in port expansion and modernization, the utilization of optimization models designed to improve berth scheduling, and the implementation of advanced technologies in cargo handling equipment and operations (Oruwari 2021). However, in consideration of the matter of port congestion, it is important to acknowledge the distinctive characteristics of each port, which may vary considerably from one port to another (Gidado 2015).

In the light of above, this study aims to examine the intricate interactions and feedback loops that contribute to port congestion via system dynamics modeling approach. This paper is divided into four chapters. The first chapter presents the motivation for the study and provides a brief introduction regarding port congestion. The second chapter introduces the methodology employed in the study. The third chapter presents the application of the methodology and the results. The final section provides a conclusion and contribution of the study.

2. System Dynamics (SD) Modeling Approach

This section provides a detailed explanation of the System Dynamics (SD) approach to modeling port congestion.

The System Dynamics (SD) approach, developed by Jay W. Forrester, is a robust methodology for comprehending, designing, and overseeing intricate systems. SD employs stocks, flows, time delays, and internal feedback loops to encapsulate the non-linear behavior of systems (Forrester 2007). The system is based on the behavior of closed loops and stocks or dynamic variables that can be intervened upon at any time from the outside. The stocks in the system dynamics, the dynamic variables and the connections that facilitate interaction between the system elements enable comprehension of the interrelationships between the system and its elements, as well as the extent to which a change in a variable within the system affects another variable within the same system (Bala et al. 2017).

In the extant literature, a variety of different approaches to SD modeling, each comprising a distinct set of steps. In this study, the six-stage SD modeling approach developed by Martinez-Moyano and Richardsson (2013) is employed.

Step 1. Problem identification and definition

The initial stage of the SD modeling process entails the precise delineation of the issue to be addressed, the identification of the pivotal variables and stakeholders, and the definition of the temporal and spatial boundaries of the model.

Step 2. System conceptualization

The conceptualization stage of the SD modeling process is comprised of three key elements. Firstly, a conceptual model of the system must be developed. Secondly, feedback loops, stocks, flows and delays must be identified. Thirdly, a causal loop diagram (CLD) must be constructed in order to visualize the relationships between variables.

Step 3. Model formulation

The process of formulating a SD modeling approach consists of the translation of the conceptual model into a quantitative simulation model, the definition of the mathematical relationships and equations that govern the system, and the specification of initial conditions, parameters, and constants.

Step 4. Model testing and simulation

This step of the SD modeling approach encompasses the following processes.

- The model is executed using system dynamics software, such as Vensim, Stella or AnyLogic.
- Simulations are run to observe the behavior of the system over time.
- Different scenarios and policies are tested to ascertain their impact on the system.
- The model output is compared with real-world data to ensure accuracy.
- The structure of the model, the underlying assumptions, and the resulting outcomes are documented.

Step 5. Implementation and dissemination

At the implementation stage of the SD modeling process, the recommended policies and interventions are executed in the real world. The system's response to these changes is monitored, and the model is updated with new data and insights as they become available.

Step 6. Design of the learning strategy

The ultimate phase of the SD modeling process involves a perpetual process of learning from the system's behavior and feedback from stakeholders, with a view to adapting to evolving circumstances and emerging challenges.

These steps offer a systematic methodology for comprehending and influencing intricate systems, thereby enabling well-informed decision-making and efficacious problem-solving. Moreover, Martinez-Moyano and Richardsson (2013) augmented the system with two additional characters to enhance the SD modeling approach's intelligibility. These are the understanding of the model and the understanding of the problem and the system in Figure 1.

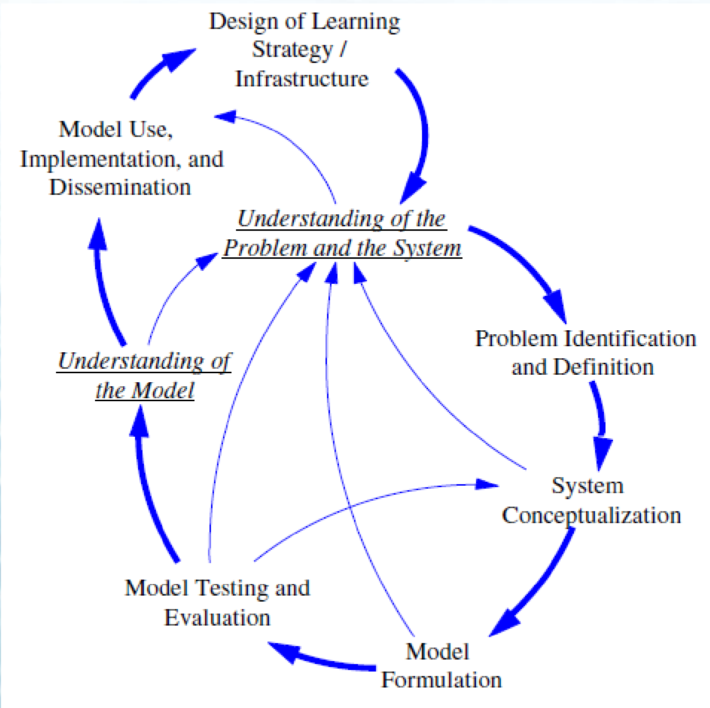

Figure 1. Overview of the SD modeling approach (Martinez-Moyano and Richardsson 2013).

3. Application of SD Approach for Port Congestion

3.1 Data Acquisition and Determination of Factors

The present study employs a SD modeling approach to identify the factors that cause port congestion, examine the complex interactions and feedback loops among these factors and develop new strategies. The data utilized in the analyses were collated through a process of expert consultation, an extensive literature review on the subject, and the analysis of port reports and case studies. This will facilitate a comprehensive examination of the extant knowledge regarding the factors contributing to port congestion. In this paper, eight experts were selected to evaluate the information obtained from a systematic literature review and reliable port documentation in accordance with the SD modeling approach. The expert profiles comprise three technical managers, three operations managers and two planning managers, all of whom possess considerable experience in port management in accordance with national and international conventions at different terminal types.

During the model design process, three-stage meetings were conducted with the eight experts involved in the research project. In the initial stage, the brainstorming stage, the objective of the research and the SD modeling approach were presented to the experts, the data obtained from the literature review and port reports were presented, and the experts were invited to express their opinions. The meeting concluded with a list of the findings on the underlying causes of port congestion. In the second stage, the clustering of ideas, the factors were grouped into clusters. In the final stage, the model design stage, models of port congestion are proposed through an evaluation of the interactions among all the agreed-upon factors.

The five key factors and their associated sub-factors, as identified through expert consultation, an extensive review of relevant literature and an analysis of port documentation, are presented in Table 1.

Table 1. Factors and sub-factors for port congestion.

Factors	Definition
Infrastructure Limitations	- insufficient berthing space and handling capacity - limited cargo handling equipment - poor road and rail connections - lack of adequate storage facilities
Insufficient Port Operations and Management	- poor management practices - inadequate coordination among port stakeholders - insufficient terminal planning and scheduling processes - insufficient workforce / labor management and training - lack of automation and technology integration - prolonged bunkering, provisioning, or maintenance activities - poor scheduling of vessel arrivals and departures
Regulatory Issues, Procedures and Policies	- complex customs clearance processes - bureaucratic processes and paperwork - delays due to port policy implementation - national and international regulations affecting port operations - insufficient inspection process (e.g. Flag State, PSC)
Trade Intensity Changes	- seasonal peaks - economic growth - fluctuations in the exchange rate - trade disputes and tariffs
External Factors	- weather conditions - system failures - cybersecurity threads - strike-lockout - supply chain disruptions

3.2 Model Design

The factors that trigger port congestion, obtained as a result of the comprehensive study described in the data collection section, are included in the model design as dependent or independent variables. This model is based on the following assumptions and settings. (1) The loading and unloading processes in the port are designed in two distinct phases: Seaside and Landside. The Seaside phase encompasses the activities occurring between the ship and the storage area, whereas the Landside phase encompasses the area between the storage area and the port gate. (2) Time Delay variables are integrated into the model to form intermediate variables or loops. In this context, the model framework and model flow diagram are shown in Figure 2 and Figure 3.

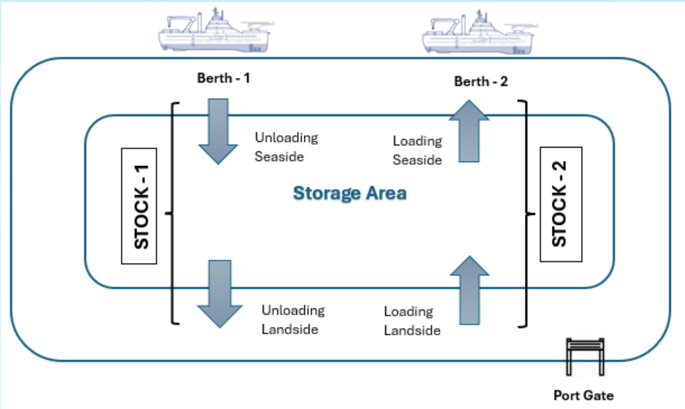

Figure 2. Model Framework.

In accordance with the stipulations set forth by Lin et al. (2022) and this study, the following equation can be derived for the congestion index. The remaining variables in the model are to be evaluated on the basis of the specific operational processes, requirements and procedures of the various terminal types.

$$\text{Congestion index} = \text{Loading rate} / (\text{Loading rate} + \text{Unloading rate}) \tag{1}$$

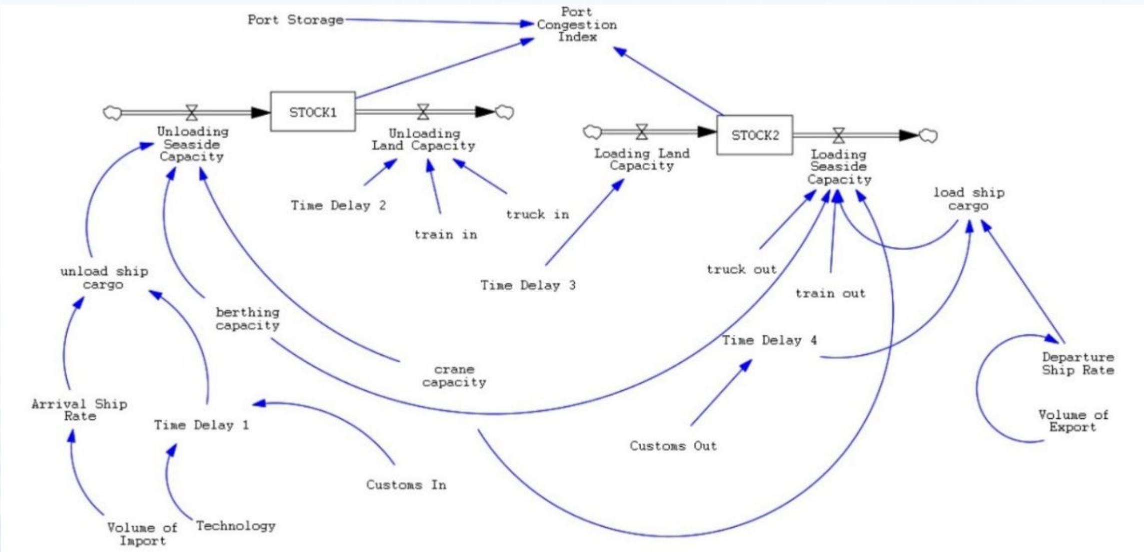

Figure 3. SD Model Flow Diagram

4. Conclusion

Port congestion represents a pervasive and complex challenge within the global supply chain, exerting far-reaching impacts that extend beyond the immediate sphere of maritime logistics and into the broader economic and geopolitical landscapes. The intricacies of port congestion not only disrupt the flow of goods but also contribute to delays, increased costs, and inefficiencies that ripple across various sectors, thereby affecting global trade and economic stability.

This study examines the potential of advanced, dynamic, data-driven modeling techniques in addressing the multifaceted issue of port congestion. System dynamics, as a methodological framework, allows for the simulation of complex interactions within the supply chain, thereby enabling stakeholders to anticipate potential bottlenecks and optimize logistics operations in real-time. By employing a system dynamics modeling technique, the research aims to offer a comprehensive understanding of the underlying factors contributing to congestion and to propose actionable approaches that could mitigate its effects. In this context, the key factors and their associated sub-factors causing port congestion are identified through a process of expert consultation, a comprehensive review of relevant literature and an analysis of port documentation. These findings are then used to develop a modelling framework and flow diagram illustration using the system dynamics approach.

Furthermore, the study recognizes the accelerated evolution of global trade and transportation networks, which requires the continual refinement and adaptation of these models. As trade routes, shipping volumes and logistical infrastructures undergo substantial transformations, the models employed to predict and manage port congestion must also be dynamic.

In order to ensure the continued relevance and efficacy of these models in future studies, it is proposed that the outputs of this study be linked with the following strategies.

- Testing different variable integrations by considering the port congestion factors proposed in our study.

- Designing novel models that consider the specific requirements and operational procedures of different types of terminals.

Additionally, it would be beneficial for future studies to concentrate on the integration of more extensive data sets, the investigation of the influence of emerging technologies such as AI and the Internet of Things (IoT), and the examination of environmental factors such as climate change and sustainability initiatives.

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DEVELOPING MARINE ENGINEERING TECHNOLOGY CURRICULUM TO MEET FUTURE WORKFORCE NEEDS

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Abstract: Ninety percent of all goods are traded through oceans, and a significant portion of the world's food and energy security depends on ocean-related activities. This growth in worldwide trade and associated developments in marine propulsion and navigational technologies have necessitated improved crews' skills and capabilities (Stuchtey, 2020). Over the past few decades, electrical and electronics systems on seagoing ships have become highly sophisticated. The efficient operation of modern vessels depends upon the operation and maintenance of electrical and electronic equipment. The country's Marine Engineering and Technology programs must prepare for this shift toward ship automation. Simulation software programs offer a cost-effective way to provide training in a classroom, followed by hands-on experience on a vessel. This article discusses developing and implementing two new Minors, Marine Electro-Technology and Marine Engineering Technology, and the development of an engine room simulation laboratory, including a high voltage trainer, at Texas A&M University at Galveston to develop the future workforce for the marine industry.

Keywords: Marine Engineering Technology; Curriculum Development; ETO program, Simulation, and Minor

1. Introduction

Today's ships are highly automated, so there is an increasing demand for marine electrical engineers in the workforce. Over the last few years, electrical systems on seagoing ships have undergone significant development and change. In addition, the complexity and number of electrical and electronic equipment have greatly expanded (Axel, 2021).

The World Bank defines the blue economy as "the sustainable use of ocean resources for economic growth, enhanced livelihoods, jobs, and the health of ocean ecosystems"(World Bank, 2017). The global blue economy is expected to double in size to $3 trillion by 2030, according to an analysis by the Organization for Economic Co-operation and Development (OECD). This growth will be driven by solid expansion in new industries like alternative energy, the digitalization and automation of port and transportation operations, food security, and coastal resilience. From 2014 to 2018, the economic activity in American seaports alone increased by 17% to $5.4 trillion, accounting for about 26% of the country's $20.5 trillion gross domestic product (GDP). The demand for marine engineers is also expected to grow since the existing vessels must be retrofitted to comply with new pollution and emission standards regulations.

In light of these developments, The International Maritime Organization (IMO) amended STCW 95 (also known as the Manila Amendment) on June 25, 2010, to introduce the certified position of Electro-Technical Officer in place of Electrical Officers. This was enacted to make modern electrical engineers competent to understand emerging, more complex, sophisticated electrical systems (Mindykowski, 2017). An Electro-Technical Officer (ETO) is defined as a licensed member of the engine department of a merchant or passenger ship and is in a critical position in the technical hierarchy of modern vessels with automated and conventional electrical and electronic systems (Maritime Training & Education, 2021). Under the direction of the Chief Engineer, Electro-Technical Officers are responsible for monitoring and repairing the ship's electrical and electronic equipment to ensure that it is operating as safely and efficiently as possible (Maritime Training & Education, 2021). To prepare the future workforce for Blue Economy, the Marine Engineering Technology Department at Texas A&M University has decided to develop two minors and a state-of-the-art engine room simulator laboratory. ETO program to address industry needs. The first minor in Marine Engineering Technology is designed to increase awareness about marine engineering careers, and the second minor in Marine Electro-Technology is designed to provide foundational courses so students can obtain an ETR rating upon graduation.

2. Future Industry Needs and ETO Program

The workforce will need to grow in tandem with the growth of the U.S. blue economy to satisfy the demands of new technologies and disciplines. With the rising use of automation on ships and shipping terminals, it is projected that skilled people would be required to support this expansion. The following five technological advancements are driven by global trade growth and climate change's escalating effects: 1. Artificial intelligence 2. Sensor technology 3. Robotics and 3D printing 4. Big data and IoT 5. Autonomous control 6. Augmented reality 7. Ship propulsion systems 8. Advanced materials (Dominica Maritime Administration (2020), (Technology & Advancements, 2020).

The advancements in intelligent, highly automated, and autonomous ships stand out among the aforementioned eight growth areas. The rising usage of intelligent systems for ship management, operation, and propulsion exemplifies this trend. The U.S. Coast Guard is expected to adopt his approach soon and mandate that an ETO man all ships in U.S. waters. No higher education institutions, not even the seven maritime academies in the U.S., currently provide a degree or a training course for Electro-Technical Officers.

In the future, the Marine Engineering Technology department at the Galveston campus of Texas A&M University plans to develop a new program in collaboration with the Multidisciplinary Engineering Technology Program from the main campus in College Station.

3. Institution

Texas A&M University at Galveston, an ocean-focused branch campus of Texas A&M University, educates early 2,300 undergraduate and graduate students in a diverse range of marine and maritime programs, including majors in science, business, engineering, liberal arts, and transportation. With almost $10 million in research expenditures, it is an essential part of Texas A&M's unusual land-, sea-, and space-grant mission and is promoting the growth of the blue economy in the Gulf Coast Region.

The Texas A&M Marine Academy, one of seven in the nation and the only academy incorporated into a Tier 1 academic institution is located at Texas A&M-Galveston and prepares more than 400 cadets yearly for maritime duty and employment worldwide. Texas A&M-Galveston is ideally situated in Galveston, Texas, on the Gulf Coast, surrounded by the industry, environment, and programs necessary to carry out its unique mission. Aggies are renowned for their steadfast devotion to one another's success and desire to give back.

4. Pathways to ETO Endorsement

Figure 1 shows the pathways to ETO jobs for the MARE program graduates. The targeted population will include transfer students from area community colleges and first-year students entering both Galveston and College Station campuses.

5. Development of a Minor in Marine Engineering Technology

The growth of autonomous vessels and the increased presence of automation has impacted the Merchant Marine. As leaders in maritime education, we at Texas A&M are ready to meet the needs of ship owners and maritime employers. The MARE department has begun two separate minors to meet this demand, which, according to the Bureau of Labor Statistics, economic projections point to a need for approximately 1 million more STEM professionals than the U.S. will produce at the current rate by 2025 (IMO, 20214).

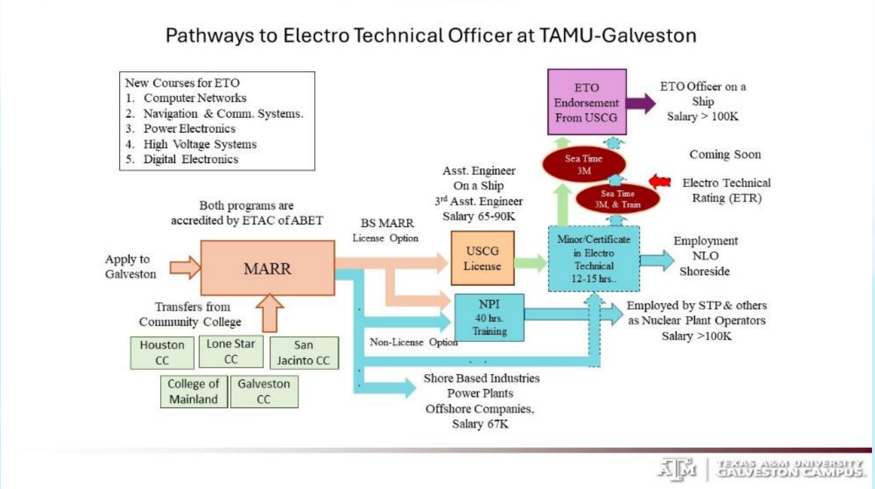

Figure 1. Curriculum Development for ETO program and its impact

Our MARE minor addresses the need by offering Maritime business and other engineering majors the opportunity to understand ship engine capabilities and operational requirements. This minor program, once USCG approves it, will allow the student to test for their Designated Duty Engineer Coast Guard Certification, allowing them to work on smaller vessels such as tugboats and river barges. This curriculum includes the MARE 200 course, where the student will spend 60-75 days as a cadet on the training vessel, participating in class, standing watch, and performing maintenance. This experience will allow the students to apply the theoretical engineering lessons learned to onboard vessels' practical skills. The classes for the MARE minor are listed below in Table 1.

Table 1. Marine Engineering Technology Minor Courses

Marine Engineering Technology Minor Courses	Credit Hours
MARE 100: Marine Engineering Fundamentals	3
MARE 103: Basic Safety and Lifeboatman Training	3
MARE 200: Basic Operations	4
MARE 401: Marine Auxiliary Systems	3
MARE 377: Engineering Risk Management in Maritime Construction and Shipbuilding -or- MARE 441: Engineering Economics and Project Management	3
Total Credit Hours	16

6. Development of a Minor in Marine Electro-Technology

The Marine Electro-Technology minor will introduce students to the cutting-edge technology now on vessels. Digital electronics will be covered with advanced topics in High Voltage operations, Battery Power supply management, and shipboard automation. Upon USCG approval, the student will graduate with an Electro-Technical Rating (ETR) and, with additional sea-time, will be allowed to test for their Electro-Technical Officer Endorsement. As ships become more automated and move to alternative propulsion to decarbonize, electrical expertise will be critical onboard the vessel. This minor will allow our students to fill the need in the modern merchant marine. This minor is not limited to our License Option students; we are encouraging all of our students to enroll, as the knowledge can be applicable in Port Engineer or Maintenance Mange positions. The Marine Electro-technology courses are listed below in Table 2.

Table 2. Marine Electro-Technology Minor Courses

Marine Electro-Technology Minor Courses	Credit Hours
MARE 235: Digital Fundamentals for Marine Engineers	3
MARE 325: Shipboard Networking Systems	3
MARE 335: Power Electronics for Shipboard Applications	3
MARE 345: High Voltage Technology for Marine Engineers	3
MARE 445: Marine Navigation Systems	3
Total Credit Hours	15

7. Simulation as a Training Tool

Simulation-based learning facilitates experiential learning by allowing students to make time-based decisions with repercussions from errors in a controlled environment. This will enable students to grow their skills and knowledge, leading to a deeper understanding of their practice. Simulation-based education has proven more effective than lectures and workshops in student engagement and knowledge retention (Torpey, 2018).

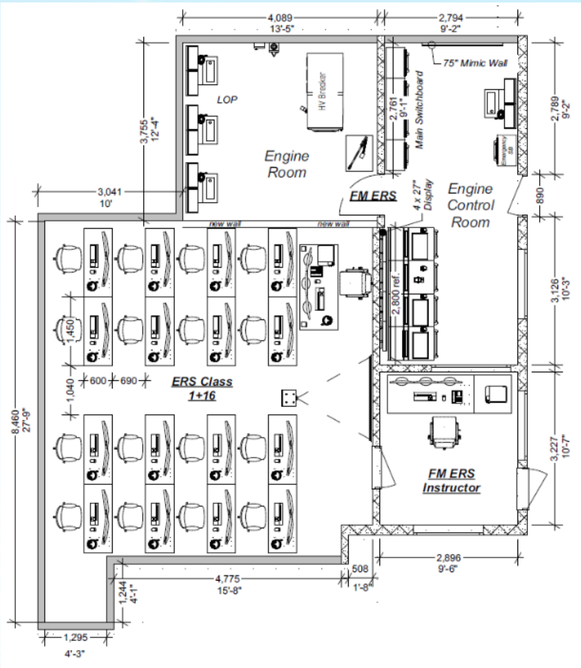

Figure 2. TAMUG MARE ERS1 and ERS 2 Layout

The maritime training and education complex adopted simulation, as required by the International Maritime Organization (IMO), following the example of Crew Resource Management Training in the Federal Aviation Administration (FAA). The guidelines developed by IMO made simulation training necessary for bridge officers for human element training (Ranchodd, 2014). However, engine room simulation was still held back based on limitations of simulation design as recommended implementation.

In the meantime, as software and technology continued to develop, many maritime schools and colleges adopted a traditional desktop or full mission simulator. IMO Model Course 2.07 Engine-Room Simulator (IMO,2014) describes an engine simulator (ERS I) as consisting of instructor and student consoles with display panels of various diagrams and panels necessary to operate the propulsion plant (IMO, 2019). The course model also describes a full mission simulator (ERS II) similarly but provides a realistic training environment; this usually involves mock-ups and large displays.

Figure 3 TAMUG MARE ERS 1 Classroom

Figure 4 ERS 2 FMS Engine Control Room

A limitation mentioned above that maritime schools face is the training and education of students on multiple forms of propulsion when only one might be accessible for their education. The maritime colleges have been given the goal by the Department of Maritime Administration (MARAD) to graduate cadets in gas turbine, steam, and diesel propulsion. For professional continuing education programs, a traditional simulator might be usable since they have the exposure to imagine the equipment and scenarios. However, this exposure is limited for new students at a maritime college. This stresses the need to have equipment available to show students. Even a full mission simulator constructed with control consoles and large displays for system diagrams would have the same limitations as the ERS I lab.

8. Development of Engine Simulation Laboratory:

Texas A&M University at Galveston's (TAMUG) Department of Marine Engineering Technology (MARE) has recognized this issue and paired with Wärtsilä Simulation and Training Solutions to update their traditional ERS I lab to a fifteen-person multipurpose propulsion simulation and full mission simulator with virtual and 3D capabilities. This new facility can supplement workshops on the training ship and existing labs with fully rendered high-fidelity experiences on six different propulsion types.

- Dual Fuel Diesel Electric
- Dual Fuel Slow Speed
- Slow Speed Diesel
- Medium Speed RoPax
- Dual Fuel Steam
- Gas Turbine

Figure 5. TAMUG MARE VR Machinery

Another challenge is the continued advancement of simulation models to meet new industry training and educational needs. Wärtsilä has continued to lead the simulation industry with new high-voltage training aids and multiple simulators for alternative fuel sources. MARE has implemented more electro-technical training, alternative fuel source training, research, and education into its programs. This has led to new classes, minors, and exercises utilizing the upgraded full mission simulator with its high-voltage breaker and the collection of four LNG models.

Figure 6. TAMUG MARE Virtual PAC

Figure 7. HV ERS 2 FMS HV Breaker

Figure 8. TAMUG MARE VR Engine Control Room

Beyond the updated fifteen-person and full mission simulator, MARE plans to use modern virtual and augmented reality (AVR) exercises in high voltage and LNG propulsion. This will allow students to gain a sense of scale and layout for the operation and design of these modern vessels. With AVR, the entire vessel can be simulated in the confines of a twenty-five-square-foot space.

9. Conclusions

The growing maritime trade and an increasing number of highly automated ships require the presence of a skilled Electro Technical officer on board each vessel to manage and maintain these systems. The Marine Engineering Technology department at Texas A&M University's Galveston campus has developed an Electro Technology minor so that existing students in Marine Engineering Technology can obtain the required technical background for the USCG endorsement as ETO. Four new courses are under development for the minor in Electro Technology, and one, the Marine Power Electronics for Shipboard Applications course, has been developed and offered. Another minor in Marine Engineering Technology was designed to increase awareness about the discipline among other majors. The ETO minor creates a pathway to highly sought-after and lucrative jobs in the marine sector.

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RISK ASSESSMENT OF THE TURKISH STRAITS FOR SERVICE PROVIDERS USING THE FCM

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Abstract: Due to its strategic geopolitical position and accessibility to the Black Sea, the Turkish Straits serves as a highly frequented transit point for ships. In this particular geographical area, with the implementation of transitions, a diverse range of services like the provision of materials, meals, LSA inspections, and crew supply are also offered. This paper addressed the challenges and hazards encountered by service providers in delivering services in the Turkish Straits using the FCM. Utilising the FCM technique and adding expert perspectives, the research focused on identifying the most common issues faced by service providers in the Turkish Straits. The key obstacles cited by service providers, in decreasing order of significance, are weather conditions, human mistakes, communication concerns, excessive vessel traffic, and lack of expertise, as shown by the study's findings.

Keywords: FCM, risk assessment, Turkish Straits, maritime risk, maritime safety

1. Introduction

The term "Turkish Straits" encompasses the Istanbul Strait to the north, the Canakkale Strait to the south, and the Sea of Marmara in between, which is an inland sea spanning 164 nautical miles (Figure 1). These straits hold significant strategic and geopolitical importance, being the sole maritime link between the Mediterranean Sea and the Black Sea for thousands of years. Consequently, the Turkish Straits serve as the primary trade route for Black Sea nations to access global markets. The straits traverse Istanbul, Turkey's largest city, with a population exceeding 15 million, and the Marmara Region, the country's most populous area, with over 25 million residents. Therefore, ensuring the safety of the Turkish Straits is crucial due to the large human population in the vicinity.

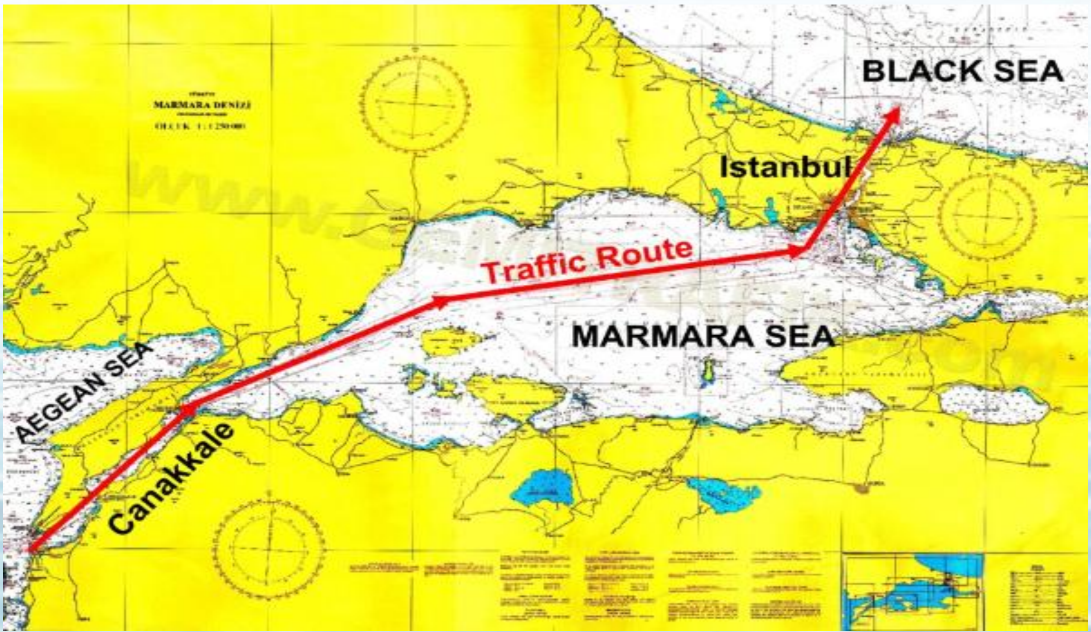

Figure 1. Map of Turkish Straits

However, these waterways are among the world's most perilous for navigation due to their narrowness, sharp turns, strong currents, heavy traffic, and various other factors. The Turkish Straits, being the only passage between the Black Sea and the Mediterranean, experience substantial commercial and local vessel traffic. Each year, thousands of commercial vessels navigate through these straits. The Istanbul Strait's narrowest point is 700 meters between Anadolu Hisarı and Rumeli Hisarı, while its widest is 3,600 meters between Anadolu Lighthouse and Türkeli Lighthouse in the north, and 3,220 meters in the south between Ahırkapı Lighthouse and İnciburnu Lighthouse. Vessels traveling north-south or vice versa must alter course at least 12 times, with the riskiest areas being Kandilli-Aşiyan, which has a 45-degree turn at its narrowest 700-meter width, and Yeniköy (Köybaşı), which has an 80-degree turn.

Similarly, the Canakkale Strait poses significant navigational challenges. Its narrowest section, between Kilitbahir and Canakkale, is 1,200 meters wide. Ships navigating this strait must change course at least 12 times, with the most critical turns being at Nara Cape, requiring over a 75° change, and the Canakkale-Kilitbahir turn, necessitating a 50° turn. The newly constructed 1915 Canakkale Bridge, with its massive piers in the strait, also adds to the risk. Both straits have strong currents flowing from north to south, adding to the navigational hazards.

These challenges contribute to a high risk of accidents in the Turkish Straits. Between 2004 and 2017, 671 accidents occurred in this area. Data from the Turkish General Directorate of Coastal Safety indicate that while the total number of vessel passages has decreased over the last 15 years, the length of ships has increased. With one in every five ships carrying dangerous cargo, the potential environmental damage from a collision is alarming. Thus, preventing maritime accidents and their consequences is vital for economic and environmental sustainability. Preventive measures such as pilotage services, vessel traffic services, tugboat assistance, traffic separation schemes, and local regulations are in place to enhance navigational safety. Nonetheless, accidents still occur, highlighting the need to analyze their main causes to determine necessary measures.

The aim of this study presents a comprehensive risk assessment of the Turkish Straits using Fuzzy Cognitive Mapping. It aims to identify, categorize, and analyze the key risk factors impacting maritime service providers. The study leverages expert input and empirical data to construct a nuanced FCM model, highlighting the interdependencies and feedback loops among various risk elements. By providing a detailed examination of the risk landscape, this research offers valuable insights for enhancing safety protocols, improving risk management strategies, and ensuring the sustainable operation of maritime services in the Turkish Straits.

This study consists of 6 section in total. The first section contains the introduction and the section 2 contains the literature review. The methodology constitutes the section 3. The application of the method is explained in section 4. The results of the study are in section 5. section 6 consists of limitations and future research.

2. Literature Review

Numerous risk analysis studies have been conducted on the Turkish Straits, with a specific focus on the Çanakkale Strait. One such study by Bayazit et al. (2020) analyzed marine accidents in this region from 2007 to 2018, identifying high-risk areas for navigation and creating risk maps using Geographic Information System (GIS) technology. Similarly, Ece et al. (2020) studied marine accidents in the Çanakkale Strait between 2001 and 2015.

In the Istanbul Strait, several studies have analyzed marine accidents. For instance, Akten (2004) provided a detailed examination of the number of ships involved in accidents, the external factors contributing to these accidents, frequent accident locations, and the types of accidents. Arslan & Turan (2009) used SWOT (Strengths, Weaknesses, Opportunities, and Threats) and AHP (Analytic Hierarchy Process) methods to analyze potential risk factors leading to marine accidents in the Istanbul Strait.

Musaoglu et al. (2015) used GIS and various quantitative methods to identify regions in the Istanbul Strait likely to be affected by accidents such as oil spills, fires, and explosions.

Köse et al. (2003) used simulation to explore the relationship between increased marine traffic in the Istanbul Strait and regional oil pipelines. Ucan & Nas (2016) applied Rockwell Arena simulation to determine the optimal number of maritime pilots required for effective pilotage services in the Istanbul Strait.

There are also studies focused on combating marine pollution following accidents in the Istanbul Strait. For example, Aşan et al. (2020) analyzed the 1994 M/T Nassica accident and simulated how modern conditions could prevent the resultant oil spill.

Studies evaluating both the Istanbul and Çanakkale Straits are also noteworthy. Bolat & Yongxing (2013) assessed potential risks associated with transporting special nuclear materials through the Turkish Straits. Uğurlu et al. (2016) analyzed serious marine accidents in the Turkish Straits from 2001 to 2010, identifying causes using AHP. Erol & Başar (2015) utilized frequency analysis and the Decision Tree Method to analyze factors causing marine accidents in the Turkish Search and Rescue region from 2001 to 2009.

3.Methodology

This section covers the fundamentals and applications of the FCM method used in the study. In order to use the FCM method, the identification of service providers operating in the Turkish Straits was first conducted. Based on discussions with six different service providers, a survey form to be evaluated by experts was developed. The detailed application of FCM and a case scenario example will be presented in the next section.

Fuzzy Cognitive Mapping is a causal representation that originated from the classic cognitive mapping technique introduced by Kosko (1986). It is depicted and visually depicts causal relationships (Papakostas et al., 2008). Fuzzy cognitive mapping, a technique that integrates fuzzy logic with neural networks, has shown its effectiveness in making inferences in situations characterised by substantial ambiguity, imprecision, and vagueness (Tsadiras, 2008).

Most FCM models are primarily constructed based on expert knowledge and experience with system operation. Aggregating information from diverse specialists in fuzzy cognitive mapping is a straightforward method (Obiedat and Samarasinghe, 2013). Every specialist assigns linguistic factors to each connection.

The iterative approach may be characterised with more precision as follows: Prior to use, it is necessary to initialise the FCM. Put simply, the activation level of each notion is determined by assigning a number based on an expert's assessment of its present state or measurements taken from the actual system. Begin by assigning a symbol A_i^((t)) to represent the value of idea i at step t. Then, proceed to replicate the process in a repetitive manner. The computation of the value of each thought in an iteration is performed (Papageorgiou et al., 2009):

$$A_i^{(t+1)} = f\left(A_i^{(t)} + \sum_{\substack{j=1,\\ j\neq i}}^{n} A_j^{(t)} W_{ji}\right) \quad (1)$$

Upon reviewing the research on FCM in the maritime industry, a multitude of diverse studies were discovered, with a predominant focus on prioritisation. Several of these studies concentrate on human aspects, identifying the underlying causes, optimising routes, and analysing accidents. For instance, Navas de Maya et al. (2018) provide the preliminary results of a research aimed at assessing the factors that influence accident incidence.

The FCMs technique involves the calculation and assignment of unique weights to each of these parameters in order to assess and establish their relative importance. According to Wang et al. (2019), their proposed technique involves integrating a fuzzy inference system with evidential reasoning to convert the original input values of variables. A nonlinear Hebbian learning approach is used to enhance the model. This study provides a method for maritime safety decision-makers to understand the current condition of navigational safety and forecast its future progression. Bakhtavar et al. (2021) investigate the applications and advancements of FCMs in the domain of systems risk analysis up to August 2020.

4.Application

In this section, six different service providers operating in the Turkish Straits will be examined in detail, followed by the application of the FCM method with the assistance of six different experts, and the results will be discussed. In order to identify the risks/hazards for service providers in the Turkish Straits, discussions were held with a total of six different companies to obtain data.

Company A, founded in Istanbul in 2008, is a safety supplier with branches in various locations such as Rotterdam, Singapore, and Dubai. Company A actively provides various services in the Istanbul and Çanakkale Straits, such as lifeboat-davit inspection, bridge equipment calibration, and firefighting equipment inspection & repair. Based on discussions with Company A and the analyzed data, examples of frequently encountered problems in the Turkish Straits include time constraints, adverse weather conditions, lack of technical knowledge, language barriers, and human errors.

Company B, established in 2010, specializes in supplying and transporting various fuels such as HFO, DO, MDO, and MGO. With a total of 27 employees, Company B currently operates primarily in the Istanbul Strait. Discussions with Company B revealed problems such as adverse weather conditions, inadequate agency boats, lack of technical knowledge, and communication gaps.

Company C, engaged in the service and supply of various provisions such as food and beverages, was established in 2004. With diverse personnel, Company C frequently operates in locations such as Kumkapı, Zeytinburnu, and the Çanakkale Strait. Following meetings with Company C, it was identified that heavy traffic, human errors, and adverse weather conditions are common problems.

Company D, providing spare parts for various equipment and systems for both the engine room and bridge, primarily operates in the Çanakkale Strait. Discussions with Company D revealed deficiencies in the English proficiency of their personnel, as well as issues such as timing errors and incorrect guidance.

Company E provides classification services for various purposes such as fuel, LSA, FFE, and bridge equipment in both the Istanbul and Çanakkale Straits. Following discussions, it was found that although the English proficiency and communication skills of Company E's personnel are sufficient, issues such as lack of technical knowledge, adverse weather conditions, and incorrect guidance/support are prominent problems.

Lastly, Company F, established in 2001 in Izmir, provides periodic maintenance services for both the bridge and engine room, as well as various other systems/equipment. With a focus on Zeytinburnu and the Golden Horn, Company F operates primarily in the Istanbul Strait. The company employs 74 people. Discussions with Company F revealed that the most common problems encountered in the Turkish Straits are, in order, human errors, adverse weather conditions, lack of English proficiency, and timing.

4.1 Determining Causal Relationships

The reasons, or concepts in the fuzzy cognitive map, are established by a thorough examination of the service providers' questionnaire. In this step, the causal linkages between ideas are determined by pairing concepts in a questionnaire format, as shown in Figure 2. This allows for a comprehensive evaluation of all connections.

Question	Concept i	does not affect at all	weakly affects	weakly-moderately affects	moderately affects	moderately-strongly affects	strongly affects	Concept j
1	Cause 1	O	O	O	O	O	O	Cause 2
2	Cause 1	O	O	O	O	O	O	Cause 3
...	...	...	...	...	...	...	...	...

Figure 2. Questionnaire format concept (Soner et al., 2015)

4.2 Combining Separate Weights and Converting Fuzzy Values

A collective map is established to enhance the reliability of the ultimate model. The language weights and group adjacency matrix are generated by aggregating the weights contributed by several experts. The equation (Ross, 2004) shown in Fig. 3 is used to compute the Centre of Gravity.,

$$Z^* = \frac{\int \mu_{\tilde{w}_{ij}}(z)\, z\, dz}{\int \mu_{\tilde{w}_{ij}}(z) dz} \quad (2)$$

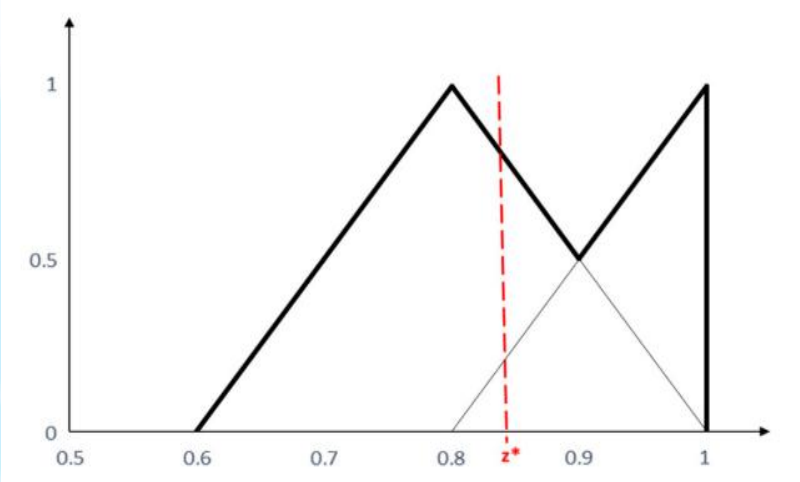

Figure 3. CoG and MAX method (Soner et al., 2015)

4.3 Determining Direct Relationships

In order to identify plausible risks/scenarios, it is necessary to thoroughly assess the function of each idea in the causal map. The outdegree (od) and indegree (id) of each variable are used to define its characteristics.

$$od(i) = \sum_{j=1}^{n} |W_{ji}| \tag{3}$$

$$id(i) = \sum_{j=1}^{n} |W_{ij}| \tag{4}$$

$$od(i) \geq \bar{x}_{od} \tag{5a}$$

$$|P|_i \geq 2 \tag{5b}$$

$$|P|_i = \frac{od(i)}{id(i)} \tag{6}$$

4.4 Identification of Indirect Relationships

By examining the adjacency matrix, one may only identify candidate causes that are directly related to each other via causal chains of length one. Regrettably, this is inadequate to ascertain the concealed prospective factors, which may have a substantial influence on the ongoing study. Therefore, it is necessary to take into account the propagation of causal effects via reaction pathways and loops (Asan et al., 2011). The first normalisation generated in this study may be expressed as follows:

$$Nod(i)^q = \frac{max_{i=1\ldots n}\{od(i)\} . od(i)^q}{max_{i=1\ldots n}\{od(i)^q\}} \tag{7}$$

$$Rod(i) = (od(i) + Nod(i)^2 + \cdots + Nod(i)^{n-1})\frac{}{Q} = \left(\sum_{q=1}^{Q} Nod(i)^q\right) \Big/ Q \tag{8}$$

4.5 Qualitative Simulations

The steady state calculation provides insight into the arrangement and relative importance of the variables in relation to one another (Papageorgiou and Kontogianni, 2012). The simulation procedure starts by assigning a numerical value within the range of [0, 1] to the activation level of each notion, as determined by expert opinion pertaining to a certain condition.

A number of zero indicates the absence of a certain idea in the system at that iteration, whereas a value of one signifies the maximum potential presence of that concept. The higher the number of ideas affected (i.e. activated) by a single concept in the first iterations, the more likely it is that the concept is a possible cause.

Table 1. Priority and rank order of cases

Case/scenario	# of cases	# of Activated concepts		Rank order w.r.t. (I1)	Rank order w.r.t. (I2)	Priority
		Iteration 1 (I1)	Iteration 2 (I2)			
Communication concerns	A1	3	4	3.5	4	3
Vessel traffic	A2	2	3	4	4.5	4
Lack of expertise	A3	1	2	5	5.75	5
Lack of technical knowledge	A4	1	1	6	6	6
Weather conditions	A5	4	5	1	2	1
Human error	A6	4	4	2.5	3	2

5. Results

When considering the outputs of the FCM analysis, it has been determined that weather conditions are the most triggering/influencing factor among other factors. Weather conditions are seen to affect four different scenarios in the first iteration and five in the second. Following weather conditions, human error, affecting four scenarios in the first iteration and four in the second, comes next. The third most influential condition, communication concerns, triggers three scenarios in the first iteration and four in the second. Vessel traffic ranks fourth, triggering two and three different scenarios, respectively. Lack of expertise ranks fifth. Lack of technical knowledge, triggering only one scenario in each iteration, is identified as the sixth difficulty/condition.

Examining the results, it is observed that the most common problem faced by service providers operating in the Turkish Straits is weather conditions. Especially considering the unique current structures, geographical conditions, and structures of Istanbul and Canakkale Straits, this issue is deemed highly critical. To minimize the impact of weather conditions on service providers, a database could be created to share real-time data. Similarly, to mitigate adverse weather conditions, there is a need for agency boats with high maneuverability, stronger and more effective, and sufficient technological equipment.

To eliminate delays, transfers, and errors such as incorrect crane usage caused by human errors, relevant personnel could undergo periodic training. Through periodic training that includes both technical information and practical applications, human-factor errors/accidents can be prevented. For addressing communication concerns, personnel could receive support from various training platforms to learn English. Similarly, the English proficiency of personnel working in the Turkish Straits could be enhanced through internal company training, seminars, and other support.

Additionally, various practices could be considered to ensure familiarity with maritime terminology. The density of traffic in the Turkish Straits can be critical for service providers in terms of time, cost, and manpower. Traffic density should be reported by relevant personnel at regular intervals and disseminated to everyone through a common platform/interface. For addressing lack of expertise and lack of technical knowledge, technological equipment could be utilized. For example, tests could be administered to marine pilots at intervals using AR-VR-simulator applications. Similarly, knowledge and experience gaps of service providers' personnel could be addressed by providing remote support. Various applications such as remote support or remote inspection centers can enable real-time monitoring of the Turkish Straits and mitigate issues stemming from human errors and knowledge/experience gaps.

6. Limitations and Future Research

This section will discuss the limitations that need improvement in the performed research. Furthermore, this paper will also address recommendations for improving the aforementioned constraints in future studies, with the goal of offering advice for future research endeavours.

Firstly, in the conducted study, the FCM method was employed to analyze the problems and situations encountered by service providers in the Turkish Straits. Although the FCM method is widely used and useful for prioritization, weighting, and finding the importance order of various situations, its integration with different methods can be ensured. In future studies where various approaches/methods such as AHP, ANP, CM, TOPSIS, FTA, FTOPSIS are used together, the results and findings may be more accurate and consistent.

Secondly, in the conducted study, data from a total of six different service providers including fuel suppliers, spare parts providers, and classification society firms were utilized. To identify the problems and risks faced by other companies/organizations operating in the Turkish Straits, this number may be increased in future studies.

Thirdly, assistance was obtained from six different experts in the study to both identify the risks/problems of companies and implement the FCM method. In future studies, increasing the number of experts and criteria can enhance the consistency of the results and provide a more comprehensive perspective.

Lastly, the recommendations/comments in the results section of the study have not been tested with real data. In future studies, the integration of various technological developments such as simulation, AR-VR, can be utilized. Thus, the obtained data, recommendations, or suggestions can be tested before being implemented in real life.

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INTEGRATING 21ST CENTURY SKILLS INTO STCW COMPETENCES: IMPLICATIONS FOR MARITIME EDUCATION AND TRAINING

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Abstract:

21st century and interpersonal skills have been identified as one of the 22 key areas for consideration in the ongoing comprehensive review of the STCW Convention. The term 21st century skills has become ubiquitous among scholars and practitioners yet still has no widely accepted definition in the literature. In the maritime context, it is widely acknowledged that 21st century skills are critical for seafarers and for inclusion in maritime education and training curricula. This study adopted a mixed method approach entailing a scoping review of extant 21st century skills literature and a modified Skill Technology Forecast (STF), involving a survey and workshop, to collect seafarers' opinions on the skills that are most critical for the maritime context. The 10 most important 21st century skills obtained in the scoping review were considered by participants with seafaring experience, who deliberated on and assessed the anticipated necessity (over 90%; 50-90%; 10-50%) of each skill for officers as well as ratings in the short to mid-term, and identified which prevailing trends were most strongly associated with the skills in question. Trends were derived from the 22 areas of the Comprehensive Review of the STCW Convention and clustered into five overarching categories of maritime trends: digitalization, decarbonization, safe working environment, mental health, and effective and efficient training. Based on the input from the participants, the prioritization of 21st century skills for officers as well as ratings is presented and implications for maritime education and training are discussed.

Keywords: 21st century skills; scoping exercise; seafarers; Comprehensive Review of STCW

1. Introduction

Scholarly interest in future skill sets has grown exponentially in the last two decades in various disciplines, such as psychology, education, and technology (Saleem et al. 2024). A bibliometric analysis by Salem et al. (2024) identified 2662 articles published by 6579 authors from 2000 to 2021. This growing trend has implications on how future professionals should be educated and what skill sets are needed in relation to technological development (UNESCO 2023).

In the maritime sector, 21st century skills are also considered important for future maritime professionals. 21st century and interpersonal skills are identified as one of the 22 key areas for consideration in the ongoing comprehensive review of the STCW Convention and Code. The Human Element, Training, and Watchkeeping (HTW) Sub-Committee of the International Maritime Organization (IMO) reported the need "to address twenty-first century competence and interpersonal skills, such as digital skills, communication, information management and the ability to adapt to a changing work environment". In the maritime context, it is widely acknowledged that 21st century skills are critical for seafarers and for inclusion in maritime education and training curricula. Nevertheless, the term '21st century skills', which has become ubiquitous among scholars and practitioners, is lacking a widely accepted definition in the literature. Moreover, the skills required for seafarers are not clearly defined in the current literature or in IMO documents. It is also unclear which skills are needed to address specific prevailing trends in the maritime industry. Based on the identified problems, this research aims to identify the 21st century skills most important for officers and ratings and relevant trends for those skills. The study also discusses the implications of 21st century skills for maritime education and training (MET).

The following sections are divided into methods (Section 2), scoping exercise (Section 3), results of survey and workshop (Section 4), implications of 21st century skills in MET (Section 5), and conclusion (Section 6).

2. Methods

Studying a relatively new concept, such as 21st century skills, requires a systematic approach which is logical and procedural to understand how the concept is understood in a specific context (Buljan 2023). To do this, the research employed a structured mixed method approach with three research phases: Desktop review; empirical data collection; and validation (Figure 1).

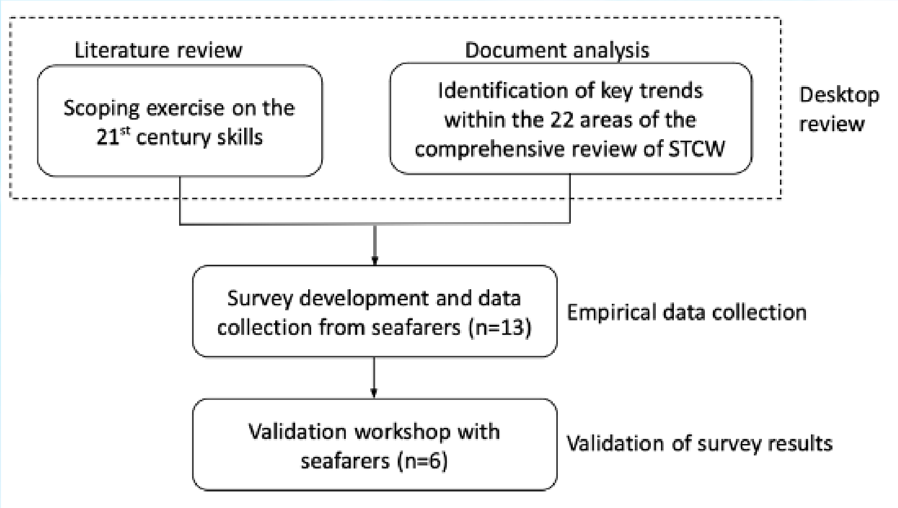

Figure 1. Research process (Source: Authors).

In the desk review phase, a scoping exercise on 21st century skills as well as a document analysis on the 22 areas of the Comprehensive Review of the STCW Convention and Code were conducted. To carry out the scoping review, the keywords "21st century skills" and "definition" and "framework" were entered into Google Scholar and a time frame was set from 2020 to present. Scholarly articles identifying 21st century skills were found to be based primarily on reviews of existing frameworks, with several frameworks being highly cited (e.g., ATC21S; EnGauge; OECD; P21; UNESCO). These frameworks were selected together with scholarly literature reviews that proposed new frameworks or restructured existing 21st century skills frameworks. The scoping exercise identified the 10 top 21st century skills from 15 sources which included academic and gray literature. The 22 areas of the Comprehensive Review of STCW were thematically categorized into five maritime trends: digitalization, decarbonization, safe working environment, mental health, and effective and efficient training.

The next phase of empirical data collection was to develop an online survey targeting seafarers. The survey sought to elicit their views on the level of importance of the top ten 21st century skills extracted from the scoping review as they pertain to the maritime trends (Figure 2). A modified Skill Technology Forecast (STF) methodology was used as an effective and proven approach to understand the association between skills and trends (WMU 2023). Participants with seafaring experience were asked to assess the anticipated necessity (over 90%; 50-90%; 10-50%) of each skill for officers as well as ratings in the short- to mid-term, and identify which prevailing trends are most strongly associated with the skills in question. Participants were recruited from MSc and PhD students as well as researchers who are currently studying or working at the World Maritime University (WMU) and who have seafaring experience. The survey participants provided their consent before undertaking the online survey, which was administered in mid-May 2024. A total of 13 valid responses from seafarer participants were obtained. All 13 participants were officers (7 deck officers; 5 engineers; one other officer), representing 10 different nationalities (Philippines, India, Ecuador, Indonesia, Japan, Jordan, Nigeria, Panama, and South Korea).

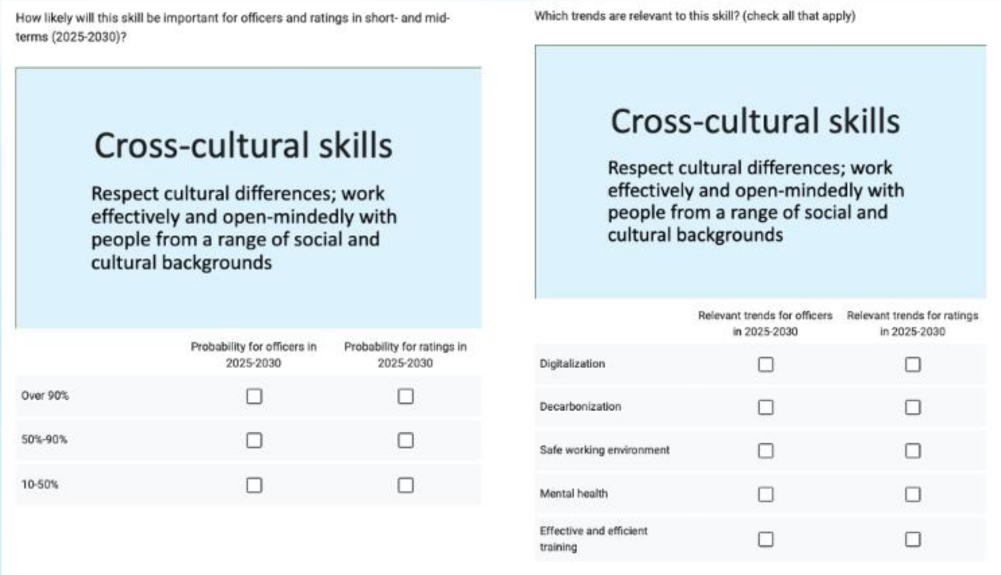

Figure 2. Example of the survey

The final phase of the study involved the validation of the survey results by way of a workshop in which six seafarer participants from WMU voluntarily gathered in late May 2024. All participants signed a consent form prior to engaging in the workshop. Participants were asked to sit in a circle, which allowed them to discuss the survey results face-to-face. They were given both the survey results and score cards of the top ten 21st century skills and took turns to take the role of facilitator in the group discussion (Figure 3). Participants were asked to agree with consensus on the necessity for each 21st century skill in relation to each trend. The facilitator was charged with leading the discussion and recording the result on the scorecard. The participants argued from their perspectives to justify their selections. The workshop discussion was audio-recorded and transcribed by software and manually checked by the researchers for qualitative analysis.

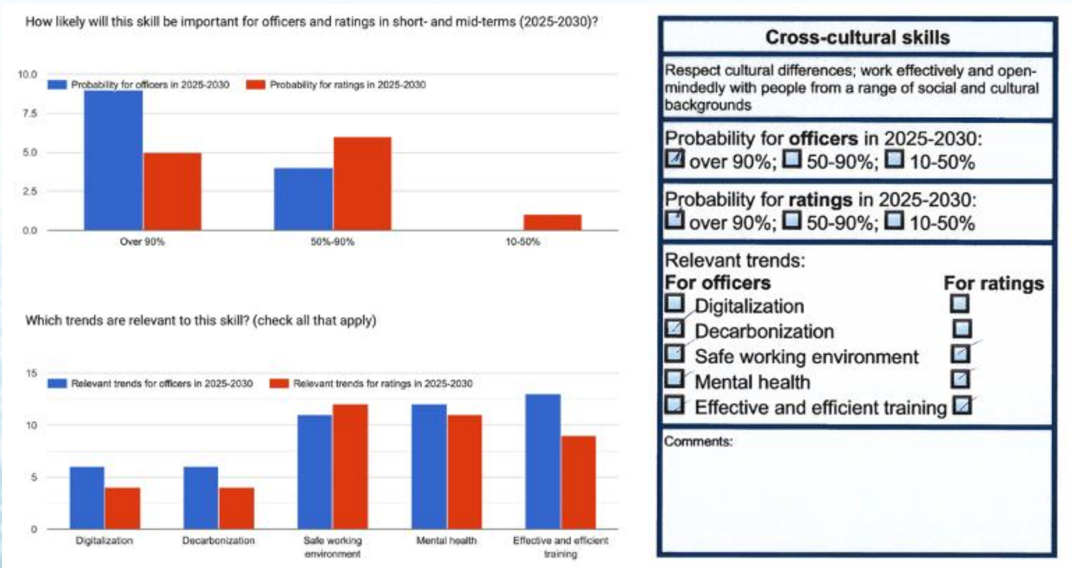

Figure 3. The example of survey results and the score card filled at the workshop

3. Scoping exercise

3.1 21st century skills defined

There is no widely agreed upon definition of 21st century skills in the literature identified in the scoping review. However, common elements exist among the various definitions. By and large, the term is used to refer to the knowledge, skills, expertise, attitudes and dispositions needed to be effective students, workers and citizens in the 21st century. The most comprehensive definition is provided by Scott (2015), who conceptualizes 21st century skills as *the knowledge, skills and attitudes necessary to be competitive in the 21st century workforce, participate appropriately in an increasingly diverse society, use new technologies and cope with rapidly changing workplaces* (p.3) Twenty-first century skills are differentiated in the literature from 20th century skills due to their relevance to contemporary social and economic developments and, in particular the emergence of advanced information and communication technologies (van Laar et al. 2017). Modern workplaces, characterized by increasing digitalization, automation and globalization (Dede 2009; Voogt & Roblin, 2010), require a highly skilled workforce equipped to deal with complex, non-routine problems and adapt to rapidly evolving job-requirements (van Laar et al. 2017).

The scoping review identified key contributors to the 21st century literature representing private organizations, partnerships and projects, both national, (e.g, Partnership for 21st century skills (P21) (2008); National Research Council (NRC) (2012); and NCREL and Metiri Group's (2003) EngGauge) and international (e.g, Assessment and Teaching of 21st century skills (ATC21S) (Binkley et al 2012); World Economic Forum (WEF) (2015); OECD (Ananiadou & Claro 2009)); United Nations agencies (e.g., ILO (2021); UNESCO (Scott 2015)), and individual scholars (e.g., Chalkiadaki 2018; Finegold & Notabartolo 2009; Joynes et al 2019; Kotsiou et al. 2022; Trilling & Fadel 2009; van Laar et al. 2020). The frameworks developed by these initiatives are largely consistent in terms of the specific skills identified. Moreover, many skills are considered transversal and transdisciplinary, meaning that they intersect and underpin each other, and that they have the potential to be integrated into any subject curricula (Kotsiou et al. 2022). Differences between the frameworks are mainly in the ways in which the skills are classified and categorized. For example, critical thinking as a 21st century skill is classified as a learning and innovation skill (P21 2008), a way of thinking (Binkley et al. 2012), a cognitive/metacognitive skill (Ananadiou & Claro 2021; NRC 2012) and an analytical skill (Finegold & Notabartolo 2010) in various frameworks. Table 1 identifies the 10 skills most frequently mentioned in the reviewed literature, while Table 2 presents the 21st century skills frameworks developed by the 15 sources reviewed for this paper.

Table 1. Top ten 21st century skills from scoping review

	NCRL & Meteri Group (2003)	Partnership for 21st Century Skills (2008)	Ananiadou & Claro (2009)	Trilling & Fadel (2009)	Finegold & Notabartolo (2010)	Binkley et al. (2012)	National Research Council (2012)	Scott (2015)	World Economic Forum (2015)	Chalkiadaki et al. (2018)	Joynes et al. (2019)	van Laar et al. (2020)	Global Partnership for Education (2020)	International Labour Organization (2021)	Kotsiou et al. (2022)	Total
Critical thinking	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
Collaboration	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
Communication	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
Creativity/Innovation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
Information/ICT/digital literacy	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
Problem solving	x	x	x	x	x	x	x	x	x	x		x	x	x	x	14
Social responsibility/global awareness	x	x	x			x	x	x	x	x			x	x	x	11
Learning to learn				x	x	x	x	x	x	x	x			x	x	10
Cross-cultural skills	x	x	x	x			x	x	x	x						8
Flexibility/adaptability	x	x	x		x		x		x		x				x	8

Table 2. 21st century skills frameworks identified by the scoping review

NCRL & Metiri Group (2003)	P21 (2008)	Ananiadou & Claro (2009)	Trilling & Fadel, 2009	Finegold & Notabartolo (2010)	Binkley et al (2012)	National Research Council of the National Academies (2012)	Scott (2015)	World Economic Forum (2015)	Chalkiadaki (2018)	Joynes et al. (2019)	van Laar (2020)	Global partnership for education (GPE) (2020)	ILO (2021)	Kotsiou et al (2022)
Digital-age literacy: Basic, scientific and technological literacies; Visual and information literacies; Cultural literacy and global awareness;	**Learning and innovation skills:** Critical thinking and problem solving; Creativity and innovation; communication and collaboration	**Information dimension:** information as a source (searching, selecting, evaluatong and organizing information); information as product (restructuring and modelling information and developing own ideas; creativity and innovation; problem solving and decision making)	**Critical thinking and problem solving**	**Analytical skills:** critical thinking; problem solving; decision making; research and inquiry	**Ways of thinking:** Creativity and innovation; critical thinking, problem solving and decision-making; learning to learn and metacognition	**Cognitive Domain:** critical thinking; problem solving; reasoning/argumentation; interpretation; decision-making; adaptive learning; executive function; information literacy; ICT literacy; oral and written communication; active listening; creativity, innovation	**Learning to know:** mastery of core subjects	**Foundational literacy:** Literacy; Numeracy; Scientific literacy; ICT literacy; financial literacy; Cultural and civic literacy	**Personal skills:** Self-development and autonomy; Creativity; problem-solving and critical thinking; Presesence in the globalised environment	**Communication skills:** language and presentation of ideas	**Technical skills:** fluency in skills and language of ever-changing technologies	Creativity and innovation	**Basic digital skills:** use basic hardware; use basic software; operate safely in an online environment	**Higher-order thinking skills:** decision making; problem solving; critical thinking; systems thinking
Inventive thinking: Adaptability/ability to manage complexity; Curiosity, creativity, and risk-taking; higher-order thinking and sound reasoning;	**Information, media and technology skills:** information literacy; media literacy; technological literacy	**Communication dimension:** Effective communication; information and media literacy, critical thinking; collaboration and virtual interaction; teamworking; flexibility and adaptability	**Creativity and innovation**	**Interpersonal skills:** communication; collaboration; leadership and responsibility	**Ways of working:** Communication; collaboration and teamwork	**Intrapersonal domain:** flexibility; adaptability; artistic and cultural appreciation; personal and social responsibility (including cultural awareness and competence);; appreciation for diversity; continuous learning; intellectual interest and curiosity; initiative; self-direction; responsibility; perseverence; productivity; grit; self-regulation; professionalism/ethics; integrity, citizenship, career orientation	**Learning to do:** Critical thinking; problem-solving; communication and collaboration; creativity and innovation; information, communication and technology (ICT) literacy	**Competencies:** Critical thinking/problem solving; Creativity; Communication/ Collaboration	**Social skills:** Communication and collaboration; Cultural awareness and global awareness; leadership	**Collaborative skills:** management of group activities and social interaction	**Information skills:** search, evaluate and organize information from multiple sources	Critical thinking/ problem-solving / decision-making	**Basic skills for green jobs:** environmental awareness; waste reduction and waste management; energy and water efficiency	**Dialogue skills:** Collaboration communication; empathy; listening
Effective communication: teaming, collaboration, and interpersonal skills; Personal and social responsibility; Interactive communication;	**Life and career skills:** flexibility and adaptability; initiative and self direction; social and cross-cultural skills; productivity and accountability; leadership and responsibility	**Ethics and social impact dimension:** social responsibility (critical thinking; responsibility and decision-making skills); social impact (reflection on social, economic and cultural implications of ICT)	**Collaboration, teamwork and leadership**	**Ability to execute:** initiative and self direction; productivity	**Living in the world:** Citizenship - local and global; life and career; personal and social responsibility	**Interpersonal domain:** communication; collaboration; teamwork; cooperation; coordination; interpersonal skills; empathy/perspective taking; trust; service orientation; conflict resolution; negotiation; leadership; responsibility; assertive communication; self-presentation; social influence with others responsibility	**Learning to be:** Social cultural skills; Personal responsibility, self regulation and initiative; sense-making skills; metacognitive skills	**Character Qualities:** Curiosity; initiative; Persistence/grit; Adaptability; Leadership; Social and Cultural Awareness	**Information and knowledge:** Learning; Information management	**Individual learning approaches:** critical thinking; metacognition; new skills acquisition	**Communication skills:** ability to transmit information effectively taking audience and medium into account	communication, collaboration, information and IT literacy	**Social and emotional skills:** communication; collaboration and teamwork; conflict resolution and negotiation; emotional intelligence	**Digital and STEM literacy:** Computational thinking; digital literacy; ICT literacy; Digital citizenship; Online safety
High Productivity: Ability to prioritize, plan and manage for results; effective use of real-world tools; produce relevant, high-quality products			**Cross-cultural understanding**	**Information processing:** information literacy; media literacy; digital citizenship; ICT operations and concepts	**Tools for working:** Information literacy; ICT literacy		**Learning to live together:** seek and value diversity; teamwork and interconnectedness; civic and digital citizenship; global competence; intercultural competence	**Lifelong learning**	**Digital literacy:** critical use of digital tools; attend to ethical reponsibilities required in participatory culture in technology	**Individual autonomy:** flexibility; adaptability; entrepreneurship	**Collaboration skills:** teamwork	citizenship	**Cognitive and metacognitive skills:** foundational literacies; analytical and critical thinking; creative and innovative thinking; strategic thinking; problem-solving and decision-making; self-reflection and learning to learn; collect, organize and analyse information; planning and organizing; career management	**Values:** Ethical reasoning; citizenship; sustainability; global awareness;
			Communications, information and media literacy	**Capacity for change:** creativity; innovation/adaptive learning/learning to learn/flexibility						**ICT and digital literacy:** use of technology as tools for learning, communication and collaboration	**Critical thinking skills:** transforming information into new knowledge; creativity for problem solving	Personal and social responsibility		**Self management:** self-awareness; resilience; emotional intelligence; positive attitudes; confidence
			Computing and ICT literacy								**Problem-solving skills:** solve problems in complex and uncertain situations; identify necessary actions, gaps and steps to obtain information			**Lifelong learning:** learning to learn; metacognition; willingness to learn; active learning
			Career and learning self-reliance											**Enterprise skills:** creativity; initiative; entrepreneurship; curiosity
														Leadership: responsibility; goal oriented; courage; management
														Flexibility: adaptability; multi-taking; agility; executive function

3.2 Top 10 21st century skills

The top 10 21st century skills according to the scoping exercise are described in this section with a view to providing an overview of how they are defined, classified and discussed in the literature.

Critical thinking is highlighted as an essential skill across all of the sources though only a few explicitly define it. The term generally encompasses the ability to find, analyze, interpret and evaluate information and evidence to make sound judgements and decisions (Chalkiadaki 2018; ILO 2021; P21 2008) and to formulate solutions to problems (WEF 2015). In particular, the ability to filter vast amounts of data to locate quality sources and select relevant information on which to form independent and well-grounded perspectives is considered a fundamental skill in the 21st century (Dede 2010; van Laar et al 2020). Key concepts often associated with critical thinking include logic, rationality and reason and many frameworks pair critical thinking with problem solving skills (e.g., Chalkiadaki 2018; Trilling & Fadel 2009). There is general agreement in the literature that critical thinking skills can be taught (e.g., P21 2008; Scott 2015); however, some studies have found that students lack the necessary competencies (Dede 2010).

Collaboration and teamwork have always been considered as valuable skills in the workplace, but even more so in the 21st century. Wang (cited by van Laar 2020) notes that 21st century work is becoming "more knowledge-based, interdisciplinary and specialized" (p. 3). In the contemporary workplace, increasingly complex tasks are being accomplished less by isolated individuals and more by teams with complementary expertise (Dede 2009). Globalization, internationalization and digitalization are driving shifts in the nature of collaboration. Increasingly, collaboration is taking place across distances and is being supported by ICT (Joynes et al. 2019; van Laar et al. 2020). Workers, therefore, require more sophisticated skill sets to connect, share information and engage in proactive problem solving with others using social media and collaboration tools. The literature also highlights the need to work effectively and respectfully in diverse teams, requiring the ability to identify and acknowledge different viewpoints and show empathy for others (ILO 2021). According to Joynes et al. (2019), simulating such interactions in the educational setting will have clear benefits on the skills of the workforce.

Effective communication skills, which include the ability to clearly and persuasively express thoughts both orally and in writing, articulate opinions, communicate coherent instructions and motivate others, are highly valued in the workplace (Scott 2015). In an increasingly digitalized workplace, the ability to communicate effectively using technologies and social media is critical, requiring skills in processing, transforming and formatting information for different audiences (Ananiadou & Claro 2009). Practical communication skills cited in the literature involve using appropriate tools and language to achieve effective communication, which also encompasses information, media and ICT competencies (Joynes et al. 2019). The ability to transmit information clearly, considering the audience and the medium is also essential according to Ananiadou and Claro (2009). Social and emotional skills are also linked to effective communication and are increasingly sought after across industries for their role in active listening, empathy and conflict resolution (ILO 2021).

Creativity involves the ability to generate innovative ideas, techniques and strategies, think outside the box and develop original solutions to problems (OECD 2018; Scott 2015). It is essential for adapting to rapidly changing environments and addressing complex challenges in the workplace and beyond. In the 21st century, creativity is not limited to artistic expression but also encompasses the ability to approach tasks with a fresh perspective, experiment with new methods and apply creative thinking to various disciplines. Creativity is closely linked to other skills such as critical thinking, problem solving and collaboration, as it often involves working with others to develop and refine ideas and drive progress (Ananiadou & Claro 2009; Trilling & Fadel 2009). The integration of technology and digital tools enhances creative processes (van Laar et al. 2020), enabling individuals to explore new possibilities and collaborate with peers worldwide (Joynes et al. 2019). Moreover, fostering creativity in education and professional settings promotes a culture of continuous learning, encouraging individuals to take risks and embrace failure as part of the innovation process (Dede 2010).

Problem solving is another essential 21st century skill encompassing abilities such as defining problems, evaluating, selecting, organizing, analyzing and interpreting information (Ananiadou & Claro 2009; P21 2008; Trilling & Fadel 2009). According to the 21st century skills literature, the problems facing today's workforce are increasingly complex, non-routine and non-recurring (Autor et al. 2003 cited by Trilling & Fadel 2009; Joynes et al. 2009; van Laar et al. 2020) requiring workers with the ability to navigate and integrate often contradictory information from multiple disciplines (Joynes et al. 2009; NRC 2012; van Laar et al. 2020) and discern relationships between new and existing information (Scott 2015) in order to find solutions. Intrapersonal competencies, such as collaboration and complex communication are also highly relevant to effective problem solving (NRC 2012; van Laar et al 2020) particularly in the digital environment.

Digital and ICT literacy are cited as essential 21st century skills by all 15 frameworks analyzed for this study. While some of the frameworks consider ICT and digital literacy as a discrete skill set, others see it as underpinning all other skills. Van Laar et al. (2020) integrate digital and generic 21st century skills, but acknowledge that the combination is not yet sufficiently defined. Practical digital literacy skills mentioned in the literature include the ability to use digital technologies and software to access, organize, manage, evaluate and create information (e.g., Ananiadou & Claro 2009; Scott, 2015; Trilling & Fadel, 2009). However, the approach to defining digital/ICT skills has shifted from a purely technical perspective to encompass a wider array of skills. Kotiou et al (2022), for example, argue that digital literacies go beyond technical competencies for creating and using ICT, and highlight the need for safe and responsible use of technology. This is in line with other authors such as van Laar et al. (2020) and Chalkiadiadaki (2018) who emphasize the cognitive and socio-emotional skills necessary for performing tasks in digital environments, including ethically responsible use of technology and skills to communicate and collaborate with others in a participatory ICT environment.

Social responsibility and global awareness, although not as universally recognized as the skills discussed above, appear in two-thirds of the frameworks analyzed for this study. Global awareness, in particular, has gained importance in the 21st century as the emergence of cross-border problems and advances in communication technology have resulted in a situation of global interconnectedness and interdependence. A globally competent and socially responsible workforce possesses interpersonal competencies (Soland et al 2013) and character qualities (WEF 2015) such as empathy, together with cognitive skills (NRC 2012) such as critical thinking. Both are needed to recognize the interrelatedness of individuals, institutions and systems and to connect how local events influence global events and vice versa (Chalkiadaki 2018; Soland et al 2013). Social responsibility involves making ethical decisions that benefit society and the environment, promoting fairness, and addressing social justice issues (Scott 2015). The ILO (2021) framework specifically includes basic skills for green jobs, including environmental awareness, waste reduction and energy and water efficiency. These skills are deemed necessary for workers to work in accordance with "environmental policies, green business practices and environmentally friendly technology and innovation" (ILO 2021).

Learning to learn is considered by many to be a critical skill in the era of rapid technological innovation, information growth and evolving knowledge. Also referred to as metacognition, learning to learn is a transversal skill, influenced by other skills, such as critical thinking, creativity and problem solving, while playing a central role in their development (NRC 2012; OECD 2009; WEF 2015). It is described in the literature as "the ability to reflect on one's own learning and make adjustments accordingly" (NRC 2012). The cognitive and intrapersonal competencies associated with learning to learn include flexibility and adaptability to changing circumstances, initiative, self-awareness and self-regulation (Binkley 2012; NRC 2012). Vrugt and Oort (cited by Soland et al 2013) found that these competencies are predictors of achievement and workforce success. Cultivating these characteristics and skills fosters a growth mindset and enables individuals to become lifelong learners capable of adapting to new challenges and opportunities.

Cross-cultural skills are frequently discussed in the context of global awareness, but also appear as an isolated skill in some frameworks. Cultural literacy is described as a recognition of and respect for diversity of people and cultures (NCRL & Metiri Group 2003; Scott 2015). In the workplace, collaboration with people from a wide range of social and cultural backgrounds is increasingly common. Scott (2015) describes some of the necessary competencies for working effectively in diverse teams, including professionalism, open-mindedness, while the Engauge framework (2003) highlights the need for flexibility and cooperation in intercultural teams. Cultural literacy goes beyond tolerating cultural differences, requiring actually seeking out and valuing the concerns and perspectives of others (Barrett et al. 2014 cited in Scott 2015) and the intentional construction of cross-cultural networks and relationships (Chalkiadaki 2018).

Flexibility and adaptability are identified as 21st century skills by almost 50 percent of the studies under review. The two skills are linked, both involving the capacity to change in response to shifting circumstances (P21 2008; Chalkiadaki 2018). The 21st century workplace requires workers who have the ability to adapt to varied roles and responsibilities and who are able to function effectively in the face of ambiguity, shifting priorities (EnGauge 2008; Trilling & Fadel 2009) and diverse and multicultural environments (Trilling & Fadel 2009). Recent frameworks in particular (e.g., Kotsiou et al. 2022; WEF 2020) emphasize skills related to preparing for uncertainty. Kotsious et al (2022) cite UNESCO's suggestion that "education should focus on helping learners embrace uncertainty and exert agency in changing and critical situations rather than trying to predict and understand what may come" (p.182). Thus, a number of key 21st century skills, such as critical thinking, problem solving and cultural awareness underpin flexibility and adaptability. Moreover, openness and ability to learn new skills are critical components in this context in light of the rapidly evolving digital landscape (van Laar et al. 2020).

4. Results of survey and workshop

Survey results were summarized as outputs of each skill and they show a range of opinions about the importance of each skill for officers as well as ratings (Left in Figure 3). In the workshop, six experts with seafaring experience discussed the survey results until they reached a consensus on the score cards (Right in Figure 3). Based on the validated results of 21st century skills for officers and ratings, the following subsections present an analysis of the data in: (1) identification of the 21st century skills important for officers and ratings; and (2) relevant trends.

4.1 Most important 21st century skills for officers and ratings

It is indicative that those skills with the probability of over 90% in 2025-2030 are the most important as perceived by seafarers. Table 3 summarizes the most important 21st century skills for officers and ratings in the short- and mid-terms (2025-2030). Seafarer participants considered all top ten skills to be important for officers while only six skills were identified as being essential for ratings.

Table 3. Most important 21st century skills for officers and ratings in 2025-2030.

21st century skills	Officers	Ratings
Critical thinking	X	
Problem-solving and decision-making	X	
Effective communication	X	X
Information/ICT /digital literacy	X	X
Creativity and innovation	X	
Collaboration and teamwork	X	X
Social responsibility/global awareness	X	X
Cross-cultural skills	X	X
Flexibility/ adaptability	X	X
Learning how to learn	X	

It is important to note that the seafarer participants took five trends into consideration when evaluating the most important 21st century skills. If it were a general question without considering future trends, the results might have been different. For example, a workshop participant stated: "why decarbonization is important for ratings [in terms of] critical thinking, because I can see for officers but I don't know for ratings" (brackets added by the researchers).

4.2 Relevant trends

Relevant trends for STCW were discussed by the seafarer participants in the context of the 10 most important 21st century skills. All five trends were identified as relevant to officers, while two trends (digitalization and decarbonization) were considered to be less relevant to ratings in terms of their 21st century skills. Indeed, the five trends that emerged from the ongoing Comprehensive Review of STCW can be divided into technical and social trends. With respect to the most important 21st century skills, technical trends (digitalization and decarbonization) are largely relevant to officers; and social trends (safe working environment, mental health, and effective and efficient training) are relevant to both officers and ratings.

This result is generally in line with a study on digitalization by DNV (2023), which reported that the impact of digitalization on seafaring careers in the next 5-7 years is more significant for officers than ratings. Interestingly, other studies indicate that automation and technology will affect the job security of ratings whose jobs may be automated (WMU 2019) and that MASS remains a job boundary between officers and ratings (Jo et al. 2020). Despite the vulnerability of ratings to digitalization, the seafarers in this study did not consider 21st century skills relevant to technical trends, including digitalization, as essential for ratings. This implies a passive state of ratings in preparing for the future in terms of their 21st century skills.

5. Implications of 21st century skills for maritime education and training

The empirical data analysis revealed a clear distinction between officers and ratings who should prepare for future maritime industry needs. Officers are required to adapt to all five trends linked to the ongoing Comprehensive Review of STCW, including digitalization and decarbonization which are in rapid progress. The 21st century skills considered essential for officers in the context of the future maritime industry are all top ten skills. On the other hand, the 21st century skills considered important for ratings are limited to only six skills and the relevant trends are also only three out of the five. The common required skills are the so-called soft skills, such as effective communication, Information/ICT/digital literacy, collaboration and teamwork, social responsibility/global awareness, cross-cultural skills, and flexibility and adaptability. The future MET should prioritize training to support these soft skills which are important for both officers and ratings. In the era of new trends, both officers and ratings are expected to be equipped with the necessary 21st century skills through continuous education and training, namely, lifelong learning, but this is more important for officers who tend to be affected by digitalization and decarbonization trends.

To integrate 21st century skills training into existing MET curricula, METIs can take inspiration from the 21st century skills literature. According to the most widely recommended approach, 21st century skills should not be taught as discrete or add-on subjects separated from content courses, but integrated into all subject areas (e.g., Binkley et al. 2012; Gonzalez-Perez & Ramirez-Montoya 2022; Scott 2015; Trilling & Fadel 2019;) Crucially, the idea that mastering content knowledge must necessarily precede higher level engagement with key concepts has been contested. Instead, applying skills such as critical thinking, problem solving and collaboration to content knowledge as it is being learned is thought to not only promote such skills in learners but to enhance motivation and improve the achievement of learning outcomes (Trilling & Fadel 2019). Moreover, while the literature acknowledges the potential of emerging technologies such as artificial intelligence and virtual and augmented reality to enhance learning, pedagogical strategies that align with the 21st century learning are considered more important (Gonzalez-Perez & Ramirez-Montoya 2022). The most prevalent strategies associated with 21st century skills development include research-based techniques, such as project and problem-based learning, and reflection strategies, such as case-based learning (Gonzalez-Perez & Ramirez-Montoya 2022). Equally critical are strategies aimed at developing the often neglected social and interpersonal skills that foster globally aware and socially responsible individuals able to communicate and collaborate effectively in diverse teams and in rapidly changing environments. In this vein, Scott (2015) advocates "pedagogy 2.0" approaches, such as collaborative and project-based learning built on complex real-world challenges and spanning multiple disciplines. Finally, the literature stresses the need for flexibility, including room for learner input, self-direction and self-monitoring (Scott 2015), in 21st century curricula in order to enable learner autonomy and responsiveness to change.

6. Conclusion

The ongoing Comprehensive Review of STCW includes 21st century skills as a key area for consideration. Based on a scoping review and modified Skill Technology Forecast (STF), this paper sought to identify which 21st century skills will be most essential to future officers and ratings. Ten critical 21st century skills were derived from the scoping review and five prevailing maritime trend categories were formulated from the 22 areas highlighted for consideration in the C~~c~~omprehensive R~~r~~eview of STCW. The study revealed that all five trends and ten 21st century skills will be highly relevant for officers. In contrast, six of the ten skills will be necessary for ratings in three of five trend categories. According to the study, both technical and soft skills are needed for officers whose work will be most affected by digitalization and decarbonization, while soft skills are most critical for ratings. The 21st century literature reviewed for this paper suggests that the acquisition of 21st century skills require 21st century learning, which goes far beyond the traditional focus on knowledge acquisition. 21st century seafarers require appropriate career and life skills in order to adapt to the complex and rapidly changing expectations of the maritime work environment. Digitalization and decarbonization efforts, in particular, involve complex, ill-defined and multi-disciplinary challenges that require innovative and collaborative problem solving. To future seafarers with the 21st century skills needed to tackle such challenges, METIs must adopt dynamic curricula and learning strategies and integrate 21st century skills into all maritime subject areas.

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ECOLOGICAL MONITORING OF AJARA COASTLINE USING DRONE

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Abstract: Aim: Timely detection of ecological imbalance and its eradication present one of the main activities of environmental protection. Anthropological impact upon the coastline influences the environmental conditions, requiring its monitoring and taking appropriate measures. Polluted marine environment causes the risks for ecosystems, food safety and local climate. The research object: factors, influencing upon the Black Sea ecological condition at Ajara coastline.

Results: The results of the research reveal the sources of pollution of the coastline. The research results are presented in the conclusions and recommendations.

Conclusion: Plastic is accumulating on the seabed, net fragments enlace marine plants mixing with food of fish, birds and marine mammals. Finally, thrown away waste is washed ashore, causing necessity of time and finances allocation for polluted areas rehabilitation. All mentioned above factors negatively influences upon tourism and economic condition of the region. Correct and effective management of waste is a global problem, solution of which requires an integrated approach.

Keywords: drone, maritime waste

Introduction

Georgian Black Sea coastline route for centuries links Europe and Asia. With the increased number of population and shipping, as well as river runoff, drainage systems, agriculture, industry and household wastes, pollution of the marine environment has risen as well. Rivers and seas accumulate and transfer wastes in accordance with the current directions.

The research aim: monitoring of Ajara coastline via a drone. The previous researches dealt with detection of Ajara coastline pollution via photometer.

The relevance of the study is backed by application of the drone for ecomonitoring process. The drone priority is defined with its universal application – operative provision of fast and mobile information responds from remote areas without the risk form the persons involved in the research.

The main stages of the research: selection of the research object (Ajara coastline), definition of the research aim and tasks, selection of the research methods (educational/scientific using DJI MATRICE 30 FREE BASIC COMBO drone), arrangement of the research area map.

The reasons, pollution nature (point, diffusive), origin, localization, movement, forecasting of expected results of the waste, plotting on the map and legislative regulations are researched. The problem identification, solution and results monitoring are also implemented within the frame of the research.

The students of Batumi State Maritime Academy are involved in the practical parts of the previous (1, 2) and the current researches, presenting not only educational process component, but also ensures the development of the practical skills in civic consciousness process (3, 4, 5).

The drone is equipped with the systems providing effective monitoring implementation. We are able to mark the monitoring place and the drone proactively takes photos and videos and returns to the starting point.

It is provided with the cloud system, keeping photos and videos, allowing their transfer to the mobile phones and computers.

Waste Monitoring and Classification

The Black Sea is adversely affected by plastic wastes and microplastics. The purpose of our research is to identify the location of plastic wastes accumulation currently posing a serious global problem. Plastics can degrade water quality, increase the risk of flooding and harm various plants and animal species, affecting individuals, populations and communities.

Scientists are developing new approaches to reduce the existing level of the plastic wastes affecting the Black Sea as well as to minimize the product decay of microplastics (6, 7). Researches were implemented according to the following scheme:

I. Determining the sources of the most probable wastes accumulation locations in the Ajara coastline taking the following into account:

1) Shipping - as a source of household wastes;

2) Water circulation peculiarities of the Adjara coastline;

3) Tourism and social activities; Fish market and nearby cafe-restaurants;

4) Fishing activities (types of wastes resulting from activities);

5) Aquaculture activities (exploration of aquaculture areas, including the water column and coastal areas such as rocky shores and sandy beaches.

Figure 1. Sources of garbage accumulation on research sites

The first step in arranging the problem, concerning the coastal litter accumulation, is to identify the polluter. In addition to the above-mentioned factors, characteristics of water circulation affects the accumulation of garbage as well. Currents in the Black Sea are cyclonic in nature. The main current goes around the sea counterclockwise near the coastline, where two cyclonic currents are highlighted (Figure 2.). A steady counterclockwise anticyclonic current is observed offshore the Batumi water area, with a speed of about 45 cm/s. But the water circulation can vary in compliance with the wind effects. The main as well as coastal currents are changeable and vary depending on the seasonal oscillations of the rivers flowing into the sea and the winds.

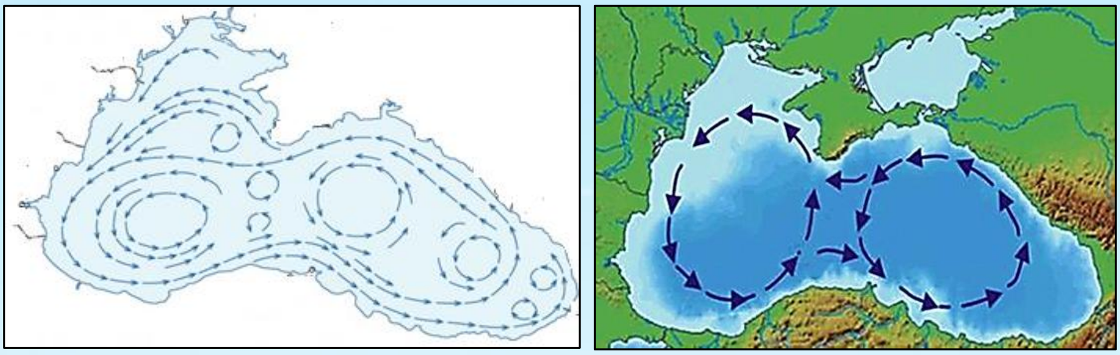

Figure 2. Water circulation in the Black Sea

II. Garbage accumulation, identification and categorization: plastics, wood (branches, chips, fishing net, paper, etc.) (Figure 3). The work has been carried out with students of the Faculty of Navigation.

Figure 3. Garbage collection and sorting

III. Creation of electronic maps taking the places of the garbage/ litter accumulation (into account Figure 3).

The aim of the project is based on two directions:

1. Works implemented along with students;

2. Independent research works.

A group of students, using a low-flying drone, implemented the certain work to detect pollution in coastal waters, resulting mapping accordingly (creating maps of the most polluted sections of the mouths of the rivers of the coast of Adjara). One of the leaders of this group, Otar Tvaradze, independently described the sequence of work carried out, created a map indicating the points of wastes disposal and made the appropriate conclusions, given in his individual article.

We have observed the coastal area nearby “fish market” - “Green Cape”). The mouths of three rivers (river: Bartskhana, Korolistskali, Kubistskali) are located in this zone.

Various methods have been tried for mapping the litter accumulation areas in different environments, but they are often occurred to be complex or expensive. We used drones to detect pollution by plastic with subsequent identification of their further location along the Ajara coastline. As a result, various types of objects have been identified as potential polluters, including plastics. During the research, the locations of various types of household wastes accumulation were identified.

Figure 4. Figure 1. Debris accumulation in different weather conditions: a) sunny days b) rainy days

IV. The next stage is to expand the research area, using the method of combinations of optical and thermal images, for more exact assessment of the amount of plastic wastes, as well as other types of wastes (garbage).

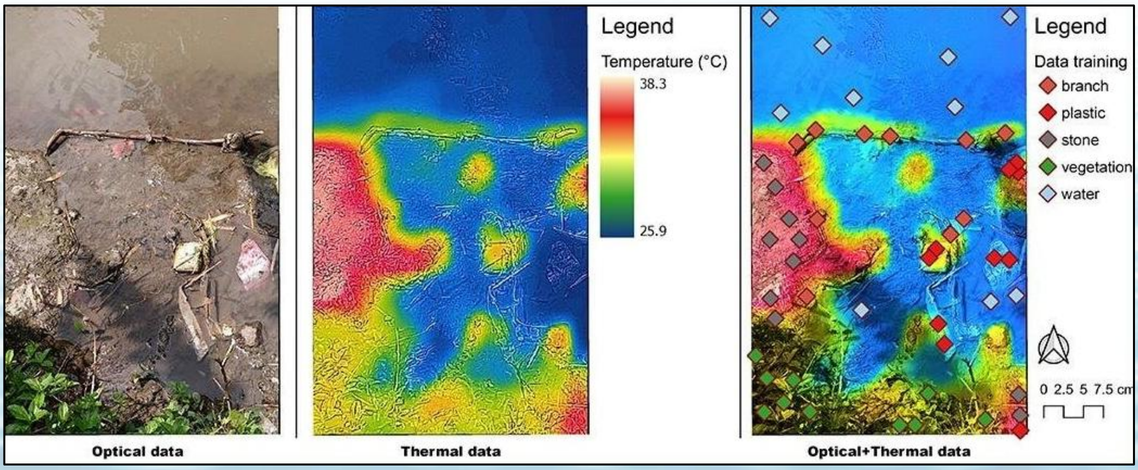

Figure 5. Optical and thermal image of waste (example).

Conclusions and recommendations

As a result of the primary research, the locations of the largest garbage accumulations were identified in the territory of Bartskhana, Gonio, the hydroelectric power station area (the confluence of the Chorokhi and Jochostskali rivers), the fish market of Batumi.

Based on the results obtained and taking the circulation of water into account, we can assume that the location of garbage accumulations, are polluters of the Adjara coastline beaches. This will affect the development of tourism and the economy of the Region accordingly.

Some issues are still unknown and affects the results of the research, as there is no information regarding as to whether the plastic floated on the surface or was submerged into water.

However, the drone detection method is a considerable step forward, quickly identifying the polluter and establishing its further distribution.

As far as we know plastic accumulates in the environment for a long period. Therefore, it is necessary to make all efforts for preventive measures, as well as for timely garbage elimination from the accumulation places determined by us.

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A STUDY ON SUSTAINABLE MARITIME EDUCATION AND TRAINING INFRASTRUCTURE

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Abstract: In this study, the basic factors related to education, which are assumed to be effective in ensuring the safety of life and property of seafarers who change direction and shape according to rapidly developing technology and play an international role, especially on commercial ships, were examined. All global institutions providing maritime training have adopted the STCW rules as a regulatory reference. IMO is always contributing to education with updated STCW based Model Courses. Each nation implements some practices in education according to its own laws and regulations. This situation is clearly seen in the curricula of all institutions providing maritime education. It has been understood through the analysis of some statistical data that visual, practical, tangible education is much easier, understandable and fun than theory in order to keep up with the rapidly developing technology. This result shows that; maritime education institutions should focus on real systems or well-designed virtual application investments. Practical training to be provided with investments made by nations and institutions and the internationally effective curriculum, plan and program to be prepared for this purpose will make an undeniable contribution to the more reliable training of the new generation of seafarers who are working under difficult conditions in the rapidly advancing technological and managerial field.

Keywords: Education, Maritime, Tangible

1. Introduction

Every training is difficult. In order to make it easier and better understood, teaching strategies must be appropriate, applicable and acceptable. Maritime training, which will be carried out by prioritizing the safety of life and property, is an important issue that should be taken seriously due to its international nature. Sailors who work continuously on all kinds of offshore platforms, where activities such as transportation, storage, energy, waste, efficiency, environmental protection and atmospheric pollution are carried out, need to be well trained.

The mandatory requirements of Maritime Education and Training (MET) required for seafarers to perform their duties safely are specified in the international convention on Standards of Training, Certification and Watchkeeping (STCW) prepared by the International Maritime Organization (IMO). General requirements for master, deck and engine departments, radio personnel on certain types of ships, emergency, occupational safety, medical care and survival functions, alternative certification and watchkeeping are included in various sections of STCW. The minimum requirements in MET, are constantly updated by STCW.

On the other hand, the rapid development in the digital industry has not only affected the improvement of marine navigation and engineering systems but also accelerated the shaping of maritime education. The European Maritime Safety Agency (EMSA) has set its vision as an international sustainable and reliable reference in the entire maritime field, including training, by leveraging its unique knowledge in the maritime sector. The World Maritime University (WMU) aimed to advance sustainable global development by increasing postgraduate maritime education and research capacity. In the agreement prepared by the International Association of Maritime Universities (IAMU), which was founded by a group of maritime universities in 1999, it was emphasized that international maritime is rapidly globalizing, that safety, security and environmental protection are vital issues related to maritime, and that the acquired knowledge and skills should be transferred to future generations through quality education and training. Many real and simulative models, research and publications, based on the standards specified in international maritime laws and regulations, continue to be researched in the scientific environment about the difficulties and opportunities, weak and strong points encountered in every field of maritime, especially in education and training. (Ekow Michael 2016). When we look at maritime education from a global perspective, we see that more effective education models are needed in areas such as standards, qualifications, simulator training, e-learning, lifelong learning, expertise, industry, academia, international cooperation and green maritime, which have many dependent and independent variable factors and parameters (Table 1).

Table 1. International existing legal regulators of the Maritime requirements.

Maritime Bussiness	Education and Training (MET)	International Maritime Organization (IMO)	Training, Certification and Watchkeeping (STCW)	Manila Amendments (2010)	European Maritime Safety Agency (EMSA)	World Maritime University (WMU)	Association of Maritime Universities (IAMU),
Industry	Correlatins area between Convansional Maritime bussiness and Maritime Laws, Regulations and Standards						
Awareness							
Standards							
Academy							
Qualification							
Expertices							
Simulation							
e-Learning							
Life-lomg earning							
Green Naritine practices							
International collobrations							

The status of training practices for all areas of the maritime industry is consistently reported in the Journal of Naval Architecture and Engineering Statistics (MarTID2018). A statistical qualitative research related to the mods of trainings needed for personnel working in all sectors of maritime is shown in the table given in the article titled "E-Learning in Maritime Affairs" prepared by S. Galić at all. (Table 2).

Table 2. Trainings needed for personnel working in all sectors of maritime

WHICH TRAINING METHOD/S YOUR ORGANIZATION USES:				
	High usage	Medium usage	Low usage	Not using
Face to face (classroom)	65%	27%	8%	0%
E-learning video sources	35%	35%	19%	11%
E-learning Internet based sources	26%	34%	31%	9%
Simulation	42%	47%	6%	6%
Table-top exercise	17%	58%	22%	3%
Job shadowing	18%	41%	26%	15%
Mentoring	17%	40%	29%	14%
Coaching	21%	41%	21%	18%
ANTICIPATED CHANGE IN TRAINING METHODS USED FOR THE UPCOMING YEAR:				
	Increase	Unchanged	Decrease	
Face to face (classroom)	23%	54%	23%	
E-learning video sources	43%	37%	11%	
E-learning Internet based sources	71%	24%	6%	
Simulation	77%	14%	3%	
Table-top exercise	38%	53%	6%	
Job shadowing	26%	56%	9%	
Mentoring	47%	37%	9%	
Coaching	50%	35%	9%	
USING SIMULATORS TO TRAIN OFFICERS:				
	Bridge officers		Engine officers	
Delivered primarily in-house	44.4%		30.2%	
Delivered primarily in an external facility	42.2%		32.6%	
Not used	13.3%		37.2%	
USAGE OF SIMULATION TRAINING IN THE NEXT 5 YEARS:				
	Increased use	Leave unchanged	Decreased use	
Bridge simulator training	68.2%	18.2%	-	
Engine simulator training	62.8%	18.6%	-	
ANTICIPATED CHANGE IN INTERNAL VS. EXTERNAL SIMULATOR TRAINING IN THE NEXT 5 YEARS:				
Use more in-house simulator	38.1%			
Use more external facility simulator	21.4%			
Maintain status quo	40.5%			

In the article prepared by Junzhong Bao and his co-authors using the survey analysis technique, it is stated that the four main factors affecting the quality of MET in China are the lack of skilled instructors, lack of on-board training opportunities, over-reliance on theoretical teaching and limited financial resources.

One of the most important factors affecting the quality of maritime education is teachers. Perception of talent management, work motivation and their impact on the performance of maritime lecturers were examined by Retno Sawitri Wulandari et al. in the article titled "The Paradigm of Cadet of Motivation and Its Impact on Lecturers'

Performance in Maritime Education". Although the research mentioned in this article was conducted for Jakarta, the subject examined is valid for almost all countries.

The conventional dominant current factors affecting the effectiveness of MET instructors were mentioned by Srđan Vujičić at all in the article published in the WMU Journal of Maritime. (Figure 1).

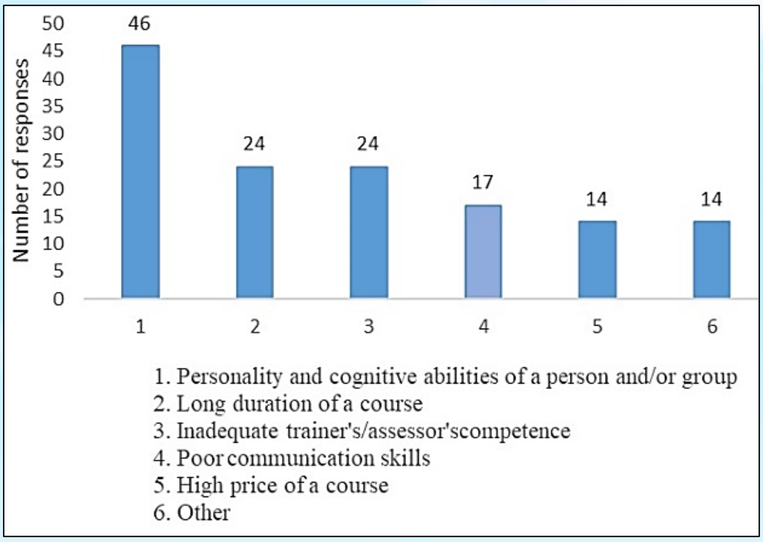

Figure 1. Teacher characteristics affecting maritime education

2. Research and methodology

This article was prepared to ensure the safety of life and property in all maritime-related fields and to compare the training principles, criteria, factors and parameters that will ensure and establish sustainable work efficiency, environmental awareness and energy saving with existing and recommended models. For this reason, the current legislation on maritime education was examined and the literature was scanned as much as possible. Dominant factors such as more than twenty years of theoretical, practical and experimental training experiences, developments in maritime fields, students, teachers, educational opportunities and opportunities were taken into account. Taking into account the parameters of existing conventional maritime training, new training models were shaped according to the dominant factors and parameters that should be present in all training models in maritime fields. It will be possible to prepare mathematical models by converting these preliminary models, which include effective factors and parameters, into more meaningful numerical values through surveys, and to perform the necessary analyzes with the data obtained.

International maritime authorities generally manage the sector with the regulatory standards they prepare for the safety of life and property. On the other hand, in the last fifty years, they accelerated their efforts especially in regulatory mandatory standards, education and applications on energy saving, sea and air pollution.

Ensuring and establishing the safety of life and property in the maritime sector, where people, education and experience play a very important role, is definitely possible with well-prepared theoretical and practical training models. Although there are many theoretical and practical training models currently implemented national maritime training programs vary considerably, excluding international practices. When these differences are examined, it is seen that each country's authority looks at the future of maritime with a different vision and purpose. For example, while some countries accept that the maritime sector is unique and structure their training on this subject, some countries implement their training through this model, considering that all disciplines are already included in all maritime-related fields. Therefore, the question arises whether maritime is based on basic sciences or whether it is a unique sector. This question is important in that the theoretical and practical training to be given in all areas of the maritime industry will meet national and international regulatory standards.

Based on the safety of life and property, which is more important than economic concerns, the maritime sector expects its employees to start work with sufficient knowledge and experience within the framework of these principles, and to increase their experience based on this basic training over the years. In this case, what methods and curricula can be used to meet this training-based need of the maritime industry emerges as an international question that needs to be seriously considered.

Maritime industry regulators, all deal with, defense and develop their own boundered subject, in terms of international aspects. In order to make these relations more effective and efficient, then the factors, especially dominant ones, and the parameters with sub-mods, need to take in account. This is true because Maritime industry became more sensitive in more feasible operations and management. In order to achieve these goals, Maritime education quality treshold continue to increase exponentially.

In this context, the dominant variable subjects, factors and parameters, assumed to affect sustainable maritime education, were taken into consideration from a different perspective in this study. The number of these areas and the dominant factors and parameters they contain may vary depending on need, economic conditions and technological progress. This situation may also cause the maritime education model provided to change. The maritime education planning authority in every sector must revise these changes quickly and sensitively in accordance with international laws, regulations and standards.

The dominant variables on the subject were included in the matrix, which was prepared by taking into account the words mostly included in the surveys about the compliance of the works carried out in all areas of the maritime sector with international standards and which was assumed to be useful in creating a training model (Table 3) (1)

Table 3. Dominant variable subjects, factors and parameters effecting maritime education.

Need	Platform	Subject	Worker	Instructor	Environment	Facilities	Doctrine	Timing	Assesment and evaluation
reason	national	administrative	local	academician	school	classroom	theoric	periodic	laws
scope	international	financial	foreign	specialist	field	laboratory	experimental	seasonal	regulations
level	private	legal	gender	practitioner	online	simulator	operational	optional	standards
		technical	age	laborant		workshop			
			education			multimedia			

Here *N, P, S, W, I, E, F, M, T and A* are the least but not last *n* numbers of dominant areas assumed that effect the preperation of Marine Education Methods in the industry.

$$\boldsymbol{MEM \propto (N, P\ S, W, I, E, F, M, T, A)_0^n} \quad (1)$$

2.1 The needs of effective maritime training model

In order to make the right decision about the Maritime Education Model *(MEM*), the reason (r), scope (s) and level (ℓ) must be fully and precisely stated (2).

$$\boldsymbol{MEM_N \propto [(r_N, s_N, \ell_N)]_0^n} \quad (2)$$

Here r_N, s_N and ℓ_N are *n* numbers of variables related to the needs of any maritime sector.

This is true because it limits the educational model to be applied in terms of the aim pursued, the goal to be achieved and the tools to be used. Since there are many different areas of application in the maritime industry, choosing the right training model and Level for the operating sector is important. Although all sectors such as ship navigation, fleet management, port and hub management are included in the maritime field, the training model and level of the personnel to work must be different. However, global maritime laws, regulations and standards must be fully met. Since the Maritime Sector involves many different administrative, financial, legal and technical issues, the chosen training model must provide and establish these issues in sufficient scope and level.

2.2 The student type impact on the Maritime education model

The global maritime industry covers many sectors with different characteristics. All kinds of education projected for these sectors carry out different goals, objectives and tools with various factors and parameters that influence national, international and private maritime education. (3)

$$\boldsymbol{MEM_P} \propto [(\boldsymbol{n_P}, \boldsymbol{i_P}, \boldsymbol{p_P})]_0^n \tag{3}$$

Here n_P, i_P and p_P are the n numbers of variables related to the national, international and private platforms of the maritime sector.

This factor needs to be taken into account in education models to be prepared for national, international or private maritime sector groups. European Region Action Scheme for the Mobility of University Students project (ERASMUS), which was initiated in 1987, is one of the maritime education model in which this factor is frequently felt.

2.3 The subject type impact on the Maritime education model

The Maritime Sector has a dynamic structure that intensively includes administrative, financial, legal and technical issues. The training model to be prepared in every field related to maritime should cover the effective factors and parameters related to the current law, regulation and standards.

Another issue that should be taken into consideration in the training models to be prepared for the maritime industry sectors is the area in which the training will be given, which includes many different factors and parameters. Another issue that should be taken into consideration in training models to be prepared for the maritime industry sectors is the field that includes many influential factors and parameters. (4)

$$\boldsymbol{MEM_S} \propto [(\boldsymbol{a_S}, \boldsymbol{f_S}, \boldsymbol{\ell_S}, \boldsymbol{t_S})]_0^n \tag{4}$$

Here a_S, f_S, ℓ_S and t_S are the n numbers of variables related to the subjects of maritime sector.

Although these areas and the factors and parameters affecting these areas seem similar, the multiple relationships between them should be taken into account when preparing the educational model on the subject. For example, maritime accidents are an area of maritime law that also includes maritime technical, administrative and financial matters. This feature needs to be taken into account in educational models to be prepared for this field.

2.4 The worker type impact on the Maritime education model

The success of training models to be prepared for each maritime-related field depends significantly on the characteristics of the individuals and/or groups to be trained. It is known that the training received simultaneously by multinational and/or people with different education, knowledge, experience and application skills cannot increase productivity. In fact, although it is known that people with certain qualifications will be employed in certain jobs, it is clearly seen from the demands reflected from the sector and the reports prepared on this subject that more effective training models are needed in order to increase efficiency and prevent loss of life and property.

Since maritime is a globally dynamic business field, the characteristics of the employees such as local, foreign, male, female, education and age are the dominant factors affecting the education model to be prepared for each sector. (5)

$$\boldsymbol{MEM_T} \propto [(\boldsymbol{\ell_T}, \boldsymbol{f_T}, \boldsymbol{g_T}, \boldsymbol{a_T})]_0^n \tag{5}$$

Here ℓ_T, f_T, g_T and a_T are the n numbers of variables related to the worker characteristics of maritime sector.

2.5 The Instructor type impact on the Maritime education model

The fact that maritime-related fields and employees are very different makes it difficult to prepare different training models. Gaining the knowledge and experience required to increase efficiency is possible with instructors specialized in each field. These instructors also need to be trained and certified to be qualified teachers in their field. Training related to maritime fields includes versatile integrated subjects. For this reason, the characteristics of the instructors who will implement new training models that will increase the safety of life, property and efficiency form the basis of the new maritime training models to be prepared.

One of the areas to be taken into consideration when preparing maritime training models is the need for both theoretical and practical knowledge in every field of the sector. In this study, it was envisaged that training talented, competent and certified responsible instructors in line with the same principles for training models for different sectors in the maritime industry is one of the mandatory needs to be addressed. MEM_I is one of the important areas that will affect the maritime training models to be prepared is the trainer portfolio, which has multiple factors and parameters. (6) Instructors should be academicians, experts, laboratorians, technicians and assistants. Instructors to give numerical, theoretical and applied courses, such as workshops and simulators, must be trained according to international norms and have sufficient knowledge and experience in teaching, measurement and evaluation. Experts, practitioners, laboratory assistants and auxiliary staff suitable for the education model must be provided in sufficient quantities with international authorization certificates. MEM instructors must give the lessons in native language, but they must know a foreign language at a level that can explain the characteristics of the course to be given in multinational student applications. Assistants at simulators, laboratories and workshops must have international certificates stating that they have the authority to prepare and organize the training area and to immediately intervene in situations such as possible accidents, malfunctions and errors that may occur.

$$\boldsymbol{MEM_I} \propto [(\boldsymbol{a_I}, \boldsymbol{s_I}, \boldsymbol{p_I}, \boldsymbol{\ell_I})]_0^n \tag{6}$$

Here, a_I, s_I, p_I and ℓ_I are the *n* numbers of variables related to the type of instructor characteristics required in preperation of maritime education models.

2.6 The environment type impact on the Maritime education model

In every training model to be prepared for the maritime sector, the environment in which theoretical, experimental and practical training will take place is an important factor that will affect the quality of education. Any place where all the quality of life, educational tools, equipment and multimedia opportunities specified in the education model are available is considered the best educational environment. Deficiencies in issues such as poor layout, assembly, lighting, ventilation, security and safety will negatively affect training.

In this study, the school (face-to-face), field (application area) and online (multimedia), where the lectures will give, is defined as "environment" (MEM_E). The field, specified in each MEM_E with multiple factors and parameters (7), was considered as important dominant field in preperation of each *MEM*.

$$\boldsymbol{MEM_E} \propto [(\boldsymbol{s_E}, \boldsymbol{f_E}, \boldsymbol{o_E})]_0^n \tag{7}$$

Here, s_E, f_E *and* o_E are the *n* number of fields consist of not last but least dominant variable factors and parameters related to the environment where the lectures will give.

2.7 The facility type impact on the Maritime education model

All types of training models need spaces to be applied efficiently. Since the maritime field covers a wide range of applications, training areas need to be selected and planned correctly in order to effectively train existing employees in these fields theoretically, experimentally or practically. If there is no appropriate classroom, workshop, simulator and/or laboratory in which the training will take place, the training model to be prepared will not be useful. On the other hand, these training places should contain a sufficient number of tools and equipment foreseen in the model in a sustainable manner. This issue is very important in effective education models. Although the investment cost is high, the return on benefits will be short. However, in order to carry out such education models that require high investment in a sustainable manner, the employment of the necessary and sufficient number of experienced personnel responsible for these facilities should also be taken into account.

As in every education model, although theoretical knowledge constitutes the basic teaching in the training models to be prepared for all business areas related to the maritime sector, it should not be forgotten that an effective and efficient teaching and learning is gained by touching the objects, actually working on them, immediately seeing and correcting the mistakes and deficiencies. The issue that should be taken into consideration in this regard, which is a very important factor in the preparation of maritime training methods, is the supply and installation of training tools such as laboratories, workshops, simulators and multimedia in sufficient numbers specific to that field.

The other dominant area affecting *MEM* is the n number of facilities (MEM_F) (8), which include many dominant factors and parameters such as classrooms, laboratories, workshops and simulators, where the courses specified in each model are given. For successful maritime training, these facilities must have a license to comply with international laws, regulations and standards, especially life and property safety.

$$\boldsymbol{MEM_F} \propto [(\boldsymbol{c_F}, \boldsymbol{\ell_F}, \boldsymbol{s_F}, \boldsymbol{w_F}, \boldsymbol{m_F})]_0^n \tag{8}$$

Here, c_F, ℓ_F, s_F, w_F and m_F are the n number of fields consist of not last but least dominant variable factors and parameters related to the facilities where the lectures will give. These places should be equipped with all kinds of laboratories, workshops, simulators and multiple communication devices for the work that the student will do by disassembling, assembling, analyzing, trying, operating, observing, in short, using five senses.

2.8 The doctrine type impact on the Maritime education model

Since the Maritime Sector has areas where many different jobs are performed, different training methods containing different theoretical, experimental and applied knowledge and experience are needed. This issue should be taken into consideration in the models to be prepared. No matter how different the training methods are, all of them require extensive theoretical, experimental and practical knowledge and experience. The training model to be prepared for each field should mainly include the subjects related to that field while providing the necessary basic teachings on maritime. In this type of education models, the theoretical, experimental and practical necessary and sufficient teaching limits are very important in optimizing the expected efficiency in that field. Any unnecessary information will cause the employee to lose attention, responsibility and control.

Each *MEM* belonging to the relevant maritime sector should cover theoretical, experimental and operational areas (MEM_D) (9) including dominant factors and parameters without exceeding the purpose of the subject taught. Curriculums covered by areas should be the same and revised, updated, upgraded by the international authority when necessary and published to the sector on time. Dominant factors and parameters that effect experimental and operational areas should be precisely and correctly specified to meet the international laws, regulations and standards relevant.

$$\boldsymbol{MEM_D} \propto [(\boldsymbol{t_D}, \boldsymbol{e_D}, \boldsymbol{o_D})]_{\boldsymbol{0}}^{\boldsymbol{n}} \tag{9}$$

Here, t_D, e_D and o_D are the n number of doctrine areas consist of not last but least dominant variable factors and parameters related to each sector of the marine industry.

2.9 The timing type impact on the Maritime education model

The Maritime Sector covers very different business areas, employee characteristics, working hours and durations. Improving the efficiency expected from business areas depends entirely on the training, knowledge and experience of those responsible for these areas. In order to train field managers without disrupting ongoing work, separate training programs are required for each business area, but applicable at different times and compatible with each other in terms of subject and timing. Training timing may be recurring, seasonal, or adjusted based on field workload. Administrative, financial, legal and technical laws, regulations and standards must be taken into account in the training schedule of each maritime field.

Timing is one of the most important issues in determining theoretical, experimental and operational course durations (MEM_T) (10) in *MEM* to be prepared for all areas of the maritime industry. Each MEM_T must include sufficient course time to effectively teach seasonal, periodic and elective theoretical, experimental and applied courses.

$$\boldsymbol{MEM_T} \propto [(\boldsymbol{p_T}, \boldsymbol{s_T}, \boldsymbol{o_T})]_{\boldsymbol{0}}^{\boldsymbol{n}} \tag{10}$$

Here, t_D, e_D and o_D are the n number of doctrine areas consist of not last but least dominant variable factors and parameters related to each sector of the marine industry.

2.10 The assesment and evaluation type impact on the Maritime education model

As in all education models, different factors and parameters needed to measure and evaluate all aspects of teaching and learning can be taken into account in education models related to the maritime sector. In order for the measurement and evaluation processes to be successful, the method to be prepared must cover the legal, managerial, financial and technical issues related to the maritime field. On the other hand, the factors and parameters to be used in measurement and evaluation should be determined strictly based on the maritime field training needs to be applied. The scales and units to be used in evaluations should be concrete enough to enable numerical analysis of the results. The fact that the unit that will scientifically determine the impact of the model to be applied on the education to be given is composed of experts in measurement and evaluation is undoubtedly a separate factor.

In this study, it was envisaged that global *MEM*s, which will be prepared by taking into account many dominant variable issues, factors and parameters, must strictly comply with international laws, regulations and standards (MEM_A) (11) in order to be effective.

$$\boldsymbol{MEM_A} \propto [(\boldsymbol{\ell_A}, \boldsymbol{r_A}, \boldsymbol{s_A})]_0^n \quad (11)$$

Here, ℓ_A, r_A *and sA* are the *n* number of assessment and evaluation areas consist of not last but least dominant variable factors and parameters related to each sector of the marine industry.

3. Results and discussions

The development of the global maritime industry in every field, especially the safety of life and property, is possible with properly prepared training methods that include many factors, variable areas, factors and parameters related to administrative, property, legal and technical norms such as international laws, regulations and standards. Rapidly developing digital technology enables more precise measurement, analysis and interpretation, and more accurate decisions in the preparation of training models related to all areas of maritime.

The fact that people are the most important factor in the development of the maritime industry in the right direction requires their training to be in the right direction. Purpose, students, teachers and educational tools are the indispensable basic elements of the MEN to be prepared. Global education technology has shown that on-site practical teaching and learning supported by theoretical knowledge is more economical, technical and efficient because it is easier, permanent and quicker. This type of training enables employees to make quicker and more accurate decisions in the face of events and take the necessary precautions.

It is not yet known to what extent technological developments such as artificial intelligence made possible by digital technology will make autonomous operations reliable. What impact these developments will have on MEMs today is an important issue that cannot be answered yet, as they have many active areas, factors and parameters. Under these conditions, it was envisaged that it would be a good decision to continue the work on new MEMs that cover the dominant factors and parameters that will cause all possible problems that may be encountered in all areas of the maritime industry.

4. Conclusion

The Maritime industry is global. All sectors in this industry, which include multiple variable factors and parameters, need to develop training methods in accordance with all laws, regulations and standards prepared by international authorities, especially the safety of life and property. The factors and the parameters effecting every individual Marine Education Models, that makes a large matrix (cluster), in this study, has not been shown in detail due to variate at any time. On the other hand, they have to take into account for optimizing the MEMs. The training methods to be applied must be applicable, practical and acceptable. Vision, purpose, task and tools are the main topics that should be taken into consideration when determining the most appropriate training method. For this, all possible factors and parameters needed by each training method must be taken into account. Regardless of the purpose and method, the basis of the maritime education to be implemented is determined by the quality of the main elements: student, teacher, curriculum and tools. Sustainable success of maritime sectors equipped with training of this nature is inevitable. The most important issue that every teacher who has been teaching for many years, not only in maritime education but also in other sectors, always emphasizes is that no other method can replace tangible (tactile) learning. The most important issue needed when preparing Maritime Education Models is national, international and personal behavior that accepts human, safety, environment, laws, regulations and standards as a global reference. Although studies on digitization, automation, autonomy and artificial intelligence are still continuing intensively, it cannot yet be predicted what effects they will have on Maritime Education Models. In this case, it is necessary to continue working on models that will be prepared for a longer period of time, taking into account international norms on Maritime Education Models and the dominant topics, factors and parameters envisaged in this study.

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WEB-BASED ROUTE PLANNING TRAINING PRACTICES

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Abstract: With the existing and upcoming new technology integrated into MET (Maritime Education and Training) as well as the simulator-based trainings, the new exploration of MET practices has been conducted accordingly. To shorten the gap between the land-based training with the onboard ship operation, the web-based training activities have been carefully designed including the real time weather forecast (wind, current, tide, etc.), optimal route planning, the calculation of fuel consumption and ETA (Estimated Time of Arrival), etc. The planned optimal route can be drawn via the platform Hi-Fleet in terms of a serial data processing and group discussion. The follow-up simulator-based training is conducted afterwards to test their efficiency of the teamwork. Three-year contingency training results showed most of the students or trainees can optimize their route in an energy and time efficient manner as well as to avoid the bad weather hamper via HiFleet. Thus, the teamwork efficiency evaluated in bridge simulator showed the group internal anxiety. The recommended group counselling activities prior may ease their untrust and anxiety. The actual effect and practices need to be exercised and tested further.

Keywords: MET; route plan; web-based; simulator-based

1. Introduction

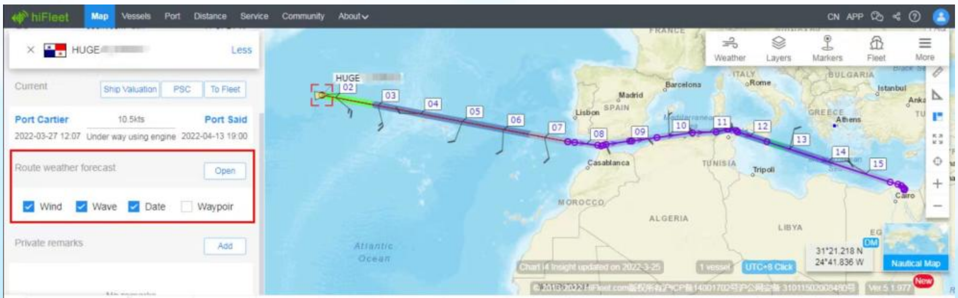
The MET (Maritime Education and Training) has developed continuously for decades to facilitate the seafarers worldwide in operating the modern ships better and more efficiently. The new updates for the MET process arose from the revised IMO (International Maritime Organization) model courses, class-in activities, online courses, APPs, new technology integrated into simulator training as well. The required skills of seafarers have been revised accordingly with regarding to the energy efficiency, risk avoidance and better team work cooperation. With the adequate knowledge but segmented from different subjects, the planned courses which can integrate the mastered knowledge and assist the students or trainees in applying this knowledge into practice for example in simulators is of significance.

The well-designed HiFleet APP as well as its official website will be adopted into the MET activities to immerse the students or trainees into real time weather forecast including the fouling weathers (rough sea, typhoons, dense fog, etc) so that they can plan their route more optimal with the consideration of fuel consumption as well as ETA (Estimated Time of Arrival).

2. Methods

The HiFleet platform (APP+website) is constructed to track the managed fleets regarding the ship's real position, real time meteorological data, traffic density, planned route etc. For this project, the functions of real time weather forecast, route planning, fuel consumption, ETA will be utilized. The optimal route can be updated according to the time interval of weather forecast data as well as the real time weather data (Du et al, 2022).

The planned route can be formed automatically with the input of departure and arrival co-ordinates or location, and the weather forecast along with her route can be displayed with the alternative layer. See Fig 1 below in detail.



Time UTC+8	04-01 18:00	04-02 00:00	04-02 06:00	04-02 12:00	04-02 18:00	04-03 00:00	04-03 06:00	04-03 12:00	04-03 18:00	04-04 00:00	04-04 06:00	04-04 12:00	04-04 18:00
Pressure	1005	1004	1005	1006	1010	1010	1012	1012	1015	1017	1021	1021	1023
Wind deg/speed(kts)	113/26	129/23	159/21	176/28	167/24	165/24	163/22	168/13	224/11	270/16	262/15	255/16	232/14
Class	6	6	5	7	6	6	6	4	4	5	4	4	4
Wave(m)	4.0	4.2	4.2	3.7	3.9	4.1	3.9	2.9	2.6	3.1	2.4	2.6	2.9
Current deg/speed(kts)	307/0.1	344/0.2	358/0.1	015/0.2	082/0.1	076/0.1	146/0.0	343/0.1	047/0.1	111/0.2	150/0.1	152/0.1	163/0.1

Figure 1. Planned route with the weather forecast along the voyage

Global marine weather forecast from US NOAA, is more user-friendly for mariners, including pressure, wind, sea and current forecast in the next 15 days.

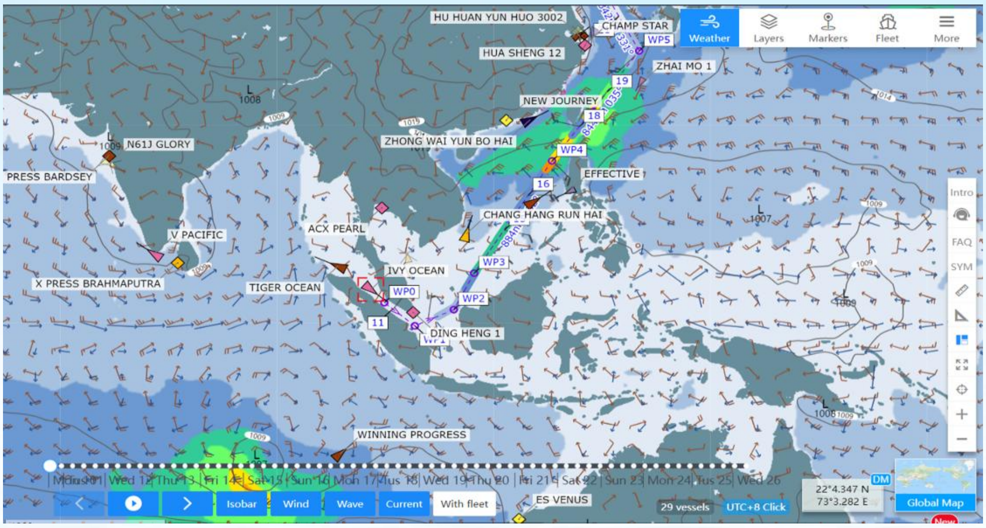


Figure 2. Weather forecast with fleet

After the ship's route planned, the weather forecast can deduce with the ship's planning route. The video will predict the future weather condition along the ship's pathway.

Refer to the predicted pathway of typhoon, the route can be planned to avoid it. The closest point and closest distance from the typhoon can be marked. There is multi-typhoon option, and ship's position and speed are editable. An optimal route can be formed with the consideration of calculation of fuel consumption as well as sailing time.

Voyage weather forecast mail service

After the captain sending the current voyage planned route to the HiFleet email reports@hifleet.com by registered email and the daily weather forecast data updating, the weather forecast for this voyage will be sent to vessel's email automatically, including the weather elements, speed estimation, deck reckoning and weather facsimile chart for the next 5 days. See Picture 1 below as the email report sample to captain.

Dear Captain,

Your vessel "(IMO ,MMS),had a weather report as attached issued at 20230619 1800UTC

This forecast was reckoned by using **12.0 kn,** to set up the planned speed, please click the following speed figure.

8.5kn 9kn 9.5kn 10kn 10.5kn 11kn 11.5kn 12kn 12.5kn 13kn 13.5kn 14kn 14.5kn 15kn 15.5kn 16kn 16.5kn 17kn 17.5kn 18kn 18.5kn 19kn 19.5kn 20kn 20.5kn 21kn 21.5kn 22kn 22.5kn 23kn 23.5kn 24kn 24.5kn 25kn 25.5kn 26kn 26.5kn 27kn 27.5kn 28kn 28.5kn 29kn 29.5kn 30.0kn. Or reply this email with the planned speed, for example, **reply 12.5** if you want to set the planned speed as 12.5kn.

Besides, this report is issued once per day. **To receive 6-hour updated reports,** please click This link. To unsubscribe this report, please click This link.

You could login our web www.hifleet.com to follow more vessels. And you are welcomed to install our APP, hiFleet in App Store or Google Play, for ready availability.

Bon Voyage!
www.hifleet.com

Picture 1. Update report to captain

3. MET practices-web-based route planning courses

At Linnaeus University, Kalmar Maritime Academy, the Master Mariner class has for more than 10 years completed a real-time journey between Europe and the United States. The trip is carried out with full consideration of all current external factors such as weather, waves, currents while the students are on campus in Kalmar and from there have daily briefings within their team for various decisions and making the required position reports to the company (The senior lecturer) for the ongoing trip. Students must pay close attention to the weather to avoid damage on cargo and vessel but must meet the required ETA, set in the assignment. During the ongoing task, the teaching team follows the progress of the journey through the daily position reports. After completing the trip, all reports are compiled, and the assignment is summarized at group seminars and lectures.

3.1 In-class tasks

The students are grouped into ship teams of 3-4 participants per group and receive all information for the task by lectures and via the course pages at a web-based learning- platform, currently "Moodle".

The task has varied to some extent over the years, but in recent years it has been a journey between Gothenburg, Sweden, and New York, USA. During the spring semester of 2004, the sea voyage commenced (COSP) on Tuesday 6 February at 08:00 ZT and ended (EOSP) on Saturday 17 February at 17:00 ZT.

The time for the voyage is adjusted each year based on the forecasted weather situation. Required ETA is set for the vessels to be able to operate at an energy-efficient speed and not have to run full sea-speed to meet the requirement for arrival time.

The ship type has been a half-loaded car carrier with a draught between 7-8 meters. A type of ship and cargo that requires great consideration of prevailing waves and swells. The students get additional information of recommended speed in different wave situations.

The initial question the groups face is to decide on the best course of action. Normally, teams make a variety of route options well in advance of the COSP, with the main options being (1) via the English Channel (2) via the Pentland Strait. After that, it is discussed what speed the ship must maintain and how the teams should relate to the ECA and SECA zones. The ship has a full bunker at departure, both MGO and HFO are used on board. A challenge for the teams is how to consider the type of bunker and the bunker cost when deciding on speed inside the different areas. Actual bunker-price and currency exchange rate are given in the precondition.

Over the years, Kalmar Maritime Academy has used various partners to deliver weather forecasts. For a few years now, a good collaboration has developed with the team behind Hi-Fleet, which enables the students to take part of weather forecasts by a Web-based tool, and to carry out the routine reports from the ship. As a complement to Hi-Fleet's weather data, it is customary for students to use "Windy.com" to collect weather forecasts for their daily decisions.

The student teams must carry out all the reports from their vessel that are common in today shipping. Hi-Fleet enables (1) Route Plan, (2) Departure report, (3) Daily Position report, (4) Arrival report. In parallel with the reports via Hi-Fleet, the teams carry out the same type of reports to the "shipping company" via the course page in a simplified system.

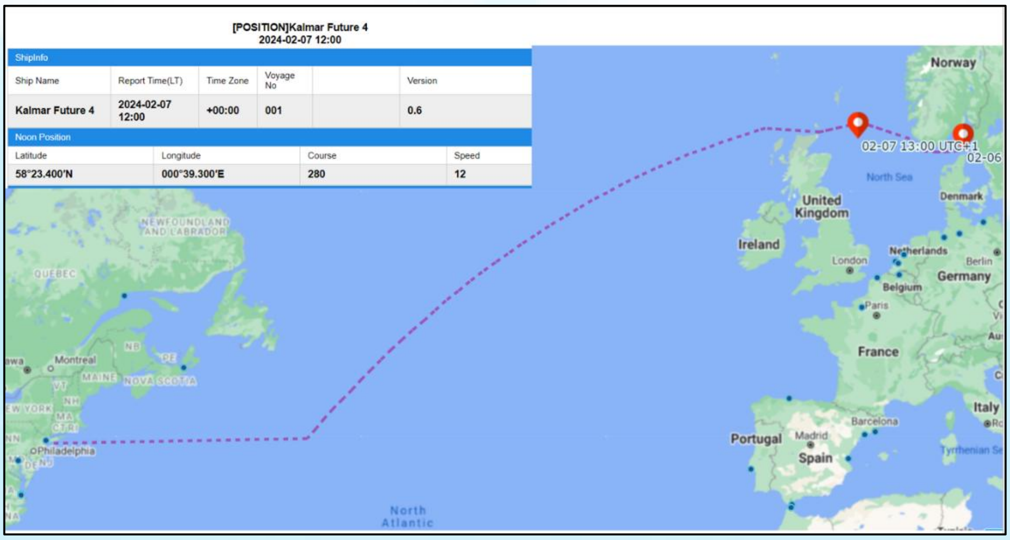


Figure 3. Daily report from team "Kalmar Future 4" shown in Hi-Fleet system by the lecturer.

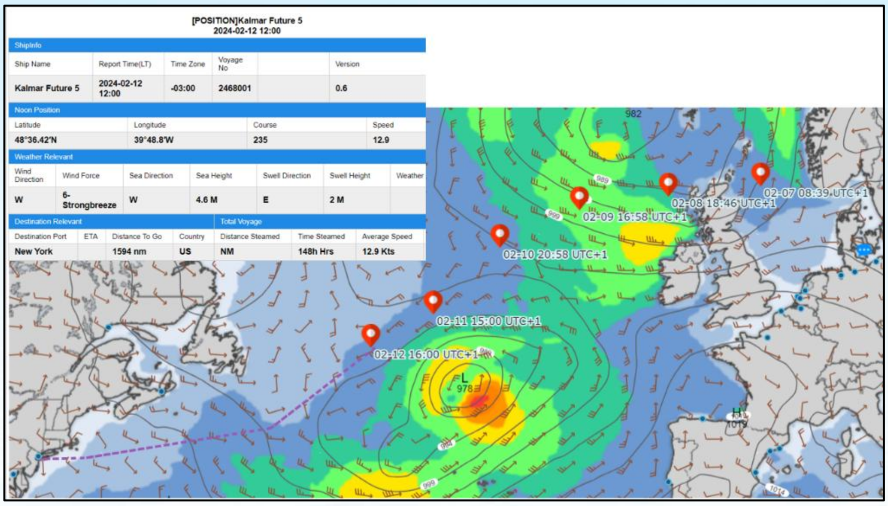


Figure 4. Daily report from team "Kalmar Future 5" after six day voyage, shown in Hi-Fleet with weather overlay

The bridge team will complete their watch and steering as well as coordination with master, other ships, and shore stations until the arrival of their port of destination.

3.1.1 Result

The results vary from year to year, largely depending on what weather situation that occurs. In 2023, the students experienced "the storm of the century" where the shipping company, the senior lecturer, had to adjust the required ETA during the trip. This year's task, 2024, offered weather conditions that meant that all ship teams chose to route via Pentland sound.

After the trip is completed, all reports and results are compiled, after which the various decisions and opportunities are discussed at group seminars. Tables 1 and 2 present some of the results for the last three years. It can be stated that due to weather changes, the ships chose to go different ways. Sometimes a change of route means that the vessels need to go a longer or shorter route in the US SECA zone than planned, which results in a change in bunker consumption of the different grades, MGO and HFO.

Table 1. Average value for all teams, Voyage year 2022, 2023, 2024.

		Planed before departure	Reported at arrival
Distance	-2024	3557 M	3490 M
	-2023	3814 M	3609 M
	-2022	4041 M	4333 M
Average speed	-2024	13,0 knot	12,6 knot
	-2023	14,2 knot	13,1 knot
	-2022	15,3 knot	15,9 knot
HFO consumption	-2024	206 m3	160 m3
	-2023	305 m3	269 m3
	-2022	359 m3	377 m3
MGO consumption	-2024	70 m3	105 m3
	-2023	134 m3	164 m3
	-2022	287 m3	156 m3

Table 2. Average value for all teams, Voyage year 2022, 2023, 2024.

		Average	Min	Max
Cost (Euro)	-2024	154 000	138 000	172 000
	-2023	241 000	137 000	304 000
	-2022	278 000	217 000	355 000
EEOI (g CO2)/tonM)	-2024	52,8	46,6	62,1
	-2023	82,5	57,4	103,9
	-2022	27,3	20,7	33,3
Consumption (liter /M)	-2024	76,7	68,5	88,1
	-2023	119,5	80,4	149,2
	-2022	123,8	93,7	153,2

3.1.2 Route optimization

In addition to the task described above, different types of tools for route optimization have been used in these exercises. The aim has been for the students to become familiar with existing tools and at the same time be able to evaluate the effect of an optimization process.

One year, the ship teams were given various opportunities to use optimization tools and weather data/forecasts. Some of the teams were given the opportunity to carry out the trip solely based on optional weather forecasts, but no opportunity for optimization. A few other teams were given the opportunity to use a conventional optimization tool in addition to optional weather data and based on this make their decisions about how the trip should be carried out. The third option assigned to the other teams was to use optional weather data but also optimize the route with a new AI tool.

A total of 11 groups carried out the current task where the results indicated that those who used the AI tool as a basis for their decisions had a lower fuel consumption and thus less environmental impact.

Table 3. Comparison between methods of optimizing the route.

	EEOI (Gram CO2/Ton M)	Consumption (liter / M)
Free choice of weather forecasts, no route optimizing	21,2	97,6
Route optimizing with conventional tool	20,0	90,9
Route optimizing with a new AI-tool	16,2	74,4

3.2 Follow-up simulator-based training

At Shanghai Maritime University (SMU), the abovementioned teaching plans are ongoing and the planned route is carefully evaluated and afterwards the more real scenario will move to the simulators so that the students can work together to complete their watch during their voyage along with the real-time weather conditions via HiFleet to enhance their team work effectiveness. With the marine simulation training, the students can update the scenario and display the detailed awareness of what is described as professional conduct in line of notion of "good seamanship" accordingly (Starup et al,2024; Heikkila et al, 1997).

The students are grouped into each simulation bridge (eight in total)with four participates: OOW, helmsman, captain, observer. The master will lead the discussion and briefing the planned route with the consideration of the forecast weather and other issues related to safe passage for the first 10-15 minutes. The designated OOW, helmsman will execute the steered orders and keep watching the radar, ECDIS, ect and communicating with other ships for collision

3.2.1 Team work efficiency

In terms of the simulation-based bridge operation, the coordination among the bridge team can be evaluated. As for the real working circumstances, the performance of the team work is always be highlighted, but the feedback of the evaluation showed that1) they feel uncomfortable and not free to steer when they are strangers to each other;2) the helmsman cannot follow the order from OOW and respond as required but reluctant to confirm with OOW again. Those difficulties the students encountered during the teamwork can be dealt with and overcome with the group counselling theories-based activities.The training scenario can be classified by stress levels, which were found to be associated with reduced visibility, equipment failure and severe weather conditions(Xue et al, 2024). The interdisciplinary collaboration is needed to tailor the mental health interventions to seafarers' unique need and unravel the mysteries of seafarers' resilience and coping mechanism(Ay et al, 2024). The instruction of skills and methods (group counselling) treatment may be effective in controlling test anxiety (bridge operation)and increase learning strategies(Zarei et al,2010).A sense of mutual trust among group members is one of the significant elements increasing the effectiveness of a group. The group members' trust level increased through group counselling process (Gultekin et al,2011).It was believed that awareness developed within group study(in terms of group counselling) would positively affect the individual's sense of self and social relationships(Erden S., 2015).

Overall, the results showed the students benefit a lot from the simulator-based practices and enhance the awareness of potential risks in fouling weathers and increase the energy efficiency in terms of serial actions.

4. Conclusions

By allowing the students to carry out the exercise in real time with required ETA and to consider actual weather, they are given a realistic task that requires that their knowledge from courses in e.g. Navigation, Meteorology, Oceanography, Seamanship, Voyage Planning, Bridge Routines, Bridge Resource Management and Team Training must be applied. In addition, the use of the Hi-Fleet tool provides the opportunity to gain experience from a modern web-based reporting system. Hi-Fleet also enables the teaching staff to continuously follow the ships on the map based on all group's daily reports. When Hi-Fleet also enabled an overlay of actual weather and wave, it gave the exercise new input for a learning purpose.

At the final seminars, the groups various decisions are discussed and the effect these have had on the ship's operation from aspects such as safety, economy, and the environment. Through analysis of the results and the various reports, common conclusions can also be demonstrated about good or less good decisions by the different teams.

The assignment is perceived as time-consuming, by both students and the teaching staff, but gives positive feedback to the learning outcome and puts together many pieces of the puzzle for the students as a summarizing real exercise before they take their exam and first job as an officer.

With the well-organized in-class demonstration of route planning utilizing the edge-cutting technology platform HiFleet, the students can monitor the real time weather data along their planned route for optimizing their route with the consideration of bad weather avoidance as well as the calculation of fuel consumption and ETA under the amended route for a better decision making. Meanwhile the bridge team operation will highly rely on the internal member trust and the group counselling activities can be executed prior to the follow-up bridge simulator training to increase their mutual trust and confidence for the purpose of realization of good team work.

Cover Letter

The authors of this paper-web-based route planning training practices recommended professor and doctor Qinyou Hu as the correspondence author with his email address (qyhu@shmtu.edu.cn). Integrated with the current simulator-based training practices, this paper recommended to utilize the flatform HiFleet for her provision of the real time weather forecast data to avoid the potential risks for the ship's planned route, to monitor the ship's fuel consumption for the consideration of energy efficiency and calculate the accuracy of ETA for the stakeholder's interests. Agreed with most of the current practices and research of MET based on simulator, this recommended model gave the students or trainees a hands-on opportunity to access their management to their fleet or ship with the real time weather forecast along their planned route as well as the consideration of the optimizing their planned route in a cost and time efficient way. The feedback of the simulator-based training afterwards showed the inadequacy of the teamwork skills will be possible to hamper the safety of bridge operation, the further group counselling techniques will be adopted to evaluate the teamwork efficiency. This practices with interdisciplinary theories and techniques exercised in Sweden and China provided a valuable sample for further simulator-based trainings as well as MASS scenario and academic practices. It is recommended to be included in IMLA29 for publication in the Proceedings.

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A SYSTEMATIC LITERATURE REVIEW ON TECHNOLOGICAL TRENDS IN THE MARITIME INDUSTRY

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Abstract: Digitalization has emerged as a transformative driver for all sectors, revolutionizing traditional practices and opening up new opportunities for efficiency and innovation. The maritime industry, with its complex and interconnected ecosystem, is also following this transformation. This paper presents a systematic literature review that aims to provide a comprehensive overview of the digitalization climate in the maritime industry. In this study, the existing literature was analyzed to identify key trends related to the adoption of digital technologies in maritime operations. Through a systematic literature review (SLR), digitalization studies in the maritime sector over the last decade were identified. The obtained data was analyzed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The analysis revealed several recurring themes, including the integration of IoT (Internet of Things) devices for real-time monitoring, the application of AI and machine learning algorithms for predictive maintenance and decision support, and the use of blockchain technology for secure and transparent operations. In addition, significant challenges such as cyber security and privacy concerns, traditionality of maritime industry, seafarers' adaptation challenges to digitalization were noticed that impede the widespread adoption of digitalization in the maritime industry. Despite these challenges, the study highlights the great potential of digitalization to enhance operational efficiency, safety, security, and sustainability in maritime activities. In conclusion, this systematic literature review provides valuable insights for stakeholders in the maritime sector, including policymakers, practitioners and researchers, to effectively manage the complexity of digital transformation. By understanding the current state of digitalization and anticipating future trends, stakeholders can develop effective strategies to leverage digital technologies and move the maritime sector towards a more efficient and sustainable future.

Keywords: maritime industry; maritime 4.0; digital transformation; digitalization; systematic literature review

1. Introduction

The maritime industry plays a fundamental role in global trade, responsible for the transportation of approximately 90% of the world's goods. The critical role of the maritime industry in the global economy highlights the necessity for the implementation of efficient, safe, and sustainable maritime operations. In recent years, technological advancements have had a transformative impact on a variety of industries, leading to considerable enhancements in efficiency, productivity, and innovation. The most significant technological trends include the Internet of Things (IoT) (Ashraf et al. 2023; Gyamfi et al. 2023), artificial intelligence (AI) (Laperrière-Robillard et al. 2022; An et al. 2023), machine learning, blockchain (Carlan et al. 2020; Nguyen et al. 2022), big data analytics, and augmented and virtual reality (AR/VR) (Filipkowski 2013; Vukelic et al. 2023). These technologies have transformed traditional practices across sectors such as manufacturing, healthcare, logistics, and finance, thereby creating opportunities for the development of new business models and operational strategies.

The maritime industry, with its complex and interconnected ecosystem, is also experiencing a digital transformation (Kavallieratos and Katsikas 2020; Kuo et al. 2022). The digitalization of the maritime industry holds the potential for significant advantages, including enhanced operational efficiency, improved safety and security, reduced environmental impact, and increased transparency and accountability. The Internet of Things (IoT) enables the real-time monitoring of vessel operations, while artificial intelligence (AI) and machine learning algorithms facilitate predictive maintenance and decision support. Blockchain technology, meanwhile, ensures secure and transparent transactions.

Despite the considerable potential of digitalization, the maritime industry is faced with several challenges that impede its adoption. Cybersecurity and privacy concerns, the traditional nature of the industry, and the adaptation challenges faced by seafarers are significant barriers to digital transformation. In order to effectively address these challenges, it is essential to gain a comprehensive understanding of the current digitalization landscape and the factors influencing its adoption.

This paper aims to fill this gap by providing a systematic literature review (SLR) that offers a comprehensive overview of the digitalization climate in the maritime industry. The study analyzes existing literature in order to identify the key trends, technologies, and challenges associated with the adoption of digital technologies in maritime operations. The findings offer valuable insights for stakeholders, including policymakers, practitioners, and researchers, to effectively navigate the complexities of digital transformation and develop strategies that leverage digital technologies for a more efficient and sustainable maritime industry. The study consists of five main sections. First section introduces the motivation of the study. Following section describes the research methodology. Third section presents the detailed keyword search process and the filtering process of the results. Next section provides a detailed analysis of the selected studies, highlighting key trends, and technological application. Section five discusses the implications of the findings, identifies research gaps, and proposes future research directions to advance digitalization in the maritime industry. Final section summarizes the main findings of the study, highlights the importance of digitalization for the maritime industry, and emphasizes the need for further research to fully realize its potential benefits.

2. Research Methodology

The research methodology of this study utilizes a systematic literature review (SLR) approach, which is essential to synthesize existing research and provide a comprehensive understanding of a given topic. An SLR methodically collects and analyzes multiple research studies or articles. It thus provides a robust framework for identifying gaps in existing knowledge, consolidating findings and drawing evidence-based conclusions. This approach is particularly valuable in rapidly evolving fields such as digitalization, where it is crucial to keep up to date with the latest developments and trends.

To ensure robustness and transparency of the review process, this study follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. PRISMA is a well-established methodology that provides a structured approach for conducting systematic reviews and meta-analyses. It ensures transparency in the review process and comprehensive reporting (Stewart et al. 2015). By following the PRISMA guidelines, researchers could ensure that their reviews are methodical and their findings are reliable. The PRISMA framework includes several stages: identification, screening, eligibility and inclusion (Sathurshan et al. 2022). Each stage is designed to systematically filter and select studies according to criteria defined in the review protocol. This ensures that only the most relevant and up-to-date research is included in the review. The use of PRISMA increases the reliability and validity of the review process, making it a widely accepted standard in academic research (Ngo et al. 2021).

Table 1. Review protocol.

Item	Description
Database	Scopus; Web of Science
Keywords	(maritime) AND ("digit*" OR "maritime 4.0" OR "Digital Technolog*" OR "Digital* transformation" OR "Internet of thing*" OR iot OR "Internet of service*" OR "artificial intelligence" OR "Big Data" OR "Cloud comput*" OR "blockchain" OR "virtual reality" OR "Augmented Reality") NOT (port OR offshore OR military)
Boolean Operators	AND; OR; NOT
Search Fields	Title; Abstract; Keywords
Exclusion Criteria	Papers that related with the digitalization in maritime industry but do not directly relate with the vessels (e.g., ports, offshore structures, underwater, military, education, etc.)
Language	English
Publication Type	Article; Review; Book; Book Chapter
Research Area	Engineering
Time Window	2014-2023

The first step in this study is to create a literature review protocol, detailed in Table 1. The protocol outlines the specific criteria and procedures used to conduct the literature review and selection process. The review protocol ensures that the study follows a consistent approach, and increases the reliability of the findings.

3. Literature Search

The literature search was conducted in November 2023 using Scopus and Web of Science, which are considered to be the most reliable and comprehensive databases in the academic literature. These databases provide a wide coverage of peer-reviewed articles, enabling research on digitalization in the maritime industry to be covered on a large scale (Harzing and Alakangas 2016; Shenoy et al. 2022; Johan et al. 2022). Accordingly, appropriate keywords were identified to reveal studies related to the digitalization of the maritime industry. The search strategy included a combination of keywords related to digitalization and the maritime industry and Boolean operators to refine the results. The detailed keyword search process and filtering steps are shown in Table 2.

Table 2. Keyword search.

Step	Keyword Search	Publications	
		Scopus	WoS
1	(maritime) AND ("digit*" OR "maritime 4.0" OR "Digital Technolog*" OR "Digital* transformation" OR "Internet of thing*" OR iot OR "Internet of service*" OR "artificial intelligence" OR "Big Data" OR "Cloud comput*" OR "blockchain" OR "virtual reality" OR "Augmented Reality")	3836	1942
2	(maritime) AND ("digit*" OR "maritime 4.0" OR "Digital Technolog*" OR "Digital* transformation" OR "Internet of thing*" OR iot OR "Internet of service*" OR "artificial intelligence" OR "Big Data" OR "Cloud comput*" OR "blockchain" OR "virtual reality" OR "Augmented Reality") NOT (port OR offshore OR military)	2956	1492
3	Filtered by year: 2014-2023	2456	1315
4	Filtered by language: English	2391	1264
5	Filtered by document type: Article; Review; Book; Book Chapter	1049	865
6	Filtered by research area: Engineering	595	407

The initial search using the expanded keywords "maritime" AND "digit*" OR "maritime 4.0" OR "digital technolog*" OR "digital* transformation" OR "internet of thing*" OR "iot" OR "internet of service*" OR "artificial intelligence" OR "big data" OR "cloud comput*" OR "blockchain" OR "virtual reality" OR "augmented reality" resulted in a large number of publications.

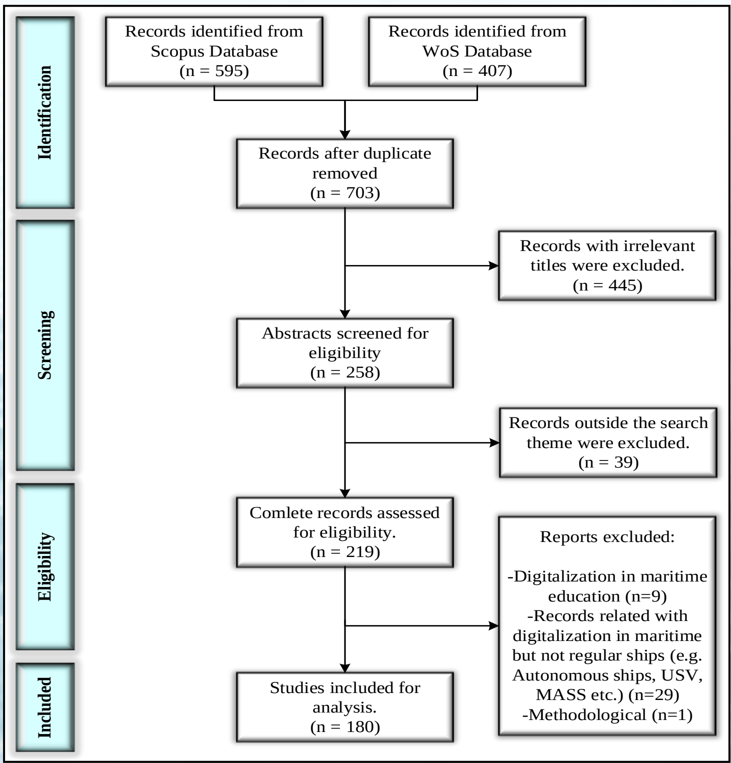

Figure 1. PRISMA flowchart of the literature search process.

Also, exclusion criteria were applied to ensure the relevance of the selected studies. This study mainly focuses on onboard ship technological developments. For this reason, the results were refined by the removal of irrelevant sectors, such as ports, offshore structures, and military applications. Following the application of exclusion criteria, the number of relevant publications was reduced to 2,956 in Scopus and 1,492 in Web of Science. The publications were filtered to include only those from 2014 to 2023. Subsequently, only English-language publications in the form of articles, reviews, books, and book chapters were filtered. Ultimately, the research area was refined to engineering, and the filtering process was concluded with 595 pertinent publications in Scopus and 407 in Web of Science.

The PRISMA flowchart (Figure 1) constructs the identification, screening, eligibility and inclusion stages of the review process. Initially, the search revealed a large number of publications. After removing duplicates, 703 publications were screened for eligibility. This was followed by a detailed review of 258 abstracts. Finally, 219 publications were fully reviewed, leading to the final selection of 180 publications that met the criteria and were included for detailed analysis.

This structured and methodical approach, guided by the PRISMA framework, ensures that the review process is comprehensive, transparent and reliable. This provides a solid base for the analysis and findings presented in the study.

4. Analysis and Findings

4.1. Main information

This study examines academic publications on digital transformation and technology applications in the maritime industry over the last decade. After a comprehensive literature review, 180 relevant publications were identified. The analysis of these publications shows a significant annual growth rate of 56.4% in the number of publications. This indicates a rapidly growing interest and research activity in this area. Furthermore, the average age of these publications is only 1.9 years. This highlights that digital transformation in the maritime sector is not only a highly relevant and trending topic, but also in its early stages of evolution. These metrics highlight the novel and dynamic nature of maritime digital transformation research. The main information on relevant publications is presented in Figure 2.

Figure 2. Main information

4.2. Annual scientific publication and time trend

The general trend of annual publications is shown in Figure 3. It can be seen that the number of publications on digital transformation in the maritime industry has increased significantly, especially since 2019. This period coincides with the rapid development and adoption of new technologies such as blockchain, augmented reality (AR), artificial intelligence (AI), and the Internet of Things (IoT). These technologies have opened new paths for research and application in maritime operations, leading to a growth in academic interest and publications. The rapid increase in the number of publications per year is a clear indication of the growing importance and awareness of digital transformation in the maritime industry. This trend reflects the industry's growing efforts to leverage digital technologies to improve operational efficiency, safety, security and sustainability. The significant increase in publications also indicates that researchers and industry stakeholders are actively exploring innovative solutions to address the complex challenges associated with maritime operations.

As shown in Figure 3, the number of publications per year increased moderately from 2014 to 2018, with a sharp increase starting in 2019. This growth trend highlights a significant change in the industry's focus on digital transformation, possibly driven by the noticeable benefits realized by early implementers of these technologies.

The increase in research output highlights the maritime industry's proactive approach to adopting digital transformation as a key strategy for future growth and competitiveness.

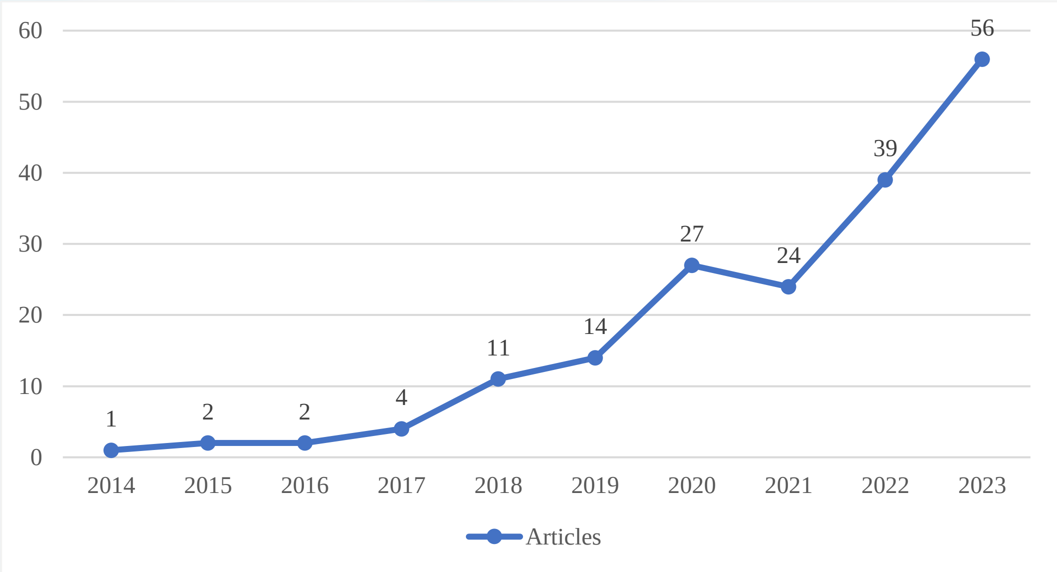

Figure 3. Annual scientific publication

4.3. Most relevant keywords

The keywords selected by the authors provide valuable insight into the thematic research areas addressed in their articles and the methodological approaches used. Examining the relationships between these keywords provides a sense of the dominant research trends in the field and the popular topics considered most relevant by the academic community. Table 3 shows the ten most frequently used keywords. The analysis of the most frequent keywords shows that maritime research is focused on rapidly emerging technologies such as the Internet of Things (IoT), artificial intelligence (AI), blockchain, and big data. This indicates a strong trend towards the adoption of these technologies in the maritime industry. These keywords highlight the industry's move towards enhanced connectivity, predictive analytics, secure transactions and large-scale data processing to improve the efficiency and safety of maritime operations.

Table 3: Most frequent author keywords

Rank	Words	Occurrences
1	internet of things	24
2	maritime	24
3	artificial intelligence	16
4	blockchain	16
5	security	14
6	machine learning	11
7	marine vehicles	11
8	trajectory	11
9	big data	10
10	transportation	10

Also, a more detailed examination of keyword co-occurrence networks provides valuable insights into the specific applications of these technologies. Figure 4 illustrates these networks, showing how different keywords are related and pointing to common themes and interests. For example, the combination of "IoT" and "real-time monitoring" indicates a focus on the use of IoT devices for continuous monitoring and management of maritime activities. Similarly, the frequent combination of "artificial intelligence" and "predictive maintenance" shows that AI is being used to anticipate and address potential problems before they occur, thereby increasing operational reliability.

Overall, the complex interrelationships between different research topics highlight the multidisciplinary nature of maritime digitalization studies.

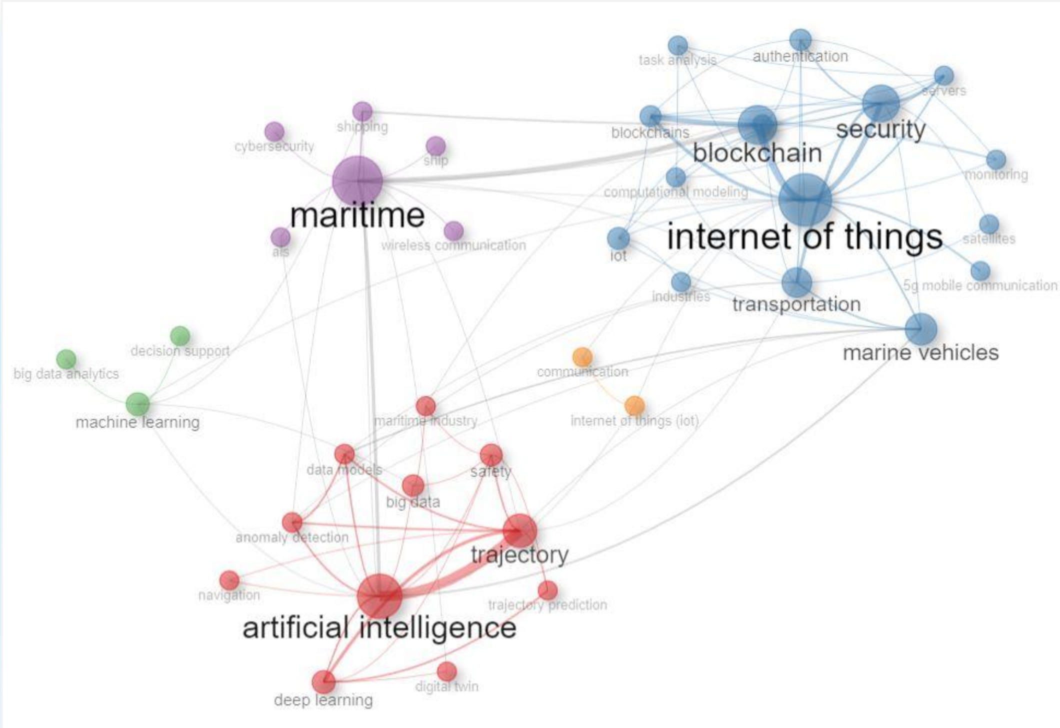

Figure 4. Author's keywords co-occurrence network

4.4. Top journals

Several metrics are used in academia to compare and measure the impact of researchers. The h-index is an internationally recognized metric that measures both the productivity and citation impact of a scientist's papers. The g-index focuses on the distribution of citations across a scientist's papers and gives more weight to highly cited publications than the h-index. The m-index aims to take into account the stage of a scientist's career and provide a timeless comparison.

Table 4: Most relevant sources

Rank	Publication Source	NP	TC	h_index	g_index	m_index	PY Start
1	IEEE Transactions on Intelligent Transportation Systems	24	520	10	22	1.667	2018
2	Journal of Marine Science and Engineering	19	84	5	8	1.25	2020
3	Ocean Engineering	16	402	8	16	1.333	2018
4	IEEE Access	12	285	6	12	1	2018
5	Maritime Policy and Management	8	256	6	8	1.2	2019
6	IEEE Internet of Things Journal	7	346	7	7	1.4	2019
7	Journal of Navigation	6	43	4	6	0.444	2015
8	Sensors	6	48	4	6	0.8	2019
9	Transnav	4	15	2	3	0.667	2021
10	Nase More	3	56	3	3	0.5	2018

* Ranking by number of publications. (NP: Number of Publication, TC: Total Citation, PY start: Year of the first published paper.)

Table 4 shows the most relevant sources with publications in the field of digitalization in the maritime industry according to the number of publications (NP), total citations (TC), h-index, g-index and m-index. "IEEE Transactions on Intelligent Transportation Systems" is the journal with the highest number of publications. It also ranks first in all other metrics, reflecting its significant impact and wide coverage in the field of digital transformation in the maritime industry.

5. Discussion and future directions

The findings of this systematic literature review provide a comprehensive overview of the current state of digitalization in the maritime sector, highlighting key trends, challenges and opportunities. As digital technologies continue to develop, their integration into maritime operations offers significant potential to improve efficiency, safety and sustainability. However, the review also identifies several barriers that need to be addressed for these benefits to be fully realized.

The analysis reveals a strong focus on rapidly developing technologies such as the Internet of Things (IoT), artificial intelligence (AI), blockchain and big data. These technologies are increasingly being adopted in maritime operations to facilitate real-time monitoring, predictive maintenance, decision support and safe operations. The significant increase in publications since 2019 indicates a growing recognition of the importance of these technologies in transforming maritime operations.

Despite the great potential of digitalization, the maritime industry also faces some significant challenges. Given the increasing reliance on digital systems and the sensitive nature of maritime data, cybersecurity and privacy concerns are critical. The traditional nature of the maritime sector is also a barrier. Resistance to change and slow adoption of new technologies could impede progress. In addition, seafarers' adaptation to digital technologies is still a critical issue and requires extensive training and support for effective implementation.

On the other hand, the systematic review highlights several research gaps that need to be addressed. While there is considerable research on the technological aspects of digitalization, there is a need for more studies focusing on the human and organizational factors that influence technology adoption. Understanding how to effectively manage change and encourage a culture of innovation in maritime organizations is critical to successful digital transformation. Therefore, maritime organizations need to analyze their digital transformation process in a strategic manner.

Moreover, digital transformation in the maritime industry seems to be limited to enhance maritime safety. Very few studies have been conducted on this area. Existing studies generally focus on improving navigational safety. However, encouraging digitalization efforts to increase safety in onboard ship operations will be beneficial to reduce operational risk on board ships.

Future research should take an interdisciplinary approach, integrating insights from engineering, management and social sciences to address the various challenges of digitalization. Collaboration between researchers, industry practitioners and policy makers can lead to more holistic and practical solutions.

Given the increasing cyber threats in the digital age, future work should prioritize cybersecurity measures in maritime industry. The development of robust cybersecurity frameworks and protocols is essential to protect maritime operations from cyberattacks and ensure the integrity of digital systems.

Research should also focus on the human aspects of digitization, including training programs for seafarers, user-friendly interfaces, and strategies to manage resistance to change. Ensuring that the workforce is adequately prepared and supported is critical to the successful adoption of digital technologies.

Future work should explore the alignment of digital technologies with maritime regulations and standards. Policymakers need to be informed about the latest technological developments in order to create an enabling regulatory environment that facilitates innovation while ensuring safety and compliance.

Digitalization offers significant opportunities to improve the sustainability of maritime operations. Future research should explore how digital technologies could be used to reduce the environmental impact of shipping, such as optimizing fuel consumption, reducing emissions and improving waste management.

Studies that follow the impact of digitalization over time can provide valuable insights into the long-term benefits and challenges of digital transformation. Such studies can help identify best practices and inform future strategies for digital integration in the maritime sector.

6. Conclusion

This systematic literature review provides a comprehensive analysis of the current state of digitalization in the maritime sector. It highlights several key trends, including the adoption of IoT for real-time monitoring, artificial intelligence and machine learning for predictive maintenance and decision support, and blockchain for secure and transparent transactions. It also shows that considerable work is focused on the safety of navigation. These technologies offer significant potential benefits and are driving the industry towards a more connected and intelligent future. However, the digital transformation is not without its challenges. Cybersecurity and privacy concerns, the traditional nature of the maritime industry, and the adaptation challenges faced by seafarers are key barriers that need to be overcome. The study also identifies several research gaps, particularly in the areas of human and organizational factors influencing technology adoption, the alignment of digital technologies with maritime regulations, and the environmental impacts of digitalization. Addressing these gaps through interdisciplinary research and stakeholder collaboration is critical to the successful implementation of digital technologies in the maritime industry.

Future research should focus on developing robust cybersecurity frameworks, promoting a human-centered approach to digitalization, and ensuring regulatory coordination to promote innovation while maintaining safety and compliance. In addition, there is a need for digital transformation efforts to enhance the safety of shipboard operations.

In conclusion, digital transformation in the maritime sector holds great potential to improve operational efficiency, safety, security, and sustainability. By understanding the current state of digitization and anticipating future trends, stakeholders can develop effective strategies to leverage digital technologies and lead the maritime sector towards a more efficient and sustainable future. The findings of this systematic literature review provide valuable guidance for policymakers, practitioners and researchers to manage the complexities of digital transformation and leverage its potential benefits.

Acknowledgements

This article is partly produced from Ph.D. thesis research entitled “Prioritization of the Digital Transformation Strategies for Enhancing Maritime Safety: Introducing A Novel Concept” which has been executed in a Ph.D. Program in Maritime Transportation Engineering of Graduate School in Istanbul Technical University.

This work was supported by Scientific Research Projects Department of Istanbul Technical University. Project Number: MDK-2023-45194

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DETERMINING THE BASIC PROCEDURES TO BENEFIT FROM SIMULATORS IN TRAINING THE WATCHKEEPING OFFICER CANDIDATES ON COLREG RULES

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Abstract: Learning watchkeeping duties and "COLREG (International Regulations for Preventing Collisions at Sea)" rules are among the basic training requirements for a watchkeeping officer candidate. In order for the watchkeeping officer candidate to acquire these basic knowledge and skills, it is very important to supplement the theoretical training with practical training. Simulators can provide an excellent training environment to meet this requirement of the candidate. The simulator has become an important training aid as it offers a realistic training opportunity with various scenarios. Since the installation and maintenance of simulators incur significant costs, they should be utilized at an optimum level. This study aims to reveal how the simulator can be used most effectively within the scope of a course on the learning and application of COLREG rules by examining the trainings carried out in a maritime training institution and receiving feedback from the users. Considering the characteristics of the rules, the facilities of the simulator and the training objectives, some principles were determined regarding the scenario to be set up, the number of students to be trained in the simulator within the same period of time, the tasks to be performed by the students in the training and the minimum training periods. It was concluded that it would be appropriate for the students participating in simulator training to carry out this practice with as few student groups as possible, to fulfill the duties of Watchkeeping Officer, Radar Operator and Helmsman within a certain period of time during the training period and to work on scenarios that will help them to apply COLREG Rules within a total period of 60-90 minutes. It is considered that the principles outlined in this study can be a guide for other institutions providing training in this field.

Keywords: Ship Management; Ship Movements and Control; Maritime Simulator; COLREG Rules; Watchkeeping Officer.

1. Introduction

There are many actors in the maritime transportation system, which mediates the transportation of approximately 90% of global trade. As well as the ships that transport commercial goods, the seafarers who command and operate these ships safely have an important place among these actors. Training an officer of the watch to gain the ability to command the ship takes place during an intensive training process. Theoretical and practical training, which will begin in a school or educational institution, will then continue as internship or on-the-job training on the ship.

Demirel and Bayer (2015) state that the most important factor that directly affects safety and security onboard is the human factor. Considering that approximately 80% of the accidents at sea are caused by humans (Arslan and Er, 2007; Yılmaz et. al. 2013), the importance of training on the rules of preventing collision at sea would be better embraced. It is very important that the officer of the watch commanding the ship is competent and qualified (Kan and Köseoğlu, 2019). Training on this subject - learning and practicing COLREG rules - has an important place in the training of a watch officer. A watch officer candidate must be able to determine whether he or she is on a collision course with a ship he encounters on a crossing situation, know what maneuver to do if there is such a risk, understand the position of other ships based on the shapes and the lights they exhibit, and be acquainted with the precautions to take if necessary. Such a learning and training process should enable the consolidation of knowledge and the advancement of the ability to apply maneuvers by implementing what has been learned through practical training.

Traditional Maritime Education and Training (MET) is a combination of theoretical training in the classroom and practical training at sea (Renganayagalu et. al., 2019). Theoretical training alone cannot be sufficient to learn the COLREG rules for a watch officer candidate who will take actual responsibility. The theoretical training period, which would be supported by videos and other visuals, should be followed with the practicing period. In all countries that train watch officers, the internship period or on-the-job training period has an important place in the operational training required by the profession (Manuel, 2017). Additionally, simulators have been serving as an important bridge between the theoretical training in classroom and the practical training onboard, for about a half century. The emergence of simulators and their use in vocational training dates to the 1950s (Sellberg, 2017). Today, simulators play an important role in personnel training in the maritime sector, as in all areas where safety considerations are at the forefront (Hjelmervik, Nazir and Myhrvold, 2018). And they have become an indispensable part of maritime training. To obtain optimum benefit from this important element, educational institutions have been seeking to draw conclusions by evaluating the results of their practices.

2. Method

2.1. Review of COLREG Rules and Determination of Training Objectives for Scenario Planning

COLREG rules were examined and training objectives that would be useful to be implemented in the scenario were identified. Considering how these training objectives can be constructed in a scenario, incidents (fiction) deemed to support learning were identified.

2.2. Creating the Scenario

The Training Objectives were included in the scenario in a certain logical order and by selecting an appropriate geography. The scenario was created in the control room of the simulator center, and the target ships that should be included in the scenario in accordance with the training objectives, their positions, the signs they will exhibit, the purpose for which the target ship will be created, and the expected maneuvers were noted under the possible time flow. These actions were planned to be processed by the assistant instructor.

2.3. Implementation of the Scenario

The scenario was applied separately to different groups of Maritime Higher Vocational School students in 330-degree bridge simulator of Piri Reis University. Before implementing the scenario, the groups were determined and the students were assigned as Officer of the Watch (Commanding Officer), Radar Operator, and Helmsman alternately within each group. The students currently off duty in the group were asked to act as lookouts and assist the Commanding Officer. Before the implementation, brief information was given about the training objectives and how the simulation would develop. At the end of the training, feedback was given regarding the activities of the group.

2.4. Obtaining the Opinions of the Students Participating in the Implementation

After the training was implemented; the opinions of the participant students were taken about the way the simulator training was implemented, the distribution of tasks to the students, the duration of the training, and the number of students who could participate in the training at the same time.

2.5. Obtaining the Opinions of the Instructors Who Conducted Simulator Training

Face-to-face interviews were conducted with different instructors implementing simulator training in the same educational institution in order to get their opinions on the issue of increasing the efficiency of the applications.

2.6. Evaluation of the Results

The results of each step in the methodology were analyzed as a whole and measures that could provide optimum benefit in simulator training were put forward.

3. Planning and Preparing for Implementation

3.1. Review of COLREG Rules

As a result of the review of the rules, it was considered useful to include issues mentioned in Table-1 in the scenario in order to support or apply the learning of the significant points expressed in the rules.

Table 1. Issues to be included in the scenario.

Nu.	Topics to be included in the scenario	Associated rule/rules
1	Determining whether there is a risk of collision with another ship of crossing situation	Rule 5 (Look-out), Rule 7 (Risk of collision)
2	Determining which vessel is responsible for keeping out of the way if there is a risk of collision	Rule 15 (Crossing situation), Rule 18 (Responsibilities between vessels)
3	Implementation of a maneuver to avoid the collision	Rule 8 (Action to avoid collision)
4	Maneuvering in the head-on position	Rule 14 (Head-on situation)
5	Navigation in narrow channel and overtaking within the channel	Rule 9 (Narrow channels), Rule 13 (Overtaking)
6	Joining the traffic separation scheme, proceeding on the traffic lane and leaving the traffic lane	Rule 10 (Traffic separation scheme)
7	Navigating in restricted visibility conditions	Rule 6 (Safe speed), Rule 19 (Conduct of vessels in restricted visibility)
8	Determining what kind of vessel is encountered by examining the lights exhibited	Rule 23 (Power-driven vessels underway), Rule 24 (Towing and pushing), Rule 25 (Sailing vessels underway and vessels under oars), Rule 26 (Fishing vessels), Rule 27 (Vessels not under command or restricted in their ability to maneuver), Rule 28 (Vessels constrained by their draught), Rule 29 (Pilot vessels), Rule 30 (Anchored vessels and vessels aground)

3.2. Creating the Scenario

The ship we will command in the training was determined as a coaster. A position between Marmara Island and Avşa Island was determined as the starting position. After leaving behind the passage between the islands, it was planned to proceed westerly and join the traffic lane, and then proceed towards the Dardanelles. The geography to be used in the scenario and the routing to be applied are shown in Figure-1.

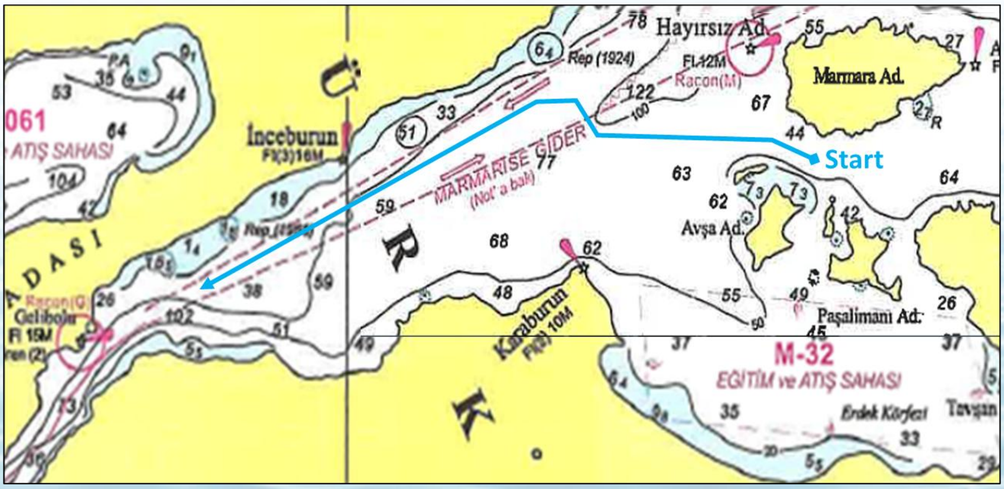

Figure 1. Geography of simulator training.

It was planned that the training would start under night conditions and the sun would rise in 40 minutes, but that navigation would be carried out in restricted visibility conditions for a while. For the navigation in the vicinity of the islands' region, target vessels were formed in such a way that sailing boats, fishing boats, vessels with restricted draft, vessels restricted in their ability to maneuver such as dredging close to the shore, and vessels not under command would be encountered. During the training, it was planned to create various vessels that would make proceed in a course that would create a risk of collision during the scenario by the assistant instructor. It was designed to create overtake situations after entering the traffic separation scheme.

4. Implementation and Results

4.1. Implementing the Scenario in the Simulator

Each group consisted of 7 to 10 students. Two groups were called to be in the simulator at the same time. First, a short briefing was given about the conditions under which the training would be implemented and the main routes our vessel should navigate. Initial assignments were made according to the students' preferences. For a 75-minute training period, for the assignments of watchkeeping officer and radar operator, two each student were identified to act alternately, and others to act as helmsman alternately. It was also stated that the students not on active duty would also serve as lookouts. While the first group was taken into the wheelhouse, the second group was in the simulator room as observers. After completing the first 75 minutes of training, a 15-minute break was given. In the next 75 minutes of training, the second group was taken into the wheelhouse while the first group became observers. Both groups participated in the training with the same scenario.

The second group was more careful not to make the mistakes they had observed during the first training period. The first group, on the other hand, better understood what kind of mistakes they had made in their training period during their observer period.

During the training, the students were asked to identify the type of vessels by examining the lights of the vessels encountered. In case of a risk of collision with other vessels, they were asked how the collision avoidance maneuver should be applied, and the practices were followed. The assistant instructor was asked to arrange for the target ships to be created at appropriate intervals within the scope of the scenario to be on the collision course. In cases where the target vessel was the give-way vessel, the appropriate maneuver was expected to be performed by the assistant in the control room. It was checked whether the entry to the traffic lane was applied through the appropriate maneuver. It was requested to respond to the overtaking intention of a vessel while proceeding on the traffic lane and also to transmit our intention to overtake a vessel and perform the appropriate maneuver.

The end-of-training briefing was addressed to both groups after completing the second 75-minute period. Thus, the maneuvers performed in both training periods were evaluated as a whole.

4.2. Opinions of the participating students

Following the practical training, a simple questionnaire was used to collect students' opinions on this practice. A total of 46 students participated in the survey.

4.2.1. Participating in simulator training as both practitioner and audience

It was asked whether the practice of taking two separate groups into the bridge simulator at the same time, the first group taking active duty in the wheelhouse while the second group was in the audience position, and the groups changing places in the second part of the lesson was a useful practice in terms of reinforcing the learning.

As seen in Figure-2, approximately 90% of the students (41/46 students) agreed with the thesis that the practice of participating in the training as both practitioner and audience reinforces learning.

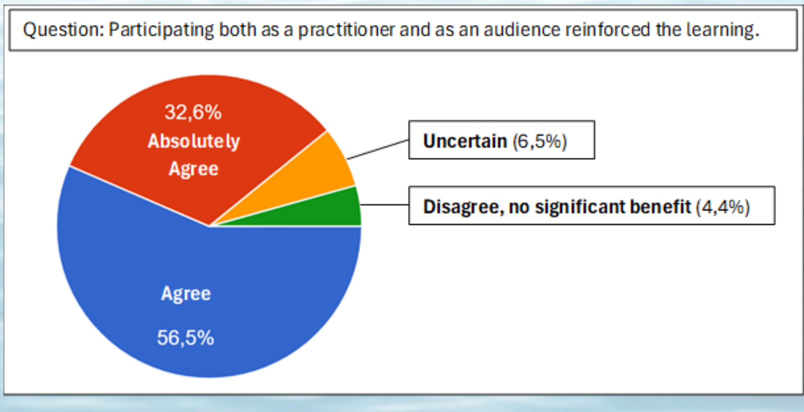

Figure 2. Opinions about participating in training as both practitioner and observer.

4.2.2. Number of students to participate in simulator training at the same time

In order to ensure maximum benefit from the training, students were asked for their opinions on how many students should be trained in the simulator at the same time.

As seen in Figure-3, 52% of the students (24/46 students) expressed their opinion that the training in the bridge simulator should be conducted with groups of 5-6 students.

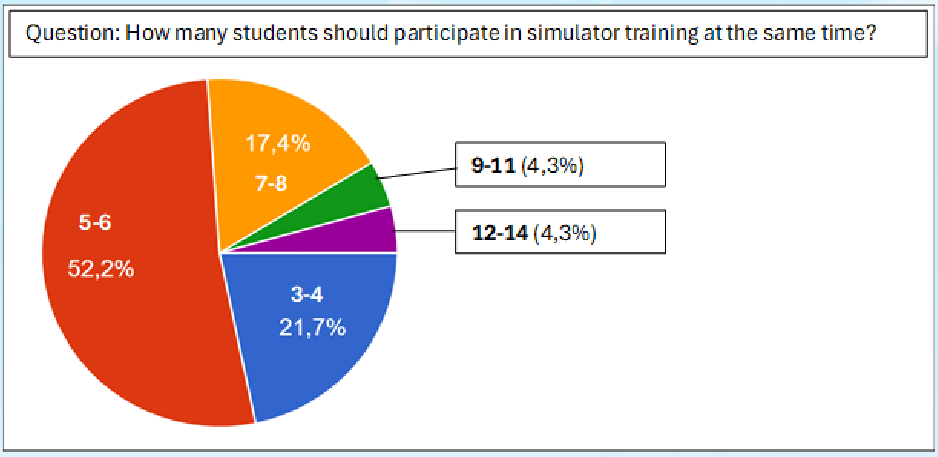

Figure 3. Opinions about the number of students to participate in training.

4.2.3. Duration of practical training in the simulator

The opinions of the students were asked about the duration of the practical training to be carried out in the simulator to meet the training objectives.

As seen in Figure-4, the highest student opinion was collected in the 60–75-minute training period with 32.6% of the votes (15/46 students).

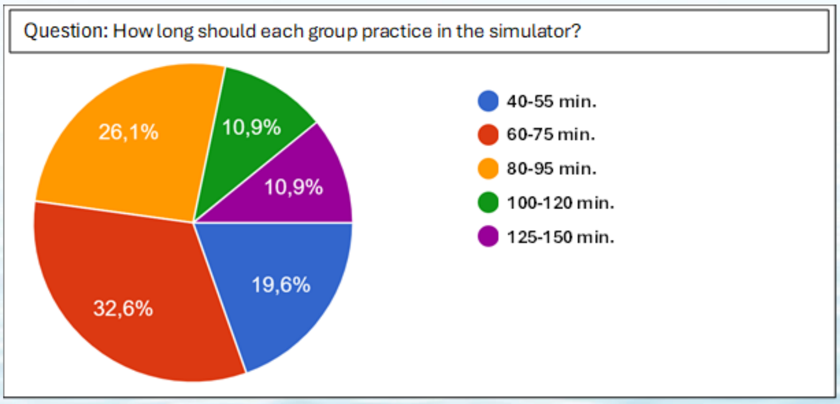

Figure 4. Opinions about the duration of the simulator training.

4.2.4. Tasks to be performed by students during the training period

The students were asked about their opinions on having all students perform the duties of Commanding Officer, Radar Operator and Helmsman within a certain period during the course.

As seen in Figure-5, 54.3% of the participants (25/46 students) stated that all students should fulfill all three tasks respectively, regardless of the duration of the training.

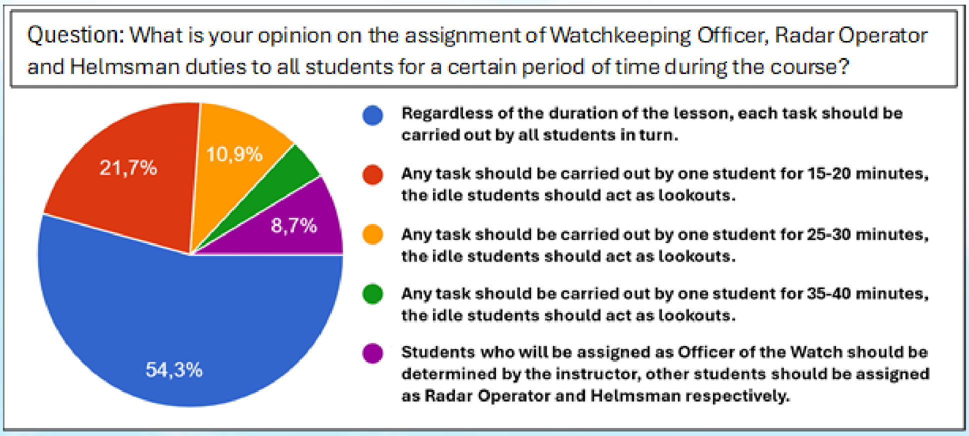

Figure 5. Opinions about the duties to perform during the simulator training.

4.3. Obtaining the Opinions of the Simulator Instructors

Face-to-face interviews were conducted with five instructors at Piri Reis University who provide hands-on training in simulators. The ideas that emerged from these interviews are given below.

4.3.1. Number of students who will participate in simulator training at the same time

Maintaining a calm and peaceful working environment on the bridge is essential to ensure the safe navigation of the ship. This is particularly important in heavy traffic and restricted visibility conditions and off-duty personnel shouldn't congregate on the bridge. With this principle in mind, the number of students should not exceed the number needed during training. Since the course aims to teach and apply the COLREG rules, the officer of the watch who will apply the rules and an assistant/radar operator to monitor the contacts by visual and radar should be assigned first. Fulfillment of the helmsman's role is also required, and it will be useful for the student to practice this. In addition to each active role, there may be another cadet in the role of assistant or observer. Under these conditions, it would be appropriate to have six students in the wheelhouse simultaneously. Having more than this number of students in the wheelhouse at the same time can cause unnecessary chaos in the educational environment.

4.3.2. Rules that should be experimented/prioritized in training

Students should first identify the contacts they encounter and be able to assess whether there is a risk of conflict. Multiple collision risk situations should be created, and the responsible student should first identify which vessel has the right of way. If the other vessel has the right of way, it should be expected to maneuver in accordance with Rule-8 and Rule-16, and if it has the right of way, it should be expected to act in accordance with Rule-17.

If the other vessel has the right of way, the assistant in the control room should ensure that the maneuvers of the simulated vessel are performed in accordance with the real situation. However, to experiment with the implementation of the responsibilities of the stand-on vessel under Rule-17, inputs should also be made to the scenario in the form of non-compliant proceeding of the give-way vessel.

Navigational practices in restricted visibility should be included in the scenario. Attitudes related to safe speed should be checked.

The lights displayed by other vessels should be identified and the type of vessel encountered should be determined. In case of risk of collision with different types of vessels, which vessel will have the right of way in accordance with Rule-18 should also be questioned.

When entering the traffic separation scheme, the vessel's proceeding in the traffic lane should be checked.

It will also be useful to apply overtaking situations separately in high sea and narrow waters.

4.3.3. Other issues recommended to be considered in simulator training

The scenario should simulate real situations as much as possible. It should not be turned into a game environment by creating abnormal objectives. However, taking into account that every minute in the simulator is precious, the student should be constantly evaluating new ship targets and new situations.

The instructor leading the training and the assistant in the control room must be in harmony. When to create new targets or when to make new inputs should be coordinated very well in advance.

Starting with the easy ones, more difficult situations should be created as the scenario progresses. For example, the scenario should include complex situations in which the student has to perform a collision avoidance maneuver and then has to evaluate close-quarters situations with other ships.

Warnings and information given by the instructor during the training will make the training more efficient. However, it will also be useful to explain the important points in the final evaluation briefing.

Recording the training, then making a detailed review by the instructor, reflecting on the parts that can be learned, and explaining them in the classroom immediately after the application will maximize the benefit to be obtained from the simulator training.

The time spent with the student in the simulator is very valuable. If the geographical environment in which the training is initiated as per the scenario is not able to meet all the training objectives within the desired period, instead of implementing continuous training, the training can be carried out in two separate scenarios within different geographical environments and in two separate periods.

5. Discussion and Conclusion

Both the students who participated in the training and the trainers who implemented the training suggested that the number of students to be trained on the bridge simulator at the same time should be limited. Considering the difficulties encountered when many students were present at the wheelhouse and the recommendations, limiting the number of students to six is deemed appropriate.

To benefit from such training, the student needs to feel responsible for his/her own practice. To be able to correctly apply what they have learned in theoretical lessons; it will be helpful if the training environment is as calm and peaceful as the real bridge environment.

In a simulator training process aiming at the application of COLREG rules, it would be useful for each student to take the duties of Helmsman, Radar Operator and Watchkeeping Officer in command respectively. Practicing the role of helmsman will be useful to understand how the rudder commands steer the ship. A watchkeeping officer candidate who has gained this experience will be able to give more accurate steering commands when he/she takes responsibility in the future and will be able to contribute to the training of a novice helmsman when necessary.

The radar operator will act as an assistant to the officer of the watch in command. He will monitor all contacts and provide information, especially about collision risk situations. The student in the role of the officer of the watch will make decisions by evaluating the information received from his assistant and his own findings together and will apply the maneuvers he deems necessary.

The training period should be divided into three parts and students should fulfill all three tasks in pairs respectively. The total training time will be determined according to the training objectives and the way the scenario is implemented. It is evaluated that a period of 60-90 minutes would be sufficient if the inputs for the training objectives are included in the scenario in an appropriate timing and serial manner.

The scenario should be designed to allow students to apply what they have learned in theoretical courses. For students at this level, instead of creating a challenging scenario with many ships at the same time, it would be more useful to set up simpler but successive risk-of-collision situations that would allow them to understand the correctness or incorrectness of the maneuver.

Sellberg et al (2018) explain that simulation-based training should be divided into three phases; first, explanations and assignments about the training will be made with the briefing, and the feedback briefing will take place in the last phase after the scenario is played. The instructors conducting simulator training at Piri Reis University shared similar views and emphasized the importance of the feedback briefing. Before entering the simulator, a short briefing should be given on the conditions and geography under which the training will be conducted, what the training aims to achieve, and how the assignments will be made. The instructor of the course should attend the training in the simulator, the important observations about the students' practices should be stated and noted immediately, and communication with the assistant instructor in the control room should be ensured for the coordination of the scenario.

It is assessed that an execution in which one group of students participates in the training having active roles in the wheelhouse while the second group is taken to the simulator as observer and the groups are switched in the following training period may be useful in terms of enhancing the learned information, as stated by the students.

Feedback briefing immediately after the training would be very useful. Students will immediately comprehend what they need to pay attention to, what they did wrong, and how to do it. The instructor should compile the findings that he/she obtained during the practices with different groups and his/her recommendations and share them with all students through a presentation in the class after these practices. Bird's eye, bridge, and radar records to be kept during the training should be utilized, and the presentation prepared from the images covering important situations should be shared with the students during this lesson. In this way, the experiences of the other group of students will be shared with all students.

In addition to all the principles set out, it is recommended to test the scenario beforehand and note the timing of the edits to be included during the training to get the maximum benefit from the training to be applied in the simulator. Testing the scenario together by the instructor and the assistant before the training will allow the scenario to be executed flawlessly during the training.

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MAAP MET DIGITAL GREEN TRANSITION: THE GREEN SKILLS ACADEMY GSA

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Abstract: The European Union has set an ambitious target for the maritime sector to achieve zero emissions from shipping by 2050. This goal is in alignment with the International Maritime Organization's broader objectives to reach net-zero greenhouse gas emissions. Achieving these targets necessitates a comprehensive transformation within the maritime industry, emphasizing the development of 'green jobs' that require significant reskilling and upskilling of the maritime workforce. This paper delves into a pioneering initiative by the Maritime Academy of Asia and the Pacific (MAAP), aimed at addressing these emerging challenges and opportunities. MAAP, in collaboration with Danish entities Aprendio and SIMAC Training, has founded the Green Skills Academy (GSA). This strategic partnership aims to develop a curriculum that supports the maritime industry's shift toward sustainable practices, thus responding to the global demand for environmentally conscious maritime operations. The creation of the GSA represents a proactive approach in maritime education, aligning academic offerings with the urgent needs of the environmental transition. The GSA is facilitated through a sophisticated Learning Management System (LMS), which is designed to offer comprehensive and accessible training in critical areas of green maritime technology and energy systems. The academy's curriculum features specialized courses on the International Gas Fuel (IGF) Code, Carbon Capture and Storage (CCS), District Energy Systems, Power-to-X technologies, Offshore Wind Energy, Energy Storage, and Wind and Wave Energy applications. These courses are intended to not only enhance the technical skills of the participants but also to expand their career horizons beyond traditional maritime roles. The platform seeks to equip both MAAP students and members of the Associated Marine Officers' and Seamen's Union of the Philippines (AMOSUP) with the necessary skills to excel in a low-emission global economy. The paper discusses the various developmental and operational phases of the GSA, emphasizing the challenges encountered during its implementation, such as integrating new curricula, adopting new technologies, and engaging stakeholders effectively. Further, the paper highlights the broader educational and training impacts of the GSA, demonstrating its role as a model for maritime education institutions worldwide. It serves as a call to action for other schools, learners, researchers, and faculty members to consider similar modifications in their educational programs. This initiative encourages potential collaborations, enrollment growth, and mobility within the academic sector. In conclusion, the collaborative initiative spearheaded by MAAP and its Danish partners addresses the immediate educational needs arising from regulatory changes while contributing to the sustainable development goals of the global maritime industry. The shared experiences and insights are aimed at inspiring and guiding other educational institutions to integrate green skills into their programs. By doing so, these institutions can play a crucial role in supporting the global green transition, ensuring that the maritime workforce is well-prepared to meet the environmental standards of the future. This paper serves as both a testament to what has been achieved and a blueprint for future endeavors in maritime education.

Keywords: Green Transition, Green Skills Academy, Learning Management System

Introduction

It was regular night at the Maritime Academy of Asia and the Pacific housing when Mr. Jeffrey Rodriguez, a MAAP alumni, sent a messenger chat for a short video call with Mr. Amon about Aprendio as per VADM Santos. In a short while, digital video communication commenced and discussion of Aprendio as Learning Management System (LMS) between Mr. Rodriguez and Mr. Amon. According to Mr. Rodriguez Aprendio is more than a typical LMS for it foster just green transition paving the way bring Denmark technical know-how and SIMAC trainings within the reach of Filipinos. Additional and possible new jobs for Filipinos seafarers and land-based technical workers if new learnings about renewable energy, International Code of Safety for Ships using gas or other low-flashpoint fuels (IGF code) (ITF, 2019), and others have been achieved.

Eventually the MAAP President, MAAP MIITD Director, MAAP QMR, Aprendio CEO/President, SIMAC Training Head and Mr. Jeffrey Rodriguez had a collaborative virtual meeting last June 15, 2023. After the meeting initial talks were made to form a working group (MAAP-Aprendio-SIMAC) for the collaborative partnership among three training providers. On MAAP side Mr. Galang was assigned the project manager and Mr. Amon as the assistant project manager.

After a series of meetings, recognizing many common interests in pursuing excellence in maritime innovation, education, training, and assessment by establishing the first maritime renewables academy to be known as GREEN SKILLS ACADEMY (GSA) with signing of Memorandum of Understanding (MOU) last September 15, 2023. With the parties seeks mechanisms for providing new and better job opportunities for Filipino workers both in maritime and green energy sector by providing knowledge, skills, and competence to ensure their adaptability to the green transition for both maritime and offshore industry. The spirit of mutual cooperation and assistance in providing high-impact learning focused on maritime and renewable sectors utilizing latest learning technologies and delivering learning content on emerging technologies.

On December 7, 2023, a formal MOU signing for the GSA with Danish Ambassador to the Philippines, His Excellency Franz-Michael Skjold Mellbin as represented by Ms. Reza Dadufalza Goyeneche, the Senior Commercial Officer of the Royal Danish Embassy Manila. Other guests to grace the occasion came from different maritime and offshore companies such as MAERSK, NIRAS, PTC Holdings, ECOP, PGEC, Acen Corp, BSM and Yan Ang Marino. On the same day Pilot Briefing of GSA platform Aprendio was conducted by Mr. Mikkel Hansen.

According to His Excellency Mellbin (2023) in his video message “Meanwhile, there is a huge global market and skill gap out there. And this will also allow Filipino overseas to capture part of that market and hopefully to have international career that I know many Filipinos dream about. Together we can bridge these skills gaps and also work internationally to make sure that the education we give and the training that we offer actually can used in a more global scale.” and closed his remarks with “Empowering people just transition”. He also stated that it was great to see Denmark and Philippines to make the green transition to happen.

This paper shall be using quantitative and quantitative method of research to fully understand the GSA digital programs pilot test run on MAAP and AMOSUP learners. Data shall be collected by survey and literature review to the sample primary source of MAAP and AMOSUP learners.

This paper shall answer the questions “Does MAAP Maritime Education and Training (MET) digital green transition responsive to the global digitalization and decarbonation demand and challenges?”, “How can GSA help MAAP and AMOSUP learners to upskill and reskill?”, and “What are the GSA Digital packages and programs that can be offered for schools, businesses and government?”.

Review of Related Literature

Global Just Green Transition Perspective:

What is just green transition? According to Tavares (2022) even there varying definition, the transition refers to refers generally to strategies, policies or measures to ensure no one is left behind or pushed behind in the transition to low-carbon and environmentally sustainable economies and societies. She further added that the term has been used in relation to the transition to a digital economy like the Global Accelerator on Jobs and Social Protection for Just Transitions launched by the UN Secretary-General in September 2021. Meanwhile, Europe’s new growth strategy to overcome climate change and environmental degradation and transform the Union into a modern, resource-efficient and competitive economy is called the “European Green Deal” (European Commission, 2024). Just transition for European Union (EU) Member States is to mobilize resources and take actions to ensure targeted support for the regions and sectors that are most affected by the transition with the help of European Commission (EC).

Table 2. Just Transition Timeline

Year/s	Just Transition Milestones
1990s	• Unionists and activists in the United States call for mechanisms to address job losses related to new environmental regulations • Just Transition Alliance is formed, bringing together unionists and environmentalists
2000s	• International trade union coalitions bring the concept into international debates, including COP15 (Copenhagen) in 2009
2011	• COP17 (Durban); South Africa begins discussions on a just transition
2015	• ILO Guidelines, 2030 Agenda, Just Transition included in Paris Agreement
2018	• Solidarity and Just Transition Silesia Declaration signed by 50 countries at COP24
2019	• UN Climate Action Summit, 46 nations committed to developing just transitions strategies
2021	• Just transition prominent at COP26 (Glasgow). • Just Transition Declaration – Supporting the conditions for a just transition internationally signed by a group of developed countries. • Global Accelerator on Jobs and Social Protection for Just Transitions launched and €8.5 billion support for South Africa's just transition committed by EU, US, UK, Germany and France
2022	• References in IPCC report, HLPF, Secretary-general's priorities

Looking at the Table 1, from 1990s to 2011 discussion and debates on the just transition took place, until the International Labor Organization (ILO) published in 2015 Guidelines for a just transition towards environmentally sustainable economies and societies for all. One of the ILO visions in the guidelines is just transition for all towards an environmentally sustainable economy that needs to be well managed and contribute to the goals of decent work for all, social inclusion and the eradication of poverty. Skills development policy as one of the key policy areas stated that the government and social partners should formulate a holistic skills development policy to promote skills for green jobs that are coherent with environmental policies, including means for appropriate recognition through certification of skills.

At the 24th Conference of the Parties (COP24) to the United Nations Framework Convention on Climate Change (UNFCCC) at Katowice, Poland, the Solidarity and Just Transition Silesia Declaration was scheduled to be adopted on 3 December 2018. This declaration highlights sharing experiences from Parties, encouraging taking into consideration the issue of just transition of the workforce and the creation of decent work and quality jobs, encouraging support for developing countries, and encouraging that the transition to low greenhouse gas emission and climate resilient development.

According UN (2024) the central purpose of the 2019 Climate Action Summit, hosted by the UN Secretary-General António Guterres, is to boost ambition and accelerate actions to implement the Paris Agreement United Nations. "I called the Climate Action Summit to serve as a springboard to set us on the right path ahead of crucial 2020 deadlines established by the Paris Agreement on climate change. And many leaders — from many countries and sectors — stepped up." stated by Guterres (2019).

After two years, it was at COP26 it was agreed at Glasgow the limiting the increase in the global average temperature, urgent action on carbon dioxide emission reduction, moving away from fossil fuels, delivering on climate finance, doubling of finance support developing countries, completing Paris rulebook, and strengthen a network known as Santiago Network. According to Carver (2022), the main goal of the conference was to secure global net zero by mid-century which means total emissions are equal to or less than the emissions removed from the environment. The Paris rulebook includes agreements on an enhanced transparency framework for reporting emissions, common timeframes for emissions reductions targets, and Mechanisms and standards for international carbon markets.

Launched in September 2021, the Global Accelerator on Jobs and Social Protection for Just Transitions signaled the UN system's collective response for addressing the multiple challenges that threaten to erase development progress. The main goal Global Accelerator is to bring together Member States, UN agencies, international financial institutions, public development banks, social partners, civil society, and the private sector to create a virtuous cycle of sustainable development that generates economic and social returns and facilitates the transition to a resilient, sustainable, and inclusive world (ILO, 2024).

A staggering over $85.1 billion commitment on climate finance (energy, finance, live and livelihood, inclusion, green climate fund (GCF), loss & damage, adaption fund, least developed countries, special climate fund) on COP28 at Dubai last 2023. According to H.E. Dr. Sultan Al Jaber (2023) to remain target, science tells us that emissions must be halved by 2030 and for us to rethink, reboot, and refocus the climate agenda . We must urgently implement the roadmap laid out in the UAE consensus – which Parties agreed at COP28, for a just, orderly and equitable energy transition while protecting nature, lives and livelihood everywhere and securing climate resilience for all.

Denmark Just Green Transition Perspective

Denmark is widely recognized as a global leader in sustainable development and green transition initiatives. The concept of a "just green transition" emphasizes not only the shift to sustainable energy and technologies but also ensuring that this shift is equitable, inclusive, and socially just. Denmark's commitment to sustainable development dates back to the 1970s, driven by the oil crisis that underscored the need for energy independence and efficiency. Over the decades, Denmark has developed comprehensive policies promoting renewable energy, energy efficiency, and environmental protection. Key milestones include the 2012 Energy Agreement, which set ambitious targets for renewable energy, and the 2019 Climate Act, aiming for carbon neutrality by 2050 (Danish Ministry of Climate, Energy and Utilities, 2021).

As of 2021, wind power accounted for nearly 50% of Denmark's electricity consumption (Danish Energy Agency, 2020). Denmark's investment in smart grid technology and energy storage solutions supports the integration of renewable energy into the national grid (Danish Energy Agency, 2021).

A just transition emphasizes that the benefits and burdens of the green shift should be equitably distributed. Denmark has been proactive in addressing potential social inequities arising from the transition. The Danish government has implemented various programs to support workers transitioning from fossil fuel-based industries to green jobs. Educational initiatives and retraining programs are essential components, ensuring that workers have the skills required for new, sustainable industries (Danish Ministry of Employment, 2020). The Danish experience illustrates that integrating social policies with environmental goals can foster a more inclusive green transition (International Energy Agency, 2021).

Denmark actively participates in international climate agreements and collaborates with other nations to promote sustainable development globally. The Danish Energy Agency's international programs support green transition projects in developing countries, sharing expertise and technologies that have proven successful in Denmark (Danish Energy Agency, 2021). Through these international collaborations, Denmark not only supports global sustainability but also enhances its own green innovation capabilities (European Commission, 2020).

Despite its successes, Denmark's green transition faces several challenges and criticisms. One significant challenge is balancing economic growth with environmental sustainability. While green technologies create new economic opportunities, they also pose risks to traditional industries and job security for workers in those sectors (Danish Economic Councils, 2021). Moreover, the high cost of transitioning to renewable energy can strain public finances and increase energy prices. Ensuring that these costs do not disproportionately affect low-income households is a persistent concern. Critics also argue that more should be done to accelerate the transition and meet climate targets more aggressively (Climate Action Network Europe, 2021).

Through comprehensive policies, technological innovation, and strong community engagement, Denmark demonstrates that it is possible to pursue environmental goals while promoting social equity and economic growth. However, ongoing challenges highlight the need for continuous evaluation and adaptation of strategies to ensure that the transition remains just and inclusive for all citizens.

Philippines Just Green Transition Perspective

Table 2. Just Transition Timeline in the Philippines

Year/s	Just Transition Milestones
2008	• Enactment of the renewable energy law
2009	• Enactment of the climate change act
2015	• Adoption of the Paris Agreement, INDC submission
2016	• National energy policy review • Enactment of the Green Jobs Act
2017	• Initiation of the ILO application of Just Transition Guidelines in the Philippines • Issuance of guidelines for green economy models • Initiation of the jeepney modernization program
2021	• Committed to slash greenhouse emissions by 75% by 2030
2023	• Launched Philippine Energy Transition Strategies under Philippine Energy Plan

The Philippines had responded to the global sustainable development goal seven (7) of affordable and clean energy since 2008's renewable energy law and as mapped in 2023's Philippine Energy Plan 2023 to 2050. The Philippines just transition anchored on four major components as follows:

- component such as increasing the contribution of renewable energy (RE) to the power generation mix
- build and develop a smart and green transmission system
- expand the utilization of mainstream energy efficiency and conservation efforts
- make progress on the decarbonization of the transport sector through electric vehicles.

Digital Transition is Green Transition

Learning Management Systems (LMS) have become integral to modern education, facilitating the delivery, administration, and management of educational content. These platforms support diverse learning environments, ranging from K-12 to higher education and corporate training. The adoption of LMS has seen significant growth due to the increasing demand for online and blended learning models. Research by Watson and Watson (2007) highlights that LMS platforms provide a centralized repository for course materials, enabling easy access for students and instructors alike. This centralized system improves the efficiency of course management and enhances the learning experience by providing consistent access to resources.

LMS platforms support various pedagogical approaches, including constructivist and collaborative learning theories. According to Coates, James, and Baldwin (2005), LMS features such as discussion forums, quizzes, and assignment submissions facilitate active learning and student engagement. These tools enable instructors to create interactive and dynamic learning environments that encourage student participation and critical thinking.

Technological advancements have further enhanced LMS capabilities. The integration of multimedia resources, such as video lectures and interactive simulations, enriches the learning experience. Additionally, analytics tools embedded in LMS platforms provide valuable insights into student performance and learning behaviors, allowing instructors to tailor their teaching strategies (Graf, Liu, & Kinshuk, 2010). Virtual Reality (VR) is revolutionizing training and competence development by providing immersive, engaging, and standardized learning environments. It enhances knowledge retention, offers a safe space for practicing high-risk tasks, and delivers real-time feedback. VR is widely used in healthcare for surgical training, aviation for flight simulations, and corporate training for soft skills development. Despite challenges like high costs and technical requirements, advancements in VR technology promise to further integrate it into training programs across various industries (Radianti et al., 2020).

Despite their benefits, LMS implementation faces several challenges. Technical issues, such as platform reliability and user accessibility, can hinder the learning process. Furthermore, the effectiveness of an LMS depends significantly on the quality of the content and the pedagogical skills of the instructors (Al-Busaidi & Al-Shihi, 2010). Adequate training and support for educators are crucial for successful LMS adoption. With this transition from traditional mode for teaching and learning into digital platform brought also new job opportunities on a global scale. LMS relevance punctuated that made the education and training sustainable during the pandemic make it an accepted norm and international recognition.

Discussions and Results

Realizing the UN and IMO's common ambition to reach net-zero GHG emissions from international shipping around 2050, Denmark and Philippines corroborated to be part of the ambition represented by Aprendio, SIMAC Training and MAAP to form Green Skills Academy.

Aprendio is focused on High Impact Learning for the Green transition. Aprendio was founded in 2022 by the 3 founders Katherine Navarro Hansen, CTO, Carsten Ellegaard, CCO and Mikkel Navarro Hansen, CEO. Aprendio is dedicated on training and learning in renewable technologies – in the maritime and energy sectors. Aprendio has incorporated the Energy and Climate Academy, with more than 12 years of experience.

Built mainly digital learning journeys for both individuals, organizations and corporates with the best subject matter experts. Aprendio's competence and training offerings include amongst others: Offshore Wind, Carbon Capture and Storage, Power-to-X and much more. Aprendio platform provides the latest training technologies to it's clients, so training can be accessed anywhere, anytime. Using mobile apps, Virtual Reality, available offline for use on board ships and much more. Aprendio's clients are located all around the world: New Zealand, US, Czech Republic, Philippines, China, Japan and many other places.

Svendborg International Maritime Academy (SIMAC) is Denmark's leading institution for maritime education and training. Established through the merger of several maritime schools in 2001, SIMAC offers comprehensive training and educational programs designed to meet the needs of the maritime industry.

Educational Programs and Courses SIMAC provides three primary educational programs: Marine Engineer, Master Mariner, and Ship's Officer, catering to approximately 775 students annually. In addition to these degree programs, SIMAC Training offers a wide array of specialized courses aimed at skill development and professional advancement within the maritime sector.

SIMAC Training collaborates closely with various public and private entities to ensure that their courses remain relevant and up-to-date with industry standards. The institution is part of the Maritime Training of Southern Denmark (MTSD) platform, which enhances their ability to offer a broad range of courses to maritime professionals both locally and internationally.

SIMAC Training is renowned for its diverse course offerings, which cover various aspects of maritime operations and safety these include Maritime Safety and Legislation, simulator courses, automation and electricity, hydraulics, Vessel Traffic Service and special courses. SIMAC is dedicated to maintaining high standards of education and training through continuous development and adherence to quality management systems. This commitment ensures that maritime professionals are well-prepared to meet the challenges of modern maritime operations.

The MARITIME ACADEMY OF ASIA AND THE PACIFIC (MAAP) was envisioned and established by Capt. Gregorio S. Oca, the visionary founder, the President of AMOSUP (Associated Marine Officer's and Seamen's Union of the Philippines) to be at par with the best maritime education and training institutions in the world. MAAP, which was founded in January 14, 1998, is designed to be a world-class maritime academy hence; it is equipped with state-of the-art facilities compliant to the requirements of the STCW (Standards of Training, Certification and Watchkeeping for Seafarers).

The academy is accredited by the Commission of Higher Education (CHED), offers four-year scholarship grants in Bachelor of Science in Marine Transportation and Marine Engineering, a five-year courses in Integrated Maritime Studies, Brigding Program for Marine Engineering, and postgraduate course as to qualified applicants selected nationwide through competitive entrance requirements. Through appropriate arrangement with various sponsors and donors, every graduate is assured of employment aboard commercial ships plying the foreign trade.

The AMOSUP Seamen's Training Center (ASTC) on the other hand, which is accredited by the Maritime Industry Authority (MARINA) STCW Office, and the Technical Education and Skills Development Authority (TESDA), was established to carry out programs and services to benefit Union's members and their dependents. Owing to the vision of Capt. Oca, the support of Stolt-Nielsen, Norwegian Shipping and Offshore Federation, and other unions and private organization, the training center continuously improved and upgraded its quality of service and kept on increasing the number of courses offered.

MAAP Digital Green Transition Pilot Run Results

GSA pilot tested with thirty-eight (38) respondents from BSMT and BSMarE MAAP students on four (4) sample courses that include IGF-code, Anti-corruption and Bribery, Offshore wind-energy, and Cybersecurity. After two months of testing Aprendio platform and courses, a survey conducted last February 6, 2023 with eight questions with results as shown in Figure 1.

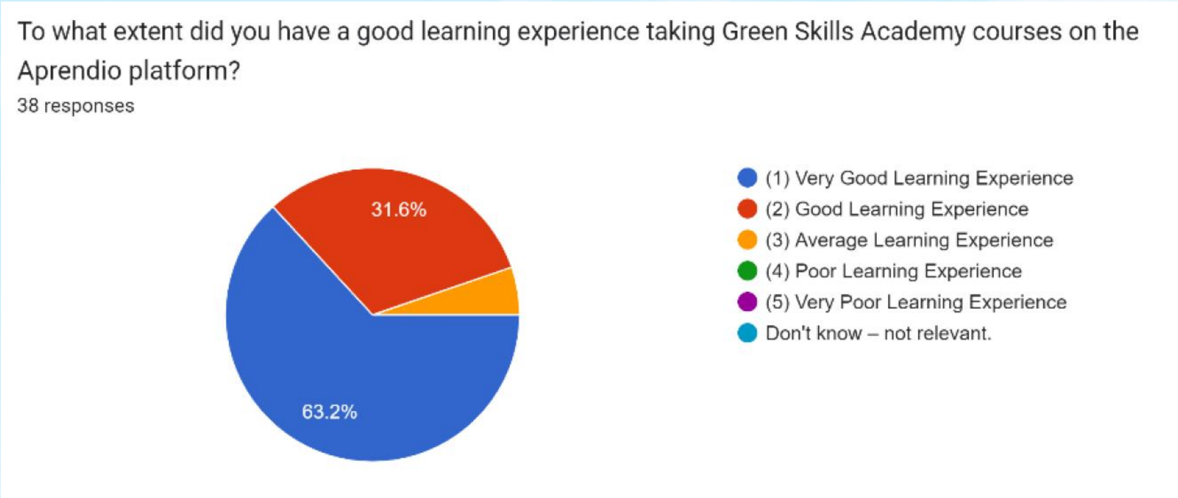

Figure 1. GSA question 1

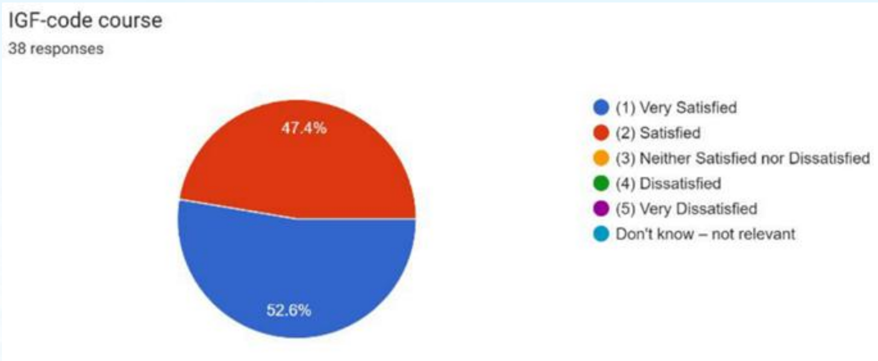

Figure 2. GSA survey question 2

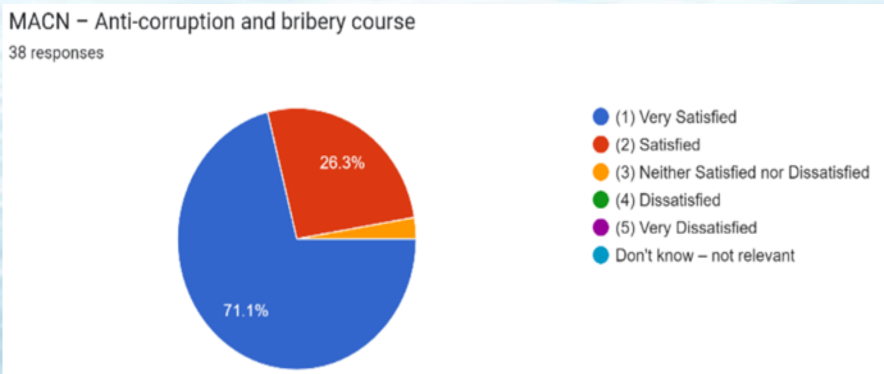

Figure 3. GSA survey question 3

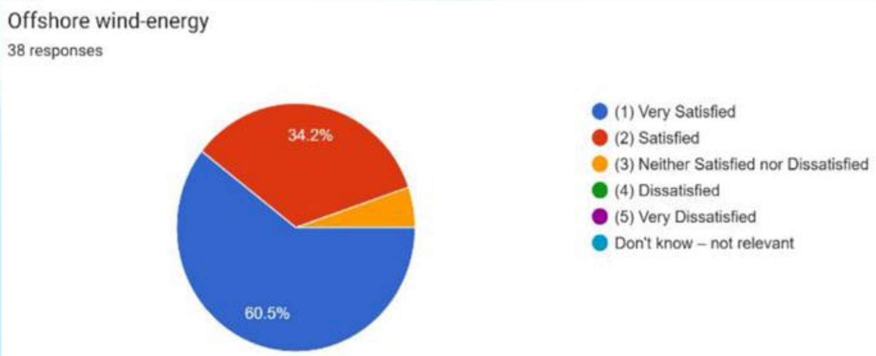

Figure 4. GSA survey question 4

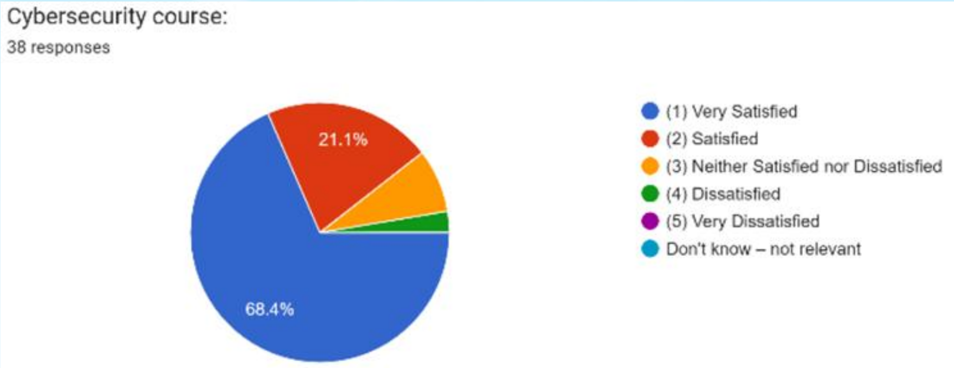

Figure 5. GSA survey question 5

Based on the Figure 1 the outcome indicates a highly positive response from the students with 63.2% responded a very good learning experience and 31.6% responded a good learning experience totaling 94.% or positive feedback. ”To what extent did you have a good learning experience taking Green Skills Academy courses on the Aprendio platform?” was the question 1. Figure 2-5 answers the question for the four courses tested using Aprendio LMS platform as “How satisfied were you with the following courses?” It was evident on the result were ranging from very satisfied and satisfied across the taken courses.

However, areas for improvement noted from pilot test such as reported technical issues, faced material comprehension challenges, and issues around internet connection. The also suggested addition green content, ease slide navigation, more interactive and features. As a starting platform, GSA shall will continue innovation taken into account expectation of the learners.

“No one left behind” as the just transition slogan and a well-received technology LMS, MAAP have entered into agreement with Aprendio to be at the forefront of Green upskilling of the Academy’s of scholars making more equipped for future job competencies and enriching their career horizon. Under GSA, MAAP has maximized it’s partnership with Aprendio and SIMAC Training into the transition the digital teaching and learning making the green content more accessible, bite size, and self-paced last December 7, 2023 with a MOA. Moreover, re-skilling of current seafarer was perceive, AMOSUP is under negotiation for the possibility to be one of the clients of GSA paving to a vast employment possibility in the renewables industry for the union members and maritime industry.

As to date MAAP student are enrolled in 11 courses in Aprendio such as IGF, Offshore Wind,Wind and Wave Energy, District Heating/Energy, CCUS – Carbon Capture Utilization and Storage, Power-to-X, Critical Infrastructure and Cyber Threats, Experiences with New Fuels, Anti-Corruption Training, Cyber Security Training and Energy Efficient Ship Handling.

Conclusion

MAAP forging strong ties thru GSA with prominent Danish organizations such as Aprendio and SIMAC Training cemented a strong response to the global ambition of Net ZERO and green jobs demands to combat digitalization and decarbonization challenges. MAAP MET digital green transition using Aprendio’s LMS and

SIMAC Training content and experience enables the Academy and AMOSUP to meet support SDG goals 4. Quality Education, 5. Gender Equality, 7. Affordable and Clean Energy, 8. Decent work and economic growth, and 17. Partnership for the goals. In spite of challenges faced MAAP and GSA, we are poised to address all of them we learn on this first step towards the just and digital transition with improvement and innovation in mind.

Recommendations

1. MAAP students to utilize GSA digital packages and obtain certificates for them not be left behind on the green just transition and promote environment care.
2. AMOSUP to get into MOA with GSA to ensure its members professional growth and securing strong employability edge towards decarbonization and digitalization.
3. IMLA members to enter into GSA that will enable educators be reskilled and upskilled in terms renewables competence for future teaching and learning capabilities.
4. MET institutions be involved in joint research on GSA and green just transition for continued collaboration among IMLA community.
5. That the GSA unlock the potential in the green digital transition, by utilizing the latest educational technology in the learning platform and using for example VR for increased learning outcome.

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THREAT ON BOARD! A MARITIME ESCAPE GAME FOR LEARNING

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Abstract: This paper recounts the creation of an Educational Escape Game (EEG), a game for learning, at the French Naval Academy. The goals of the game were to 1) teach naval cadets about the characteristics of French naval ships, 2) teach naval cadets (some) related vocabulary (ship types, ship parts, naval ranks, etc.), and 3) provide a motivating topic for meaningful oral interaction in the context of the Navy. After a presentation of the theoretical framework within which our action was conducted, we present the objectives and the expected learning outcomes, then we explain the process of creation of the actual game (including the puzzles and the gaming props), the tools and technologies used in both the design and fabrication phase. A description of a gaming session is made, before a few conclusive remarks on the validity of this approach for teaching and learning in the maritime education context.

Keywords: educational escape game; game-based learning; maritime English, naval English

1. Introduction

Game-based learning is a teaching/learning paradigm where specific learning objectives are achieved through game play. Qian and Clark [8] define game-based learning as "an environment where game content and game play enhance knowledge and skills acquisition, and where game activities involve problem solving spaces and challenges that provide players/learners with a sense of achievement". Similarly, Kim, Park and Baek [7], define game-based learning as "achieving the particular objectives of given educational content through game play". Among the advantages of this learning paradigm are the fact that games for instruction motivate, engage, and support learning where outcomes are relevant to real world contexts of practice [1], and in the past we have several times chosen to base our teaching on such paradigm [3], [4]

Escape games, originally designed for entertainment, have evolved into innovative educational tools known as Educational Escape Rooms (EERs). These activities are learner-centered, designed to enhance students' acquisition of knowledge and development of skills through immersive and collaborative experiences. EERs align with the principles of game-based learning, which integrates educational content with game mechanics to create engaging and effective learning environments.

In the context of education, an escape game is an instructional method where learners participate in a series of gamified puzzle-based activities aimed at achieving specific educational objectives. Participants must solve these puzzles within a set timeframe to "escape" a physical or virtual room, or to accomplish a thematic goal such as solving a mystery, saving someone, or preventing a disaster. The puzzles are designed to prompt learning (through the use of the targeted knowledge to solve the puzzles) and to foster critical thinking, collaboration, and problem-solving skills [6]. Escape rooms in educational settings can take various forms, including physical rooms, digital escape rooms, puzzle boxes, and hybrid games that combine elements of different game types [6]. Each format offers unique advantages, such as the ability to cater to different group sizes and learning environments, and to incorporate a wide range of educational content.

The implementation of EERs within educational curricula is supported by the theoretical framework of game-based learning. This approach emphasizes the use of games to facilitate learning through interactive and experiential activities. According to Veldkamp [9], educational escape games leverage the engaging nature of game-based learning to increase student motivation and enhance the retention of knowledge. By embedding educational content within the narrative and challenges of the game, learners are able to apply and deepen their understanding in a meaningful context.

2. Description of the game

2.1 Context and learning goals

The game was created with a particular audience in mind (French Navy 3rd year midshipmen). It is meant to be played in semester 9, at the start of the course which prepares them for a five-month training deployment at sea (known as the *Jeanne d'Arc* Mission), which takes place during semester 10. While deployed, each day, midshipmen must conduct a brief, in which they inform the Commanding Officer of the vessel of the SOE (Schedule of Events) for the following day. This includes scheduled drills and exercises, shipping forecast and possible consequences on planned activity, intended movement, equipment status and logistics, etc.

Beyond the specific language required to conduct the brief and the briefing technique, the course aims at teaching technical knowledge of the ships on which the mission is conducted (physical and propulsive characteristics, operational capabilities, sensors, equipment and armament, knowledge of spaces on board, etc.), and to introduce midshipmen to some of the activities conducted onboard warships which, being very junior and inexperienced, they know little about. Among these, they learn about the deployment of aircraft at sea, transfer of personnel, VBSS (visit board search and seizure), fire and survivability drills, etc.

The main learning outcomes of the game are:

- Revision of ranks and functions on board a French naval vessel, organization of duty
- Revision of the vocabulary of ship parts, equipment, and ship spaces
- Knowledge of the French Navy's assets, in particular surface combatants and submarines
- A specific focus on the Mistral-class Landing Helicopter Dock (LHD) and Lafayette-class stealth frigate, the two classes that the midshipmen are to embark on, during the Jeanne d'Arc mission. The game requires midshipmen to learn about the physical characteristics, armament, capabilities of both ships, in order to solve the puzzles.
- Clear communication within a group, collaborative skills, and problem-solving skills.

2.2 The creation process

In this part, we describe the creation of the game in detail.

1. We first began by listing the targeted learning outcomes (see above)
2. Then we imagined a scenario which would require this knowledge. In our scenario, a group of eco-terrorists has placed one or several threats onboard one or several naval ships. The learners must:
   a. Identify a suspect, then search his office for clues, break into his computer in and unlock several containers in the office to gain access to information
   b. Identify the targeted vessels and the threats to each through solving various puzzles
   c. Accomplish both tasks in one hour or less
3. We conducted a review of literature to apprehend the techniques used in other EERs: what type of puzzles, what type of equipment is used. We retained:
   a. Reading comprehension / cross-checking information
   b. Codes (of various types), including morse code (audio)
   c. Mathematical puzzles (of several kinds), some with physical artefacts
   d. Padlocks (both physical and digital)
   e. Jigsaw puzzles
   f. UV lighting
   g. A GPS-activated lock
4. We created a diagram connecting the learning outcomes to the puzzles, and summarizing the dependencies between the puzzles, to arrange them in an order that made sense (story-wise).
5. We designed each of the puzzles. For some of them physical fabrication was required. We made:
   a. Jigsaw puzzles (by laser-cutting cardboard) and a mathematical puzzle (in laser-cut wood)
   b. Posters, booklets, documents, for the suspect's office (at the printshop)

c. Digital puzzles (using MsExcel ® and ISpring Quizmaker®)

d. Messages written in UV ink

e. Messages printed a special font readable only through a colored filter

f. An audio file of a word in morse code (using Audacity®) and 2 video files (using Screencast-o-Matic)

g. Paper-based puzzles (at the printshop)

h. We also bought 3 padlocks (2 with numeric codes, one with letters to form a word)

i. Poems (using ChatGPT)

j. QR codes (using qrstuff.com)

6. We play tested the game, and made required corrections.

2.3 Setting up the game / resetting

We made a checklist of tasks to accomplish to set up the game. This includes:

- Printing documents that cannot be reused
- Placing props, decorating the playing space (files, posters, etc.)
- Checking the digital puzzles have been reset (on the laptop)
- Checking the contents of each of the locked containers
- Loading the media onto the projection device/display
- After the game, returning props to appropriate containers

3. Playing the game

Before starting, learners are informed that they are going to play a game which involves searching the playing space, but that nothing needs to be dismantled, and that nothing is hidden above head height, or in dangerous places (such as electric sockets or inside a computer case). They are also told that although the game requires them to open locked containers, brute force is not to be used, and that the solution is never in breaking anything. If a lock does not open, it is because the code is wrong. They are asked not to write on the documents they find or the posters that decorate the playing space, unless told to.

The game is played in an hour or less (a timer is displayed on a screen). It starts with a video message, addressed by a senior officer to the players, presenting the threat and asking them to help. The players are then shown the message sent by the terrorists. Then, the teacher/facilitator, posing as law enforcement, directs the players to a space where several copies of a list of naval servicemen have been placed, together with information to identify conspirators. Players are asked to analyze the information and identify suspects.

Once the suspects are identified, the players realize that one of them is currently assigned to the Naval Academy, where they are. They decide to search his office. The players move to a space that has been prepared/decorated to that end (an office with a desk, a laptop computer, files and folders, posters on the walls). This can be a separate room, or a part of the classroom that has been hidden behind screens.

Students search the office and find several locked containers and documents. On the walls there are also posters, and paintings. Some of these (but not all) contain information used during the game.

As they make progress, learners must organize into smaller groups to solve multiple tasks simultaneously. One of the students keeps track of progress made on a document provided by the teacher. The game is normally solved in 50 minutes or less.

Once the solution has been found and the timer has been stopped, learners usually celebrate with a round of applause. Then they are asked to gather for debrief. This is important because none of the learners can participate to solving all puzzles (since some are simultaneous). Therefore, using a chart which summarizes the game (prepared in advance), the teacher goes over each of the puzzles, asking the students who solved them to explain what they did to their shipmates. Thus, two objectives are achieved: 1) everyone gets a more complete vision of the game, and 2) learning objectives are repeated. This takes 15-20 minutes, at most.

Conclusion

Although we did not conduct a survey to gather feedback regarding the game, conversations with learners indicate that they appreciated it. During the latter part of the course, all teachers were able to verify that learning outcomes had been achieved, and that learners had learned a lot about the two ships targeted in the game. Most importantly, the learners were thankful for the commitment of the teachers in creating the game and showed high motivation and a positive attitude throughout the rest of the course.

Studies have shown that EERs can significantly impact learners' motivation, engagement, and cognitive skills [7]. They offer an immersive experience that encourages students to practice teamwork, communication, and critical thinking. Additionally, the immediate feedback and iterative problem-solving process inherent in escape games align with effective learning strategies, making EERs a valuable addition to modern educational practices [2].

Among the reasons for the success of our game, we would mention the theme (which was closely related to the learners' professional environment), and a coherent scenario which integrates the puzzles (and the learning outcomes required to solve them) in the narrative, rather than merely asking learners to solve them in order for the story to unfold.

In summary, educational escape games represent a dynamic and impactful approach to game-based learning. They provide a structured yet flexible framework for educators to create engaging and educational experiences that promote active learning and skill development.

We estimate the design of the game, creation and fabrication of the props and media to 40-50 hours for this first game, although the creation of a second one would take much less than that, given the fact that we are now familiar with the technical aspects of puzzle creation, and of prop fabrication. Although the design and preparation of such games can take a significant amount of time, it pays off in terms of motivation and commitment of the learners. Through the well though-off integration of puzzles and narratives, EERs can transform traditional educational environments into interactive and collaborative spaces that inspire and motivate learners.

Acknowledgements

Although not quoted in this paper, the S'CAPE website (https://scape.enepe.fr/) is a mine (in French), full of tips and tricks on how to create puzzles. Some of the media and props were created using their software.

We would like to acknowledge the help of the *FabLab* at Ecole Navale (the makers' workshop) in the fabrication of the props.

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NEW GENERATION NAVIGATION SIMULATOR

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Abstract: Aim: Design, construction and programming of a new generation full mission navigation simulator with a complete software bridge, with the following functionalities; (i) to be used as a standard hardware-built, fully networked desktop application, in virtual reality, or a combination of the three, (ii) to be able to be used to its full potential online. to be constructed in a suitable computer-based framework, recreating in detail the entire vessel with its surroundings, (iii) to be programmed a web-based instructor panel created, as a separate application, (iv) to have precise dynamics, as close as possible to reality. A new generation revolutionary simulator with unlimited number of participants, controlled vessels and controlled targets. There is also the possibility of the participation of invisible observers. All bridge team participants are at their respective locations. An example can be given of a complex maneuver where all the duty persons are in their places, fore and aft mooring stations, mooring gang, tug masters, even and dock masters. The virtual environment is modeled in a Unity environment, the dynamics of the ship is based on 6 degrees of freedom and programmed by ex-master mariner and present marine pilot in port of Varna. There are two calculation engines, the first is physics combined with Unity Environment scripted in C#, second one is Python external core with imported pythonic "mind", where improvements of all modules can be made. The Pythonic engine is mostly dedicated to Data Driven Models, most of simulated forces are designed as Machine Learning algorithms and measured or Computational Fluid Dynamic (CFD) data is used. Very easy for installation and user friendly, simulator causes trainees intuitively to follow real bridge steps. The simulator is mainly directed for science and research and increasing the quality of education. The simulator is found to comply with Class S - Standard for Certification of Maritime Simulators No. DNVGL-ST-0033 June 2020, SOC Statement No: 001/201117.

Keywords: Dynamic Simulation, Marine Educations, Navigation Simulators

1. Introduction

The use of Marine Simulators is an outstanding achievement and a breakthrough in improving Safety. The benefit of their use has been fully proven [1]. The BT&RM course caused a revolution. Like the Air Fleet it led to wonderful results. The STCW Convention is extremely useful in all respects. The qualities of the experts involved in the creation and development of the Convention are indisputable. Also of crucial importance is the competence of the Certification Organizations, in particular DNV (https://www.dnv.com/services/certification-of-maritime-simulator-systems-2862/, standard DNV-ST-0033, Maritime simulator systems) for the development of marine simulators. The interesting thing here is that marine simulators are still quite underrated and underestimated. Powerful computers, the development of software technologies, and the revolution in Artificial Intelligence (AI) will perhaps lead to their greater availability and wider use. Very productive and with great applications are new visualization technologies, Virtual Reality (VR) and Augmented Reality (AR). Simulations are probably the future most used technique in design and optimization tasks. At any given time, business will need a number of solutions that will most likely be outside the scope of STCW.

Essential of this simulator is its design. Simulator collaborates with modern software technology, science and marine experience. The main idea of creating such a simulator is the improvement of the quality of university education. The second goal is to attract Maritime world in this completely new field. The concept of Digital Tweens will meet us with several interesting future challenges and lead us to new knowledge and skills.

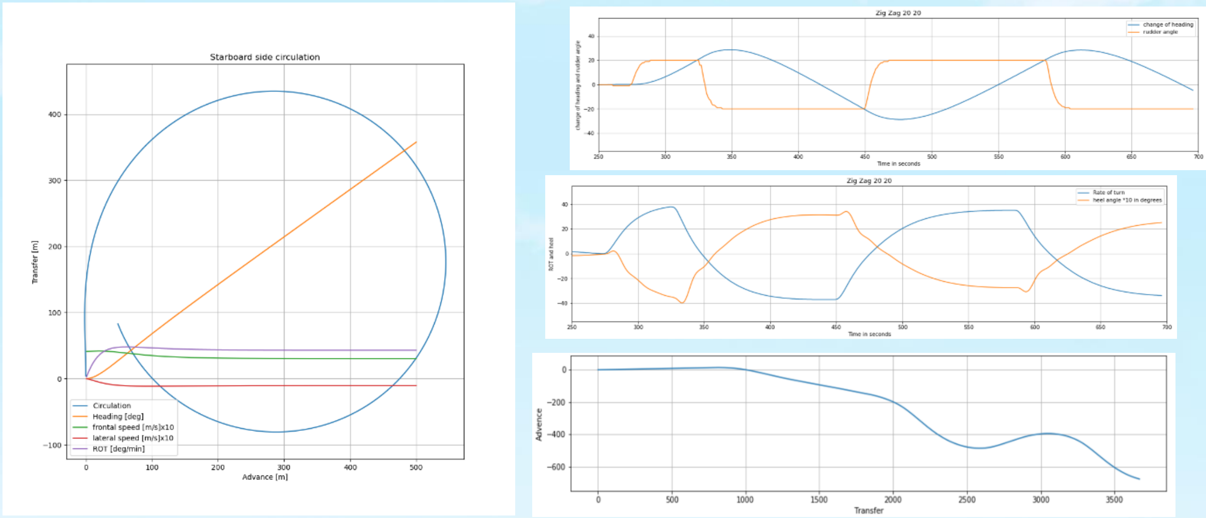
2. Dynamic Simulations

The dynamic simulation is based on a time-discrete force model. The general equations are in the six degrees of freedom, with the inertial forces equal to the external ones in the Ship-Fluid system [2-9].

$$(M_S + M_A)\dot{\nu} + \left(C_S(\nu) + C_A(\nu)\right)\nu = \tau(\nu) \tag{1}$$

The left part contains the sum of the Inertial forces of the ship as a rigid body, the Inertial forces of the Added masses, the Coriolis and Centrifugal forces, where $\nu = [u, v, r, p, q, r]^T$ is a vector of linear and angular speeds of the simulated vessel. On the right side is the sum of all External forces acting on the system, such us Hydrostatic and Hydrodynamic forces of the Hull, Propeller, Rudders, Wind, Waves, Currents, Shallow water, Suction and Interaction effects. In addition to them, there are also forces from the Anchors, Mooring lines, Tugs, Colliders etc.

Figure 4. Turn of m/v VOLA, initial speed 8 m/s, rudder angle 35° and 20°/20° zigzag.



Regardless of modern methods, a model based on numerical and empirical methods is always a very solid foundation. In addition to being reliable, the dynamic model must also be fast-acting. Our model is inspired by Japanese Scientists and MMG Group [10-15] for linear hull drags, with the addition of nonlinear Crossflow drag principles [16,17]. The propellers, rudders and their interaction are modeled on the Four quadrants [18-20], the wind pressure and the drifts with [21], the wave is represented as regular and the wave drift is mainly taken into account, such as the effects of interfering and unsteady wave, also the effects of parametric, resonance rolling and head and following waves are left for further development [25,26]. The influence of the shallow water was achieved with corrections to the resistances and added masses [27-29]. Bank and wall effects are modeled as a function of the speed of fluid and the closest point. In addition, there are force models of anchors, mooring lines and tugs [30-32] (Figure 4, Figure 5).

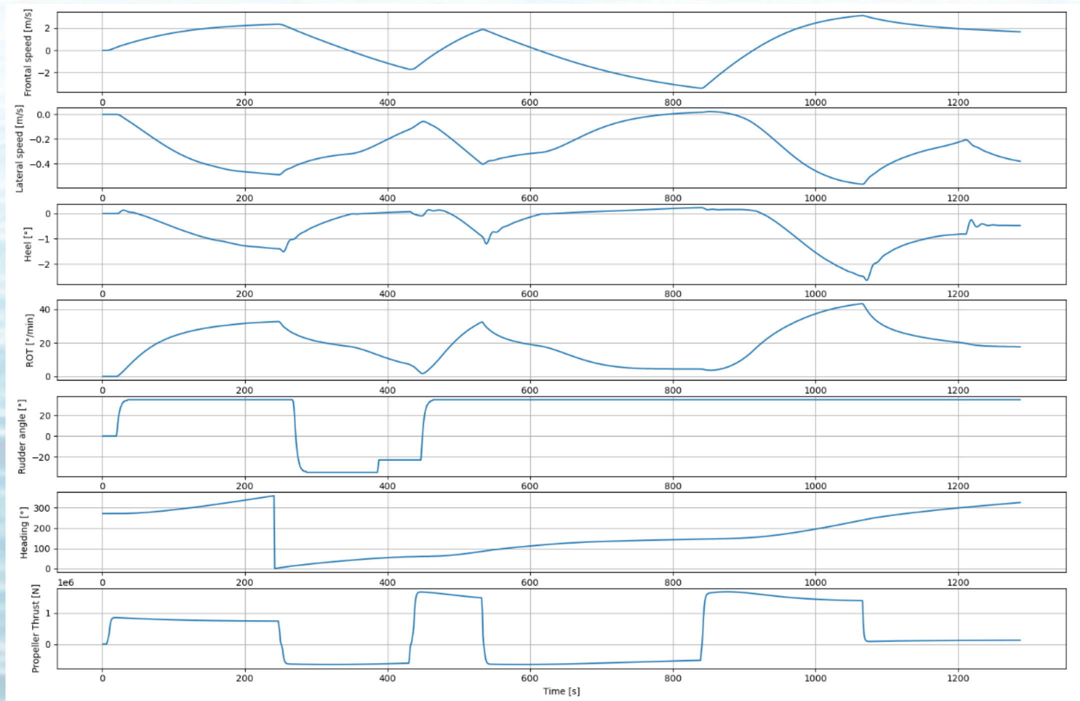


Figure 5. Statistical data in Time Series during simulations. The track is given on the chart (Figure 9).

3. Software Technologies

The platform used for simulation of the environment is *Unity Engine* [33] (https://unity.com/). The entire area of the Port of Varna, Bulgaria, together with the approaches (photo), buoyage systems, light houses, two existing vessels (m/v VOLA IMO: 9621895, m/v LANA IMO: 9484522), conventional tugs with two CPP and two rudders (SANMAR XIV MMSI: 207402000).

Figure 6. Tugboat SANMAR XIV

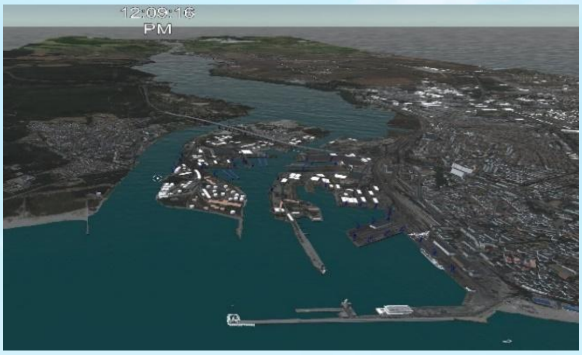


Figure 7. 12 NM approach to port Varna West

The Dynamic Model is implemented in two ways. External *Python* [34-39] based calculation Engine with communication in the simulated environment, where all accelerations, speeds and position are calculated and updated in Unity. The second way is with integrated force model *C#* (https://learn.microsoft.com/en-us/dotnet/csharp/) based, where Unity gravity, colliders and Unity calculated accelerations, speeds and position are used. Both ways have the same results and each of them has advantages. Python engine is mostly dedicated to Artificial Intelligence libraries, Import Mind of Python and the possibility of academic research. C# force model is native for Unity Engine and is the best way in order of performance and multiplayer mode. New versions of Unity Engine support also Python scripts and future full integration soon will be available.

Software is designed in three modes and can be used as a real hardware bridge with multimedia's, as desktop application and in Virtual Reality (VR) mode or mix between them. Instructor's panel is web-based application (Figure 8), which allows complete on-line solution. A big advantage is the unlimited number of trainees. All trainees can be distributed over several bridges and participate in one simulation scene.

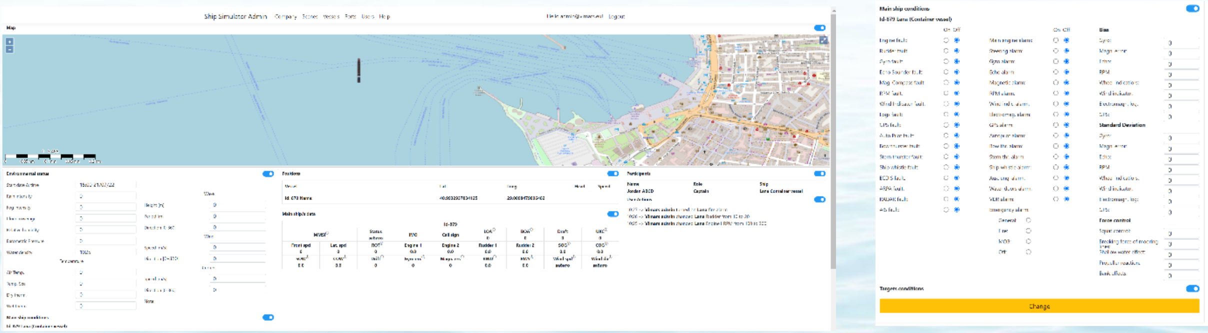


Figure 8. Screens from Web-based Instructors' console

Instructor or Instructors can take any role in bridge. Very attractive is the option of invincible observer who can "fly" in the simulated world.

Figure 9. ECS in Simulator.


Figure 10. Integrated ECS

The simulator has its own ECS, Radar&ARPA (Figure 9), but still they do not have the full functionality of modern ECDIS&Radar Systems. It has an integrated NMEA protocol that allows it to connect to ECDIS. It is also possible to visualize them in VR as shown in (Figure 10), where is integrated open source ECS OpenCPN (https://opencpn.org/). Provided that it is necessary to recreate a real bridge with real equipment, we believe that it will not be difficult to make a connection with a specific manufacturer to integrate a specific system in the simulator. Our ECS, Radar&ARPA are also integrated in Instructor's web-based application.

Delays of responses of Engine telegraph and steering gears (20 seconds from 35° on one side to 35° on the other side) are simulated with first order ODE and are scheduled for future improvement (Engine simulator). All navigational sensors can be supplied with Gauss Noise as per instructor's mind and can be changed their biases and standard deviations. Kalman and ARIMA filters [40-42] are used for stabilization of the sensors which also can be switched off by Instructors. PID autopilot is available for control of heading [5].

Figure 11. Bridge of m/v VOLA

Figure 12. Bridge of m/v LANA

4. Simulations

In all aspects one sea watch is covered by the simulator, as Software Bridge approach conception and VR Environment allow to be recreated existing or particular vessel with particular equipment. Familiar or not familiar bridge for participator can be represented. Existing vessels of world fleet can be constructed and can be doubled in Virtual Environment. Specific bridge equipment can be as much as possible close to existing equipment of presented vessels (Figure 11, 12, 13, 14). An unlimited number of navigational targets can be recreated. They are in their respective status and with their respective lights, shapes and sounds as per COLREG. Instructors can change their parameters, such as engine revs, rudder angles, follow a set track, to be adrift, at anchor, etc.

Figure 13. Restricted Visibility

Figure 14. Night vision

Especially for passage of narrow passage where steering speeds are in maneuvering table specter, wind, current, shallow water effects can be dominant, also is taken in mind additional important factor as perspective depending on location of Shiphandler, visibility from specific place on the bridge, ergonomic of the bridge, support by real look-out situated as per Master's decision, complete fill of size in point of view of bridge location and height, actual dynamic draughts as per loading conditions, related windage areas, stability, trim and list (Figure 15, 16, 17, 18).

Figure 15. Fore mooring station

Figure 16. Aft mooring station

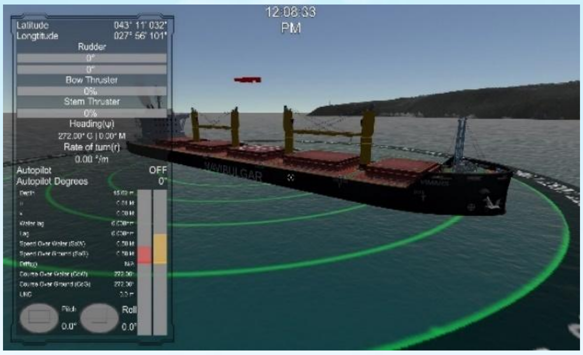


Figure 17. Fully loaded condition in Observer's mod

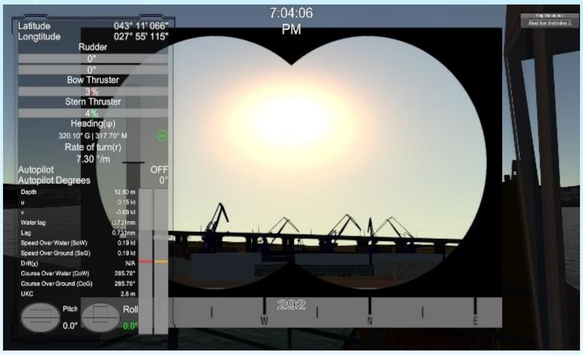


Figure 18. Compass correction during sunset

Port Pilotage where forces caused by wind, tugs, currents, wall effects, reaction of propellers are dominant and forces caused by propellers and rudders are used only for kick-ahead techniques, stoppage or for dempfering, all bridge team is presented with their personnel on the right places presented with their Avatars with their faces and their bodies. They are all in with their direct duties and responsibility in VR. In one complex maneuver, for example entrance in floating dock, Master and Pilot can command on bridge wing, dock master to observe vessel movement on the board of the floating dock, four tug master to have responsibility for the right response of given orders, Officers on duty of aft and fore mooring stations are liable to report distances and to present required information. In other words, all bridge teams are physically in remote location around world and psychologically they are on board, situated in one close to reality navigational task Figure (19,20).

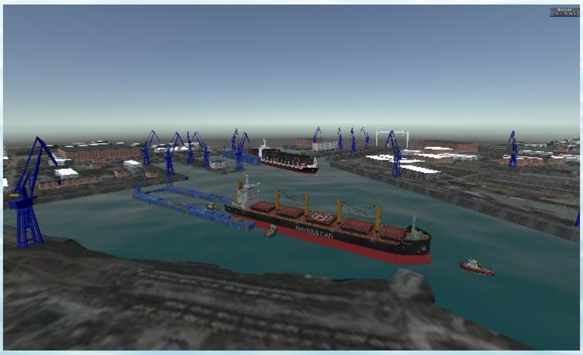


Figure 19. Floating Dock entrance

Figure 20. M/V LANA. View from the wing

4. AI and CFD

Machine Learning (ML) is a new paradigm in computer programming where, unlike classical programming, current data and obtained results are used to create trained adaptive programs called Data-Driven Models (DDM) [43]. There have been created exceptional libraries working on this principle. Many of the simulator's scripts used Machine Learning (ML) [44] and Deep Learning (DL) [45] algorithms primarily for regression and interpolation. DDMs themselves are adaptable because they are "learning" and can be pre-trained, which is a huge advantage. The fuel for these DDMs is well-structured and confident Data [46]. The new academic discipline *Data Science* (DS) offers Data Preprocessing methods Exploratory Data Analysis (EDA) and Feature Engineering (FE), which allows the collected valuable Data not only to be ordered, structured, filtered, statistically evaluated, but also appropriately visualized (Figure 5).

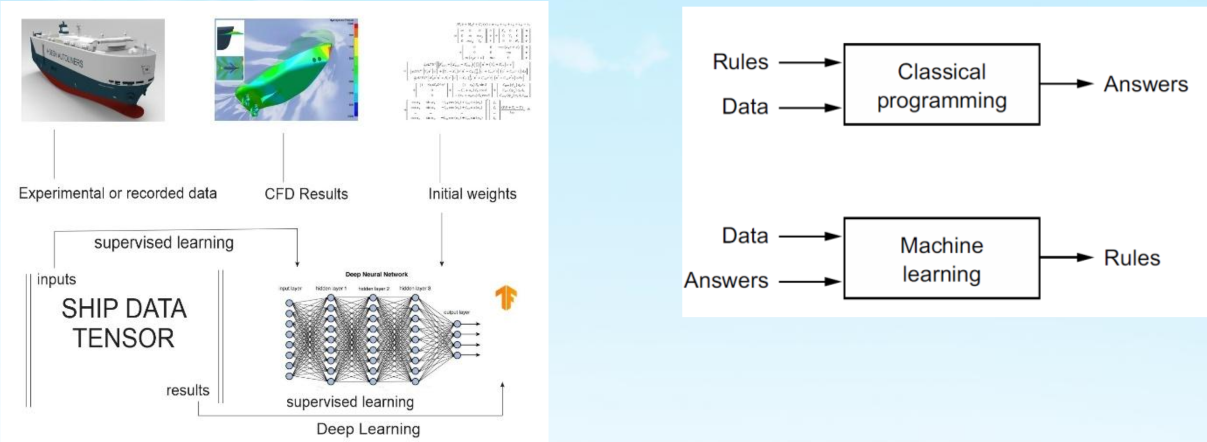


Figure 21. Data Driven Approach

CFD was very expensive, time-consuming and used only in academic research. But over the past 10 to 20 years, CFD methods have developed, and computational power has grown exponentially. As a result, CFD becomes more reliable, cheaper and more accessible. CFD can be used for dynamic calculations and parametrization of hulls, propellers, rudders, tugs, interactions effects, wind pressure and where numerical calculations are almost impossible. Thus, in the so-described Data Driven approach (Figure 21), any possible additional information is particularly valuable. The data we have can be divided into data, such as the result of Scientific research, the calculations in the design stage, results of Sea trials reports. This data can be combined with data obtained with CFD or with actual measurements from real vessels. Thus, the three simulation approaches of Dynamic Models, CFD and DDMs, complement each other.

6. Conclusion

Software and new technologies develop quite quickly. The software interface is increasingly entering navigation bridges. With utmost respect to DNV colleagues and their competence, a fully software bridge cannot yet be certified in a class other than "S" (Special) (Figure 22). Perhaps this will soon change to one degree or another.

The use of simulators is expected to increase in the near future. They may even become leaders in design, not just in training.

To conclude, a few of the advantages of the Software Bridge:- Real existing ships and bridges can be recreated.

- Possibility of fully on-line training.
- Possibility to be installed on existing hardware.
- Intuitive to use, easy to get used to the controls, resembles the real work environment.
- Opportunity for scientific research and new models.
- Possibility of improvement and future development.

- Possibility to test and implement modules with Artificial Intelligence.

DNV·GL

STATEMENT OF COMPLIANCE

Statement No: **001/201117**
DNV GL Id No: **10669456**

Particulars of Product

Function Area:	**Bridge Operation Simulator**
Name and type designation:	**VIMARS Virtual Reality Simulator**

Particulars of Manufacturer

Manufacturer:	**VIMARS Ltd.**
Manufacturer address:	**17 Kesten Str., 4th Floor, Apartment 8 9009 Varna Bulgaria**

This is to confirm:

That the above product is found to comply with Class S- Standard for Certification of Maritime Simulators No. DNVGL-ST-0033 June 2020.

Application

The above Standard is based on requirements in the STCW Convention, Regulation I/12 and corresponding industry standard and guidelines.

This Statement is valid until **2025-11-17**, provided the requirements for the retention of the Statement will be complied with.

Issued at **Sandefjord/Norway** on **2020-11-17**

for **DNV GL**

Digitally signed by Nordholm, Aksel David
Date: 2020.11.17 09:25:56+01'00'

Capt. Aksel David Nordholm
Simulator Certification Specialist

DNV GL - SeaSkill™

This Statement is subject to terms and conditions overleaf. Any significant change in simulation performance may render this Statement invalid. LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV GL AS, its parent companies and subsidiaries as well as their officers, directors and employees ("DNV GL") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any circumstance be limited to 300.000 USD.

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Statement No: **001/201117**
DNV GL Id No:: **10669456**

Application/Limitation

VIMARS is designed with web-based instructors console, which can be accessed in internet browser, Python program language engine for mathematic calculations and Unity software-based 3D environment, with full integration for use in Virtual Reality.

The simulator is designed to use advantages of Virtual Reality and modern computer programs to present software bridge for education and assessment of Marine Navigators.

There are three ways of use of simulator and installation:
- as conventional simulator - with hardware interface or on desktop computers with projectors or medias,
- as VR simulator with software transfer of position with Head Mounted Display (HMD),
- as VR simulator with calibrated position tracking system.

This Statement of Compliance is for the manufacturer offering the simulator for examination or mandatory simulator training and complies with the requirements of DNVGL-ST-0033 Maritime Simulator Systems.

Based on this statement of compliance, maritime training providers in possession of simulators that comply with the requirements of the standard can apply for a product certificate for "Maritime simulator". The simulator's function area and the simulator class according to the standard will be stated on the certificate.

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Figure 22. DNV Statement of Compliance of the simulator

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SOLVING THE DIFFICULTIES ENCOUNTERED IN FINDING A SHIP FOR SEA TRAINING

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Abstract: The availability of suitable ships for sea training is diminishing due to many reasons. While the number of cadets increases in the countries that support officers for the world's merchant fleets, the number of ships suitable for this purpose is decreasing. The shipping companies do not prefer to accept trainees due to increasing travel costs for remote operation areas. There are not enough training ships because of high maintenance costs. Some countries are trying to find alternative solutions to reduce the time of sea training such as accepting some block simulator training that is equivalent to sea training. Although some maritime administrations have taken measures to facilitate finding ships for sea training, there is not a rigid IMO policy to force shipping companies to accept sufficient places for sea training. All these improvements create an obstacle to support of seafaring officer education which also hampers the efforts to overcome officer shortage. The maritime sector, which is growing and developing continuously, has an increasing shortage of officers. To meet this, the capacity of Maritime Education and Training (MET) institutes and the number of students is also increasing. Sea training is dependent on shipping companies and there is no measure that MET institutes can take alone. The solution to the problem depends on the cooperation of IMO, Maritime Administrations, and shipping companies and this can only be possible through the establishment of permanent organizations under the leadership of IMO that will provide cooperation. This study aims to investigate the main reasons for the unavailability of a sufficient number of ships suitable for sea training and propose alternative solutions to overcome this problem including shortening the sea training period using structured simulator training as equivalent of sea phase, deployment of training ships.

Keywords Sea Training: Maritime Education and Training (MET), IMO MET Policy; Seafaring Officer Supply

1. Introduction

One of the most prominent objectives of maritime education and training (MET) is to supply qualified manpower for the shipping industry. MET provides seafarers not only with theoretical knowledge of maritime issues at schools but also practical training onboard ships which is called sea training. The sea training of cadets is conducted in defined periods according to national and international standards and includes all kinds of on-the-job training methods for ships.

The IMO's STCW 78/95 (Standards for Training, Certification, and Watchkeeping) [1] Code is the main reference of the MET and defines the technical and management skills, knowledge, and competencies of seafarers. It also regulates the basis of sea training including content, duration, and assessment. The academic and practical education and training requirements in the STCW have been clearly defined by IMO Model Courses. IMO Model Courses 7.01, 7.02, 7.03, and 7.0 4 [2] [3] [4] [5] cover all details of operational and managerial level deck and marine engineering education. ISF (International Shipping Federation) which represents the international shipping community has recommended structured Sea Training programs and these programs have been adopted by approximately all maritime administrations including some small modifications.

A major change was made in the STCW in 2011, which required changing of MET programs. This change led to the diversity of MET training courses, the existence and development of MET programs, cooperation between MET and shipping companies, and the competitiveness of students and trainees in different MET programs. The MET institutions should keep a close watch for such [6]. In particular, the success of the sea training is closely related to the cooperation between MET institutes and shipping companies including the availability of the ships for cadet training, the attitude of ship staff to conduct perfect sea training, and the providing real data to assist a perfect assessment at schools.

Sea Training is an integral part of MET and academic staff of maritime education institutions assess sea training. Today all deck cadets are obliged to complete successfully at least one year of sea training and on board, ships to become deck officers. The marine engineering cadets are obliged to complete 6-month sea training. The training records including the evidence book prepared by cadets and evaluation records of the ship officers are sent to schools then lecturers at the school make interviews with cadets to verify their achievements and make the final assessment. Some countries have training ships, and they provide sea training under the supervision of the maritime lecturers deployed on board for some phases of the training in particular for the initial stages.

2. Method

This study aims to investigate the main reasons for the unavailability of a sufficient number of ships suitable for sea training and propose alternative solutions to overcome this problem including shortening the sea training period.

The study is conducted in three steps. In the first step, it is intended to make literature research on the deficiencies. The second step covers the analysis of the problem areas by an expert group that has both sea and MET experience. In the final step, the findings of the second step are categorized and grouped for further study to formulate possible/probable solutions to be proposed. After evaluating and testing these solutions, applicable courses of action are recommended.

The research questions are based on the following areas:

- Defining problem areas related to sea training.
- Relation between duration and effectiveness of sea training.
- The best practices for shortening sea training duration in some countries.
- The special conditions to shorten sea training without compromising effectiveness.

It is strongly believed that the shortening sea training period will be a significant issue for the forthcoming STCW renewal studies.

3. Research

3.1. Sea Training Concept

Sea training refers to the training given to navy and merchant navy personnel on board a ship or vessel, as opposed to on land. It includes various types of training, such as navigation, handling of equipment, safety procedures, emergency response, communication, and more. Sea training is important because it prepares sailors/seafarers for life at sea which is full of perils. It also ensures that they can operate the ship safely and efficiently and respond appropriately in case of emergencies. Sea training may be provided by the ship's crew or by specialized training ships and may involve simulations and exercises based on real-life scenarios.

3.2. The problem areas related to the sea training

The availability of suitable ships for sea training of merchant navy cadets is diminishing due to many reasons. While the number of cadets increases in the countries that support officers for the world's merchant fleets, the number of ships suitable for this purpose is decreasing. The shipping companies do not prefer to accept trainees due to increasing travel costs for remote operation areas. There is no enough training ships because of high maintenance costs. Some countries are trying to find alternative solutions to reduce the time of sea training such as accepting some block simulator training that is equivalent to sea training. Although some maritime administrations have taken measures to facilitate finding ships for sea training, there is not a rigid IMO policy to force shipping companies to accept sufficient places for sea training. All these improvements create an obstacle to the support of seafaring officer education that also hampers the efforts to overcome officer shortage.

Some measurements are taken to potentially shorten sea training periods while still maintaining safety and effectiveness. The examples are as follows.

- Use simulation technology: Many maritime training centers now offer high-tech simulation technology that replicates real-world sea environments. This can allow crewmembers to gain experience and practice navigation, communication, and emergency response procedures in a controlled, safe environment.

- Pre-departure training: Provide extensive training on the ship's systems and procedures before departure, so that the crew already has a good understanding of what to expect onboard. This can shorten the time required for onboard training and allow for more focused, task-specific training.

- Use experienced crewmembers: Hire experienced crewmembers who require less training time before they can begin working effectively onboard. This can also be combined with offering incentives to encourage experienced crewmembers to stay with the company long-term.

- Streamline training programs: Regularly review and streamline training programs to ensure that all necessary skills and knowledge are being covered while avoiding unnecessary duplication or overlap in training.

Many MET programmers are working on strategies to shorten sea training periods while still maintaining high standards of safety and effectiveness. These strategies are based on:

- Use simulation and virtual reality technology to provide trainees with a realistic training environment without the need for actual sea time.

- Implement more efficient and focused training programs that identify and address specific skill gaps, rather than requiring trainees to complete a set number of sea hours.

- Streamline administrative processes and paperwork to reduce the amount of time trainees spend on non-training activities.

- Prioritize practical experience over theoretical concepts and lectures, allowing trainees to learn through hands-on experience and observation.

- Increase the frequency and intensity of sea training sessions to compress the overall training period into a shorter timeframe.

The international STCW guidelines have recommended minimum sea-service requirements for deck officers. The USCG, as the national license authority, has granted a remission of sea time in several areas—including license upgrades—for successful completion of specified simulator-based training. In granting these remissions, the agency has approached the issue of sea-time equivalency from a programmatic, not a technical basis. USCG's decisions to grant remission of sea time in ratios, such as 6 to 1, were based on decisions related to the achievement of licensing or other program objectives [7] [8].

Recent work in the Netherlands concluded that in cadet training a ratio of approximately 1 to 7.25 would result in the substitution of 40 hours of simulator-based training for the first 30 days of sea time, at a 50 percent proficiency level. Beyond this study, the committee could find no other technical basis for these ratios.

It may be that for some specific applications, however, none is necessary. It may be possible for the USCG to develop an effective program for remission of sea-time by applying a systematic approach. Any decision to use simulator-based training for remission of sea-time requirements, however, needs to be treated similarly to the use of simulation for licensing assessment. The same level of systematic analysis and assessment needs to be applied to both decisions.

As a best practice at the Maritime Institute Willem Barentsz (MIWB) in Terschelling, Netherlands can be introduced. The institute has a very developed Maritime Simulator Training Centre (MSTC) and delivers maritime courses for both cadets and the professional field [9] MIWB provides long-duration simulator. training which is equivalent to a definite period of sea training.

Here are some possible ways that sea training periods can be shortened in the US and UK:

- Implement more realistic simulation training: The use of more advanced simulation software and technology can allow for a more realistic training experience without the need for extensive sea training periods.

- Prioritize on-land training: Focus on in-depth terrestrial training and theoretical classes before embarking on sea training to ensure that trainees know what to expect when they get there, allowing for more efficient training once at sea.

- Introduce "fast-track" training programs: A streamlined program could be designed to prepare experienced individuals for sea training in a shorter period.

- Utilize more technology that is advanced: Making use of updated navigation, control, and engine room technology can aid in speeding up training times and reducing accidents at sea.

- Shorten the period for training: Modifying the current sea training period from the current length could be done without sacrificing the standard level of quality training provided, depending on the needs or goals of the trainee.

- Increase ship time: Provide shorter but more intensive ship time, with trainees spending extra time on board the ship during voyages or port stays.

These methods, many of which are already being employed, can help reduce training cycles and reduce the costs of training without compromising its overall effectiveness. In light of some studies and applications, here is some general information on the possible shortening of sea training periods:

Shortening sea training periods refers to the reduction of time spent at sea during naval or maritime training. The aim of this is to save costs, reduce fatigue, and increase the efficiency of training programs. The length of sea training periods has traditionally varied among different navies and maritime organizations. Some programs may have training periods lasting several months, while others may last only a few weeks.

Shortening sea training periods has both positives and negatives. Some argue that shorter training periods reduce the risk of fatigue and burnout, as trainees spend less time away from their families and loved ones. Slightly shorter training periods could lead to increased retention and motivation of personnel. However, some argue that shorter training periods could compromise the quality of training and negatively affect the knowledge and skills of trainees. Shortening sea training periods without proper evaluation of the effectiveness of training programs may result in less well-prepared personnel.

In conclusion, the decision to shorten sea training periods should be carefully evaluated and weighed against the benefits and challenges. Proper implementation and modifications to current programs may be necessary to ensure that the quality of training is not compromised.

Norberto & Ampong [10] advise the following: The incompetent students should focus on the least learned competence and undergo enrichment exercises using the simulator to improve their performance in navigation.

Marine officers should have crisis control ability because ship operation needs not only highly specialized information but also functional capability because there always exist dangers at sea, which are different from those at shore. Therefore, marine officers should be trained on the related specialized information under the systematic educational system including shipboard training. Their training is also based on strong spiritual power and physical strength through the strict training process. To have these vocational personalities, dormitory life training, and shipboard training courses seem to be essential processes, which are required of maritime education [11].

Lloyd [12] considers that “simulator training cannot substitute sea training. He says “Watchkeeping is of prime importance when crossing the oceans, occasionally can be monotonous, and seemingly, to those not familiar with seagoing, little training is involved, but ships are not all the same. As we know, every day is different, especially when considering the weather. Then there is the multitude of other aspects to seagoing. Cargo, port, anchors, maintenance, safety, drills, crew, paperwork, study, personnel, and leadership are just a few, none of which are available in a simulator.”

Several months ago, last year (2018), the director of the Merchant Navy Training Board (MNTB) announced their intention to reduce the sea-time requirement by one month and substitute a training course on simulators. This came as a surprise for professional organizations, as they had never been consulted on this most important matter. Let us hope that common sense will prevail, and this proposal will be withdrawn from the IMO, plans for a pilot scheme scrapped and we can all sit down together and dicuss the overall training of our Cadets and hopefully the possibility of a much-needed training ship [12].

Yukihira et al. [13] conducted a study to examine the educational effects of onboard training as a general academic subject. The results are shown below.

- From the results of the attitude survey of students, it is found that through the on-board training, students increased their appreciation of the importance of "ship" as well as the vocation and character of "seaman". In addition, it was suggested that the onboard training was effective in popularizing maritime affairs.

- In terms of a change of students' minds after on-board training, the minds of most students changed from the expectation and anxiety before training to the feeling that they had a very valuable experience through training. From this result, it was suggested that the students acquired a sense of accomplishment and satisfaction in training.

- It was found that there were fifteen categories of growth and experience felt by the students. The respective categories were summarized into three groups as follows: "curriculum and environment of on-board training"; "educational effects of group activities and group life"; and "own development and growth". In addition, it was inferred that these three larger categories connected each other in the effect of education.

It is a fact that the expected targets in the sea training performed onboard commercial ships are not fully achieved. The most important reason underlying this is that the shipmasters and the DSTO (Designated Ship Training Officer) responsible for overseeing the training do not show sufficient sensitivity in this regard. It is a fact that not all ships have a suitable DSTO on board. Chief Mates cannot assume responsibility due to their highly overloaded duties. This situation causes cadets to not be able to provide the expected benefit from sea training. The maritime company also has a responsibility to make maritime training more effective. The company DSTO is also a part of the straining and assumes an active role in the supervision of planning and implementation of the training onboard. The Shipboard Training Officer should review the cadet's progress regularly. It is suggested that a set time is agreed upon each week when the cadet prepares and hands in the Portfolio for inspection. Establishing a routine, will save time and ensure an efficient process. DSTO should enter comments in the 'monthly review of progress' before passing the Portfolio on to the Master or Chief Engineer officer as appropriate for common [14].

4. Expert Group Study

4.1. Establishment of Working Group:

To examine the problem areas an expert group has been established which consists of 7 maritime lecturers who hold MSc/Ph.D. degrees having both teachings in MET institutes and sea experience. Three of them are still working as staff in shipping companies. They are fully aware of the procedures and applications of sea training.

The resume of the literature study is provided to the group to update them on the latest information on the subject. The group has agreed to work on the following areas.

- Defining problem areas related to sea training.
- Relation between duration and effectiveness of sea training.
- The best practices for short sea training duration in some countries.
- The special conditions to shorten sea training without compromising effectiveness.

4.2. Defined problem areas related to sea training by WG

As the number of cadets is increasing, the number of ships is decreasing. Therefore, it is not possible to find enough ships to conduct sea training for cadets.

It is approximately very hard to find training ships for MET institutes due to high operational costs. Due to specifications, the ship particulars on board do not fully introduce the characteristics of merchant vessels and only some parts of training could be conducted on training ships.

The cadets should be familiarized with the bridge duties at least for 6 months as Junior OOW (Officer of the Watch). However, during this training, they are conducting routine jobs without emergencies and the ship staff has no interest in creating artificial emergencies during the sail. The cadets spend a full year of routine training without any special experiments on specific cases.

There is strong need to revise ISF On Board Training Record Books [for deck and Marine Engineering Cadets [15] [16] to cover new sea training applications in particular structured simulator trainings equivalent the sea training.

The ship staff has already overloaded and they are not able to spare time for cadet training.

60 percent of the shipping has moved to the Pacific area and that affected the travel costs of the crew and trainees. Some shipping companies are hesitating to send cadets to their ships operating in distant areas due to high travel costs.

5. Conclusion

The availability of suitable ships for sea training is diminishing due to many reasons as the number of seafaring cadets increases in the countries that support officers for the world's merchant fleets; there is not a rigid

IMO policy to facilitate the availability of ships for sea training. Some maritime administrations take action to increase the availability of ships for sea training and create alternative solutions for sea training.

Sea training is dependent on shipping companies and there is no measure that MET institutes can take alone. The solution to the problem depends on the cooperation of IMO, Maritime Administrations, and shipping companies and this can only be possible through the establishment of permanent organizations under the leadership of IMO that will provide cooperation and collaboration cooperation to overcome officer shortage.

Shortening the 12-month sea training for the Deck Cadet and 6- months for the Marine Engineering Cadet does not seem possible in the current standards of the STCW. Many professionals in the maritime sector are opposed to such a shortening. The IMO MSC (Maritime Safety Committee) and maritime administrations should be prepared for this issue, which is expected to be a discussion subject of future STCW work.

It is also worth considering that the navigation and watch tasks that cadets are unable to perform onboard sufficiently due to safety considerations, could be implemented in the form of simulator training at MET institutions. This method has been applied in the United States, the United Kingdom, and the Netherlands for many years. If the suitability, applicability, and acceptability once verified, this application could be defined as a new STCW standard for seafaring cadet training.

ISF On Board Training Record Books for deck and Marine Engineering Cadets should be revised to cover new sea training applications in particular structured simulator trainings equivalent the sea training.

The number of training ships, which are very expensive to operate, is decreasing day by day. Most maritime administrations are unwilling to bear such an economic burden. Additionally, it is not possible to find enough training ships that can cover many MET cadets.

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RESEARCH ON THE OPERATION SIMULATOR FOR WIND TURBINE INSTALLATION VESSEL AND ITS TRAINING SCHEME

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Abstract: Due to the high efficiency and low cost advantages of simulator training compared with real ship training, the use of marine simulator has gradually become a necessary means of training and certification for ship operators. With the rapid development of wind power around the world, the training of operators of wind turbine installation vessels also began to seek the way of simulator training. This paper firstly discussed the differences between common merchant marine and wind turbine installation vessel, and then introduced the design and development of the wind power installation ship operation simulator, and initially explores the ways and methods of operation training based on this simulator, and finally gives some plans and examples of our practice.

Keywords: navigation simulator; wind turbine installation vessel; operation training

1. Introduction

Offshore wind power is an important field of renewable energy development and one of the important directions of global wind power development in recent years. With the increasing amount of offshore wind farm work, more and more attention has been paid to the improvement of the number and skill quality of the operators. Through the operation training simulator of offshore wind turbine installation vessel, the operation training and practical operation of relevant personnel can provide virtual operation scenarios under different weather conditions and sea conditions, improve the efficiency and level of training, and reduce the training cost and safety risk of operators.

Zhang et al. studied the development trend of offshore wind power installation platform(Zhang 2016). Mai et al. studied the offshore wind power installation platform and key equipment technology, analyzed the special construction conditions of offshore wind power installation and the main difficulties and risks faced in the construction(Mai 2021). Shen et al. introduced the research and development of the 1000 t self elevating wind power installation platform "Sanhang Fenghua", and analyzed the general layout scheme of the wind power installation platform, the selection and layout of cranes, and the design ideas and schemes of the lifting system, providing reference for the design of simulation functions(Shen 2017). Ban studied the design of the visual simulation system for offshore crane ship operation, used advanced virtual simulation technology to build the visual simulation system for offshore crane operation, developed functions such as operator training and scheme preview, to a certain extent, solved the problems of high risk and huge cost of real ship training, and significantly improved the operation efficiency and safety(Ban 2012).

This paper analyzes the characteristics of offshore wind turbine installation vessel and the operation process of wind turbine hoisting, introduces the functions of offshore wind turbine installation vessel operation simulator and the actual training needs of operators, and puts forward an operation simulation system which can be used for the simulation training of the whole operation process of offshore wind turbine installation vessel operators.

2. The Function and Requirement of simulator system

In general, the simulator system proposed in this paper can simulate the installation process and extreme installation environmental conditions of offshore wind turbines and blades, and provide a simulation environment and feasible means for the professional and technical personnel training, construction process and scheme research and verification, key equipment and key operation related research of offshore wind power installation.

In this paper, the 1000 ton jack up wind turbine installation ship of CCCC third Harbor Engineering Co., Ltd. is taken as the simulation prototype. The ship was delivered, designed and built by Zhenhua heavy industry, affiliated to CCCC group, on March 29, 2016. It integrates the hoisting of large-scale equipment, piling and installation of wind power equipment, and can operate in muddy and sandy waters with a depth of 40 meters. The ship has a variable load of 3763 tons and can accommodate 75 operators. It is a representative offshore wind power operation ship in China.

2.1 The Characteristics of Wind Turbine Installation Vessel

The 1000 ton jack up wind turbine installation ship is mainly used for the lifting of offshore wind farm wind turbine installation and offshore construction operations as well as floating crane, which can carry and install mainstream offshore wind turbine models of 6 to 8MW and below. It can carry out lifting, piling, hoisting and transportation operations of offshore 8MW wind turbine equipment and other water engineering constructions; also able to carry out single pile foundations, jacket foundations, multi-pile bearing foundations and wall pile frame types of offshore wind power installations foundation construction; the wind turbine impeller can be pre-installed on the deck. The main equipment of the ship include large cranes for wind turbine installation, continuous hydraulic yoke and pin jacking system and other equipment.

Compared with ordinary cargo ships, its characteristics are: the length-width-ratio of the hull is small, the hull is short and fat, the draft is small, and the bottom is flat; Four rotary electric propulsion propellers are equipped near the front and rear ends of the hull, with good ride control accuracy (DP1 level); The ship is equipped with four pile legs with a length of about 50 meters, which can be inserted and pulled by the special facilities for inserting and pulling piles on the ship to control the rise and fall of the ship; The deck is equipped with two cranes with large lifting capacity, which can lift wind power related components individually or jointly(Shen 2017). Figure 1 shows the wind power installation vessel in operation.

Figure 1. The 1000 ton jack up wind turbine installation ship.

2.2 System functions

Through the above analysis of the characteristics of the wind power operation ship and the various skills that need to be trained in the process of wind power operation, the wind power operation ship simulator system should have the simulation functions of navigation, DP system, spud driving and pulling, anchoring system and hoisting operation system.

1) Navigation simulator. The navigation simulator establishes the corresponding ship dynamic model and attitude model according to the actual wind turbine installation ship. The rudder angle and motor speed are controlled by the hybrid operating handle on the driving control panel. The simulated ship has the functions of

rudder control, conning information display, radar operation and electronic chart operation. It is equipped with corresponding control facilities and display equipment, as well as real ship communication equipment, which can conduct navigation training, ship maneuvering, radar training, manual plotting, anchoring, port entry and departure training in different virtual training waters.

2) DP system. DP system can realize the dynamic positioning simulation function of the ship, and can carry out the operation positioning training of relevant ship operators. The DP system is composed of console, operation panel, display, control computer and simulation software. The operation panel is equipped with a number of buttons with status indicators, which are used to enable the main mode, position reference system, thruster and various functions. The menu, dialog box and other functions of the display interface adopt the standard Microsoft Windows operating platform, and the functions and various settings that can be realized are consistent with the actual DP system.

3) Spud driving and pulling. The offshore wind turbine installation platform is used to lift the offshore wind turbine by inserting the pile legs into the seabed to support the hull structure. The process of inserting and removing piles is complex and dangerous, which is the most important link in the training project. The simulation equipment is required to fully reflect the actual operation and response. The driving and pulling simulation system includes display equipment, operation panel (button with status indicator and operation handle), etc., and the hardware part is consistent with the real ship console. By operating the button like the real ship program, it can complete the simulation operation of various working conditions, such as pile leg driving (pulling), platform rising (falling), pile pulling and pile pressing, and display the support status at the same time.

4) Hoisting operation system. The system can simulate the installation process and extreme installation environmental conditions of offshore wind turbines, blades, etc. the hoisting equipment has a real joystick, control valve, switch and button to control and manipulate the crane's cargo rope and boom, control the hook to carry out up and down, pitch and swing operations, simulate various operations of the crane operation, and display it in real time in the scene. The crane simulator system can not only be used for the simulation training of crane operators, but also provide a simulation environment and feasible means for the training of professional technicians of offshore wind power installation, the research and verification of construction process and scheme, and the related research of key equipment and key operations.

5) Anchoring system. The simulated system is equipped with a set of anchoring and positioning system composed of four hydraulic winches. Each winch can be operated by the machine or remotely in the centralized control room. The winch is equipped with manual and electric proportional control operation valves, and the rotation direction and speed of the winch are controlled by the operating handle.

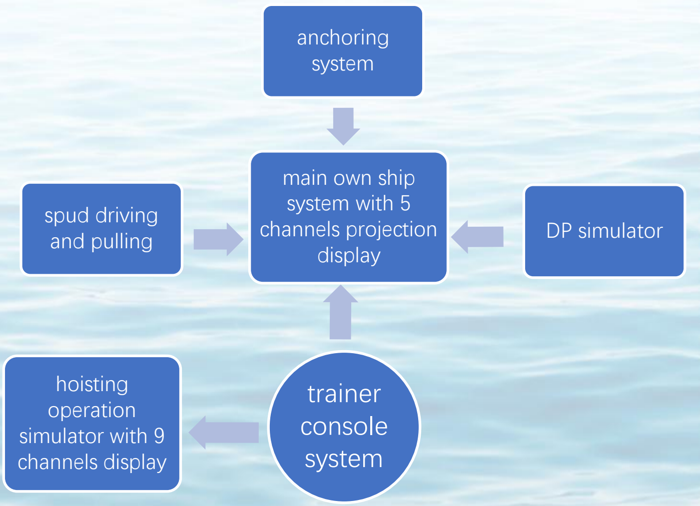

Figure 2. The overall design block diagram of the system

3. Design Scheme Of Simulator System

Through the analysis of the functional requirements of the simulation of offshore wind turbine installation vessel, the simulator system is composed of two sets of simulation units and one system control unit. The whole system is composed of a set of trainer console subsystem, a set of main own ship system with 5 channels (horizontal angle of view above 180 °) engineering level projection display and a set of hoisting operation simulation unit with vertical 3 channels and horizontal 3 channels (9 channels in total). The system can meet the requirements of various simulation training and evaluation such as navigation, collision avoidance, berthing and unberthing of ships, and can simulate the special operation of spud driving and pulling or platforms jacking. The overall design block diagram of the system is shown in Figure 2.

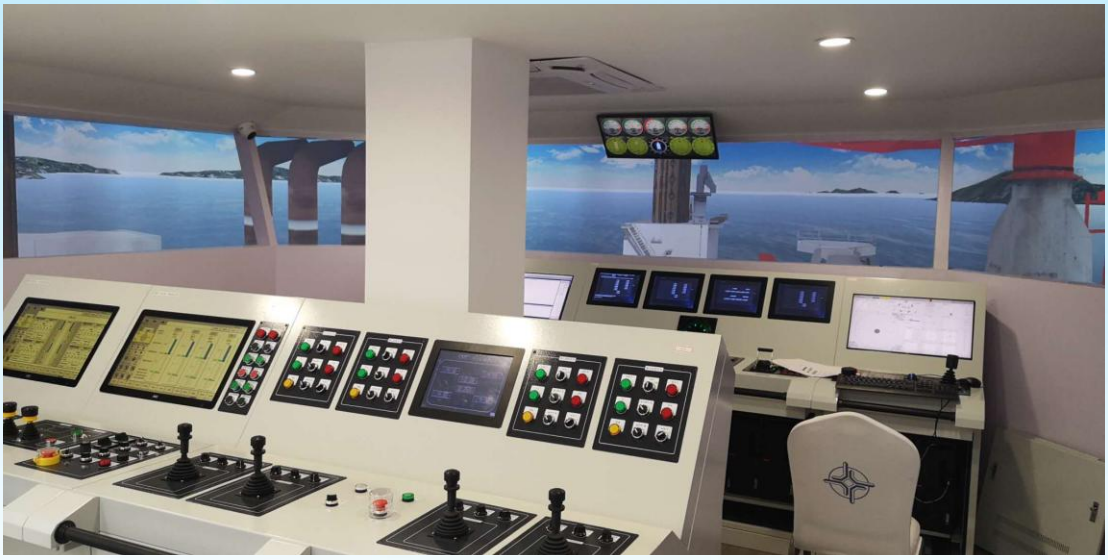

Figure 3. Main own ship system with 5 channels projection display

Figure 4. Hoisting operation simulator with 9 channels display

The coach console system is the central control unit of the ship handling system, which can be used by coaches to set training items, control the training process, view the operation of trainees in real time, replay the operation process and make comments. As the main ship, the simulation system of offshore wind power installation platform is composed of a set of 4-unit simulation integrated DP control and driving equipment and necessary related equipment, as well as a set of engineering level projection display visual system with 5-channel horizontal angle of view above 180 °. The 5-channel visual system adopts the engineering level wide-angle projection display system, and the 5-channel projection images form a complete semicircular circular visual image above 180 ° through image correction and splicing, with good depth of field and immersion. The system is equipped with DP control and information display unit, heading display unit, electronic chart and analog radar unit, VHF and GPS, which can be used for the training and practical operation evaluation of special operations such as ship navigation, dynamic positioning and spud driving and pulling.

The 5-channel visual system is driven by 5 visual computers, and the projector is equipped with a special mounting rack. The 4-unit integrated bridge is composed of DP control computer, conning control computer, analog radar computer, electronic chart computer and navigation instrument computer, which are connected to the coach console through LAN. As shown in Figure 3, the front is a 5-channel 180 degree horizontal view. The left side of the front console is the navigation simulator, the right side is the DP simulator, the left side of the rear console is the spud driving and pulling simulator, and the right side is the anchoring simulator.

The hoisting simulation unit of the system is composed of a set of 2-unit simulation control equipment and necessary display equipment, as well as a set of 3 * 3-channel (9-channel visual image in total) visual display system. The visual display device uses a flat-panel TV with a visual angle of 50 inches or more to display the visual scene, and the 9-channel visual scene forms a visual image with a horizontal angle of view of 120 ° and a vertical angle of view of 70 ° through image correction and splicing, shown as Figure 4.

4. Training Program Practice

The whole simulator system can initiate training or examination at the console, and can carry out simulation operations such as navigation, anchoring, spud driving and pulling, DP and hoisting operation of the ship in the designated water area and the designated hydrological environment. The hoisting simulator has a separate display unit, which can initiate independent crane operation training from the control console. A normal training process is shown in Figure 5. Coaches choose training items and evaluation items according to different training and evaluation objectives in different visibility and working environments such as console settings, rainy days, foggy days, night, wind force, water flow velocity, etc. The simulated ship can carry out navigation training, ship maneuvering, radar training, manual plotting, anchoring, inbound and outbound, berthing and unberthing training, positioning training, etc. in different training waters. After the ship arrives at the operation site, it can carry out DP maneuvering training and spud driving and pulling training. The hoisting operation training can be carried out at any time. The hoisting e working environment can be set separately or shared with the main own ship to realize the cooperative work between the crane and the deck. Finally, the evaluation of each stage of training can be summarized to form a complete training report and evaluation.

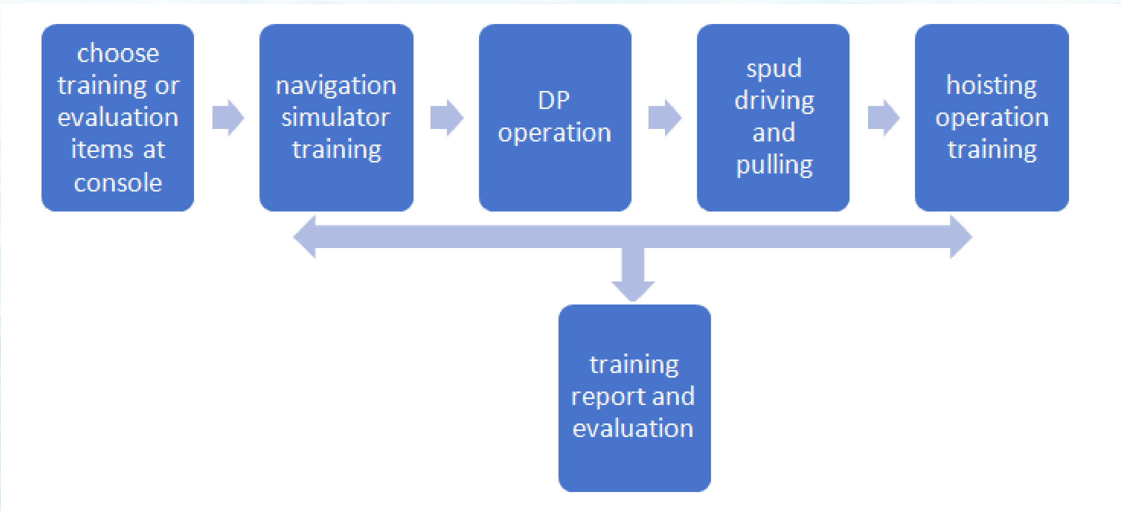

Figure 5. The workflow of simulator training or evaluation

5. Conclusion

This paper analyzes the characteristics of offshore wind turbine installation vessels, studies the operation process and training requirements, and proposes an operation simulator system for wind turbine installation vessels. Coaches can set up training programs on the console to train the operation of wind turbine installation vessels, such as navigation, berthing, spud driving and pulling, and hoisting. Through the training of simulator, not only can the professional skills of operators be improved more safely and efficiently, but also can provide a technical means in project planning, operation verification and scene reproduction in the future.

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AUTOMAREEDUNET PROJECT AND PEDAGOGICAL CHOICES FOR MET RELATING TO AUTONOMOUS SHIPPING

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Abstract: AutoMareEduNet Project cathered together the Universities and Universities of Applied Sciencess in Finland to co-operate in creating a common platform for education relating to future needs of MET education for autonomous shipping. The Consortium is financed by the Ministry of Culture and Education in Finland. The projects aim has been to gather the best expertise in all Universities in Finland and to share the knowledge to all higher degree students in Finland through a common platform, where teaching and courses are all available on-line despite where the students are situated. This platform is a government financed Digivisio 2030 in which all Universities in Finland are participating and where courses are offered since September 2025. The Consortium has worked since 2019 for creating the common pedagogical guidelines for the courses based on the approaches which have been used in MET methodology in different educational institutions. The aim of this article is to explain the choices for future educational needs. The results of this work are based on the experiences from MET education (maritime education for seafarers) and scientific education for engineers who will graduate as engineers for the shipbuilding industry and technological network of companies developing the technology for autonomous vessels. The MET institutions have a long experience in using Problem Based Learning(PBL) in teaching and the technological Universities have used Challenge Based Learning (CBL). Conclusion and outcome are that both these methods can be combine in different courses when they are offered to variety of students participating these courses simultaneously. How these methods will be implemented will be explained in the article.

Keywords: MET; autonomous shipping; PBL method, CBL method, digital learning

1. Introduction

The changing operating environment of maritime transport requires the education system to react faster than before to working life´s needs to create flexible and sufficiently multidisciplinary study modules and study paths alongside traditional degrees. This sets new demands to higher education institutions which may not be able to meet this challenge alone. As a result of AutoMare Edunet project, further strengthening of the networked activities of higher education institutions are planned to take place starting autumn 2025 at the same time when MASS Code is being implemented as a voluntary instrument under SOLAS by the IMO.

Future maritime experts will be required to have multidisciplinary competence, which is why education should be implemented more in cooperation with other higher education institutions in order to ensure high-quality teaching and competence. Therefore, it is important that effective communication is maintained all the time between working life and higher education institutions.

The results of the analysis show that the amount of information and communication technology increases with the MASS levels. With the new systems, there is a need for professionals in the maritime sector as well as computer engineering. Naturally, there will be occupation which remains more unchanged. In this report, it is identified the need for constant feedback from the maritime practitioners and industry to keep up curriculums updated to meet the needs of working life.Universities of Applied Sciences in Finland (Novia, SAMK, Turku UAS and XAMK UAS prepared a report for the AutoMare EduNet project in the Eduneed work package, which purpose is to present a holistic view of the study offering in the maritime HEI´s.

The offering of UAS is divided into two categories. Universities providing maritime education whose bachelor's degrees are based on the STCW Convention (Seafarers' Training) form their own group, and other UAS:es whose education is based on marine technology and shipbuilding/design form their own.

The STCW Convention, which regulates the training of seafarers, is a mandatory convention that strongly regulates the content of maritime bachelor's degrees. Compliance is monitored by national authorities and training is audited periodically by them. The development of this training in autonomous shipping is strongly linked to the expected changes to the STCW Convention, which has just begun. The training of seafarers will change before 2028 as a result of the amendments to the Convention, and the changes to the training can be expected to enter into force and apply around 2028 when also IMO MASS Code enters into force as mandatory instrument.

For Master of Maritime Management degrees, the situation is very different. Master's degrees act as a bridge from sea to land, so that in the future, a growing number of people with experience at sea will work in the land organisations of the maritime cluster. For these, the skills requirements will increase in line with the requirements of increasing autonomy, and the role of these persons as shipping companies adapt to the changes brought about by autonomy is essential for the development of the maritime cluster as a whole.

The purpose of this document is to describe the cooperation network created in the AutoMare Edunet project and especially the pedagogical approaches used as a basis for the education (PBL and CTL) which are based on the national education strategy and the future Digivisio 2030 educational cooperation between higher education institutions. The education network includes the key higher education actors in the maritime cluster, on which autonomous maritime expertise in Finland is concentrated.

The operating model of the education network has been developed on the basis of the national degree and further education offering to meet the requirements of continuous learning. In accordance with the goal of Digivisio 2030, the network's operating model described here also develops an ecosystem of companies and higher education institutions in which companies are involved both as education providers and customers.

Finland is a forerunner in the autonomous development of shipping and digital training solutions. Problem Based Learning (PBL) and Challenge Based Learning (CTL) have been used in different fields of teaching successfully for several decades. The differences in these methods will be analyzed in this article and their suitability in different topic relating to autonomous shipping will be analysed.

With Digivisio 2030, the national cooperation between the network's higher education institutions will also expand to international education offering after 2025, when network cooperation will also enable education export in terms of autonomous shipping. The aim of the Digivisio 2030 project for higher education institutions is to create an internationally respected learning ecosystem, which in the first phase will be based on Digivisio's digital services, the joint study offering of higher education institutions and interaction with companies and society. Data, education and skills circulate in the ecosystem.

The first implementation of Digivisio 2030 is called the continuous and flexible learning tray. The aim of the new digital service is to make the continuous learning offerings of Finnish higher education institutions easily and effortlessly available to all learners, in one place. The Digivisio 2030 project will create common platforms, common operating models and other operating conditions in cooperation between higher education institutions that enable flexible and learner-centered learning paths while maintaining the autonomy and profile of higher education institutions. Each higher education institution decides for itself how to take advantage of these opportunities.

With the implementation of Digivisio 2030, higher education institutions and educational institutions will move from administrative and system-centered thinking to meeting the different needs of learning from the perspective of individuals, businesses, society and national and international influence. Organisations belonging to the learning ecosystem have access to a set of digital services that enable the supply and demand of education to meet in a user-friendly and efficient way. The services are international, national and organizational. The ecosystem enables closer cooperation and profiling between higher education institutions. At the same time, it frees up resources for the development of working environments that support learning and research. The planning of education provision, study processes and student guidance are based on continuous analysis of competence needs, identification of effective operating methods and rapid application of the information gained. The objectives and operating models of higher education institutions encourage teachers and students to engage in networked cooperation in degree teaching, continuous working life-oriented and research-based pedagogical development, and collaborative production of learning materials. The learner has access to his/her own learning data and profile, as well as the latest information on the development of the labour market. With these, they can plan an individual study path from the offerings of several higher education institutions in degree education and supplement their competence at all stages of their lives.

The importance of continuous learning and high competence offered by higher education institutions is emphasized as autonomous maritime solutions develop, as work, technology and the world are changing rapidly. In Finland, higher education institutions have significant expertise in autonomous shipping, which can be effectively utilized through network-based cooperation, to which the higher education institutions will be committed in the AutoMare EduNet project in the future. Finland's competence and competitiveness in autonomous shipping can only be built on our relative strengths - the strengthening of technology, knowledge and know-how and their efficient utilization. Like many other small and open economies, Finland can only succeed in global competition by boldly utilizing the forces of change in the world by effectively combining the resources and expertise of higher education institutions. A thriving, prosperous maritime industry will be built on civilization, knowledge, science and technology, as technological progress leads towards shipping, where knowledge is no longer based on recruiting cheap labour from abroad, but on the effective use of the country's own innovations and technological and scientific know-how, as well as on building regulations by lowering its barriers, and on the cost-effective use of the transformative forces of the maritime economy by anticipating investments.

The AutoMare EduNet project is planned to change the future of maritime education by adapting step by step the autonomous shipping as a part of the education strategy. Therefore the pedagogical solutions have been evaluated for the future needs of the industry.

2. Problem Based learning

Problem based learning has been used in Satakunta University of Applied Sciences (SAMK) since 1990´s. Therefore we start our comparison from PBL. Different subjects are integrated together in the curriculum. Based on this, the student is able to form topics that meet the needs of working life during their studies and start developing their professional competence. PBL is described at two levels, micro and macro.

At the micro level, activities take place in classrooms or online, allowing students to develop self-direction and teamwork skills. In order for the goals of PBL to be achieved, the actions of both the learner and the teacher must be reflected. PBL is mainly a strategy that should be reflected not only in the learner's behaviour but also in the curriculum, teaching and collaboration of the entire educational institution. SAMK's PBL teaching is illustrated with examples from both options.

2.1 PBL at macro level – Degree Programme in International Trade as an example

The teaching of all subjects combined into a broad whole, simulating the operation of a company, is suitable for Bachelor-level teaching, where students are physically present. Continuous collaboration between all teachers to advance and support the work of students; K.. Business, accounting, languages, law, etc.

All courses and lectures are integrated into PBL learning, where continuous company development and problem solving require the presence and close cooperation of each teacher. Partner companies, company visits, lecturers from companies integrated into the whole. It takes committed teachers who are able and willing to work together all the time.

This Macro level PBL has not been effected in MET as it would demand huge resources when STCW would be implemented. However, with the future co-operation scheme in Digivisio 2030, this could also be evaluated how it would be possible to implement it as a co-operative effort. We now turn to the experiences in micro level, which are beneficial for the comparison we are making between PBL and CBL.

2.2 PBL at micro level – Teaching maritime law as an example

PBL either within a single study module or by combining courses sequentially placed in the curriculum (by the same or different teachers) is a good example of the micro level PBL. Lectures, case-studies, game formats combined with PBL work can all be implemented both in the classroom and online using the MOODLE platform and webex (seminars are recorded and form part of the learning material).

Bachelor's degree in sea captain (STCW Management level) can be used as an example of the Maritime Law issues. Lectures on the basics required by STCW; Conventions and other acts incorporated into the Maritime Law topics. In PBL form English court cases are selected from two subject areas, from which these preparatory seminar presentations are conducted, which combine the different topics in a practical way with all the themes of the course.

Objective: legal acts begin to "live" in the light of practical examples and the student learns how different legal acts are applied to the same legal real situation/problem. 20 court cases concerning both collision liability and salvage premiums, selected in such a way that other cases of the period also arise, e.g. Environmental liability, limitation of liability, regulation of collective wrecks, liability of dangerous goods, rules of maritime routes, liability of the carrier for goods transported (incl. previous course at STCW operational level)

As a part of the PBL method Game based tools of MOODLE platform can be used. Since the degree is taught in English, when dealing with court cases, students create a vocabulary (English-English) in the vocabulary assignment based on the new terminology they come across in legal cases and standard contracts. Students find explanations of terms and add them to the vocabulary.

The teacher checks the vocabulary and publishes it for the students to use, and creates game assignments based on the vocabulary. Game tasks include: Crossword, Cryptex, Hangman, and Snakes &; ladders, which are all MOODLE standards. This innovation was created during the Covid-19 period and the results were astonishing when compared to previous teaching methods (see a separate article in the references).

Based on regulations, legal cases and standard agreements, PBL assignments are created, in which students are forced to solve practical casualty management tasks by applying them either in groups or independently. The teacher acts as a tutor, either in class or online at different stages of the PBL assignment. PBL assignments are dismantled either in class or in an online seminar, where correct solutions are given and assignment submissions are evaluated after the correct solutions are processed.

2.3 Autonomy of the course partly in PBL format

The integration of autonomy according to the MASS levels takes place by linking the lecture sections related to the aforementioned autonomy regarding changes in regulation.

By changing PBL missions to vessels operating at different levels of autonomy in the same operating environment as conventional vessels. Examples of problems; application of maritime rules when one of the colliding ships is a ship of MASS specification I-IV, cyberattack (seizure of the vessel/piracy, application of liability agreements, environmental liability, rescue of an autonomous ship without crew intervention, etc.)

The teacher participates in the work of the IMO's Legal Committee and the Maritime Safety Committee, so the planned regulation is immediately made available to students for testing as part of PBL teaching. A similar PBL treatment continues in the following courses for marine insurance and chartering, where the effects of autonomy on marine insurance (changes in risks) and chartering and the parties' liability in a contractual relationship/relationship with third parties are discussed in terms of autonomy.

The required order of completion ensures that the competence of the previous course can be required and included as part of the PBL assignments, in which case the courses together form a working life-oriented learning entity.

2.4 Master of maritime management degree studies and PBL

The experiences from 20 years of teaching Master of Maritime Management Programme shows that PBL teaching premises at the Master level are otherwise the same as on Bachelor level, but the following differences can be found when analyzing the differences;

1) When at the Bachelor level the perspective is on the operation of one vessel from a ship, the focus of the degree is on the operations of the shipping company and the entire fleet.

2) Matters are seen from a country perspective, which emphasises the organisation of operations, risk management, finances and jurisprudence

3) the perspective and roles of the administration and different maritime operators/experts (note: most of the students are already working in these positions) and roles, as well as the strategic decision-making of the entire shipping company, taking into account its business environment.

4) peer learning and knowledge sharing play an emphasized role in PBL teaching, when most of the students already work in expert positions in shipping companies or administration and those still at sea already have long experience, e.g. in the field of education. Container, cruise or tanker managerial duties.

At the Master level studies the Case analyses are becoming more complex and involve e.g. For vessel trading, financing, docking, classification, etc. related legal and commercial issues. Case analysis tasks are divided on the basis of the students' individual background and working life skills, in which case they bring their own background experience and specific working life knowledge (tacit knowledge) to the analysis.

At the Master level studies PBL resembles the management of a shipping company in the maritime operating environment. As part of PBL teaching, a case resolved in one legal environment can be transferred in problem-based learning to another, in which case students are forced to solve it with different rules, thereby illustrating the differences between legal systems and their impact on the outcome (e.g., WEB Insuring ships in the Nordic countries or England) in the light of concrete examples.

The legal and economic impacts of autonomy are simulated for companies' operations and strategic decision-making. This was researched and analysed in the Master level studies 2022–2023 when the first Curriculum was used which was planned during the AutoMare EduNet project.

3. Challenge based learning as a solution for maritime industry educational needs

The AutoMare Edunet project has particularly examined the potential of the challenge-based learning method in maritime education in one of project´s work packages. This method responds to future learning needs and is based on the idea that students define the challenge (or it comes from outside the world of work) and students seek solutions to solve the problem. A challenge-based approach requires critical analysis, good communication skills and continuous learning, and allows us to take into account the changing landscape of the maritime industry.

The model for Challenge Based Education is based on recognized educational needs in the MASS (Maritime Autonomous Surface Ships) context. In education based on the model, student teams seek creative solutions for current and future challenges in the field. The model utlilizes genuine challenges of the maritime cluster that are defined in co-operation with working life representatives (maritime stakeholders and industry). The model is customizable and can be generalized also to other fields of education beyond the MASS context. The increasing digitalization and the introduction of MASS is changing the role of seafarers and other professionals in the maritime sector. With regards to seafarers, it has been discussed that the operation of MASS from remote control centres would require a different set of skills compared to the current situation. The need for detailed knowledge in a narrow field would be replaced by the need for being creative and finding solutions to problems fast.

It was concluded in The AutoMare Edunet project that education in the maritime field should reflect the growing need for inter-disciplinary knowledge and the development of 21st century skills such as critical thinking, problem solving, digital literacy, creativity and communication. Also, given the uncertainty regarding the development of the maritime sector with a more abundant introduction of MASS, it is necessary to develop flexible teaching and learning frameworks, which would allow for agile adjustments and modifications according to emerging needs.

Challenge-based learning has the potential to address the discussed needs because it is based on the idea that students (collectively) define the challenges, which they then solve. Such an approach calls for analyzing critically the situation at hand, develops communication skills and keeps learning close to the real-life challenges in the maritime sector. Since the challenges to be solved are defined as part of the learning process, it allows for accounting for the changing context in the maritime sector.

3.1. Differences between PBL and CBL in practice

It was stated in the The AutoMare Edunet project research that Challenge Based Learning (CBL) shares some characteristics with Problem Based Learning (PBL) where students are involved in solving real-life problems. The decisive factor with PBL is not so much the problem or how it is handled as what kind of knowledge the solution to the problem aims to achieve and what kind of learning is expected to be associated with it. The PBL model have existed for decades, but CBL has been introduced more recently, and it aims to incorporate 21st-century skills into problem-based learning and integrate technology into the process. The goal of challenge-based learning is to have students come up with real-world solutions to open-ended problems called challenges, not just to complete a critical thinking exercise. This makes challenge-based learning a natural extension of the previously existing methods.

In challenge based learning, students are given a learning experience where learning is achieved while solving real-world challenges. The challenges are sociotechnical and multidisciplinary, and they do not have an exact predictable outcome (in comparison to problems with expected solutions). The challenge solving process determines the direction the solution will take. Student groups define the details of the initial challenge and identify the knowledge needed to tackle the challenge and progress towards a solution. In the AutoMare project, challenge based learning is applied as a pedagogical paradigm rather than used as the implementation style for each course.

When developing radically new technology and surrounding sociotechnical regimes, the industry and educational sector need to take into account also other factors beyond challenges rising from inside a certain set of actors. Both technological and industrial boundaries are always in motion even if there are rather broadly accepted visions of what autonomous maritime solutions might be in the future. It is likely that not all the elements needed are yet fully detected. Path-dependency on how maritime technologies have evolved before or which are the currently active actors can lead to missing some potential coming from elsewhere. Therefore, in parallel with the pool of challenges, the AutoMare model introduces a novelties pool. Novelties refer to drivers, trends and phenomena outside the current industry boundary that might shape the technological, operative and institutional development for autonomous maritime.

Both PBL and CBL have their roles in the future of the MET when Education relating to autonomous shipping is being transformed and shared in Digivisio 2030 since 2025. As the consortium of higher education institutes is developed and based on co-operation of both institutions of more technological science Universities and the Universities of Applied Sciences which have the responsibility for Maritime Education and Training (MET) for the STCW standards, it is evident that there are two approaches which need to be combined. MET is more strictly tied education as it is strongly regulated by STCW-convention. Therefore it is also more tied to solving problems on the basis of international regulation which determines the possibilities for solutions which are legally enforceable and which follow the regulation and guidelines of the IMO. CBL is suitable for the development of technological standards and solutions how the technological problems can be solved. As MASS Code will enter into force as a goal based instrument, both the PBL and CBL will be suitable methods in their own practice areas. As the Autonomous shipping is strongly combining the traditional seafaring with technology, the consortium will use both methodological approaches and the work continues. It is evident that the mixing of methods will develop new kind of co-operations for the future of autonomous seafaring when the IMO standards are finalized.

3.2. Pedagogical models as an export product of education

At the national level, Digivisio 2030 enables the comprehensive identification of the competences and training needs needed by society and business, as well as the efficient construction and availability of corresponding education provision for learners. The digital vision will make Finland a more attractive environment for knowledge-intensive industries as employees integrate into a comprehensive and flexible continuous learning ecosystem. This supports the satisfaction of society's competence needs and raises the nation's level of education and competence. Opening up information resources supports the openness of science and research and the utilisation of information. The information gathered on learning and the labour market is used for research, targeting education and training and developing governance. Operators and suppliers can build their services on shared data: the aim is to publish the outputs and solutions concerning information resources under public licenses and as open-source code, which national and international actors from higher education institutions to education systems and companies can utilise in their own service development.

The new learning ecosystems strengthened in the digital vision are dynamic entities between higher education institutions, working life and learners that promote the development of working life practices and learners' competence. By making the national information resources on learning available to individuals and society, a globally unique learning ecosystem is created, which brings an international competitive advantage to Finland as a society and to individuals as learners.

At the European level, Finland is recognized as a forerunner and pioneer in both pedogeological expertise and digitalization as well asfor producing digital solutions safely while ensuring interoperability with European solutions. Finland is also a forerunner in the development of maritime automation. A highly educated nation and Finland as a model country for flexible learning play an important role in strengthening Finland's image, as the advancement of maritime automation changes the educational needs of the maritime cluster both nationally and internationally.

Strong national digital expertise has enormous potential to utilise digital innovations to promote education exports in shipping and the entire maritime cluster. The platform, which is based on the digital vision 2030, enables the Finnish education offering to be opened up to international target groups extensively and with significantly more competitive digital services. This will support, for example, the digital and sustainable mobility models being developed in EU cooperation in education and training. Maritime experts trained in Finland are in demand and sought-after partners regardless of national borders. In this way, the digital vision also contributes to innovation development, export opportunities and economic growth for the entire maritime cluster.

4. Conclusions

The generation of future maritime experts working with autonomous shipping will be required to have multidisciplinary competence, which is why education should be implemented more in cooperation with other higher education institutions in order to ensure high-quality teaching and competence. This means that the methods like PBL and CBL have to be used efficiently in order to create the best possible combination of pedagogical methods for the working life serving the maritime industry which is automatizing in several ways by 2030.

In AutoMare EduNet the higher education institutions have committed to create and maintain a lasting structure for co-operation to develop their offering through common platform, which is identified and decided to be Digivisio 2030 starting at 2025 to offer courses in degree program education. The offering of the AutoMare EduNet project is designed as part of the future digital vision 2030 cooperation of higher education institutions, and the cooperation is built on the rules of the game and technical solutions of the Digivisio 2030 platform.

The future of both shipping and education is changing, and in 2030 both will have changed radically compared to 2023. In terms of degree education in 2030, Finnish higher education institutions will participate in the Digivisio 2030 offering, in which sharing information between higher education institutions guarantees students the opportunity to flexibly tailor the education package they need from the offerings of different higher education institutions. AutoMare Edunet implements this model of the national higher education strategy through networking, which means that the education offering is already compiled in a coherent manner, making it easy for students and companies to utilise. At the same time, higher education institutions can focus on strategic core competence, as they do not have to produce all the expertise required for autonomous shipping themselves. This, in turn, makes it possible to raise the national level of education and allow students to specialize flexibly and sufficiently.

Autonomous shipping is increasing in parallel with the above-mentioned development. Technological development is advancing, and there are already no significant slowdowns in the development of autonomous shipping. In the future, cooperation between higher education institutions will be further deepened by the network, as maritime legislation will enable autonomous shipping globally as of 1.1.2028. The work of the network secures Finland's position as an international trainer of autonomous shipping and enables a flexible transition from conventional vessels to autonomous vessels also with regard to the training needs of the maritime cluster.

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A NEW LEARNING APPROACH FOR MARITIME EDUCATION AND TRAINING

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Abstract: Learning Station (LS) is a flexible learning tool that transforms Maritime Education and Training (MET) in light of technological developments, Standards of Training Certification and Watchkeeping (STCW) regulations and Active Learning (AL) methods. LS includes a variety of AL methods such as discussion, creating, thinking, make decision etc. AL helps the LS from basic course activities to problem-based learning with these methods. These methods go beyond passive information acquisition by encouraging student interaction, critical thinking skills and dynamic learning. In LS, students take responsibilities for their education by creating their own learning experiences. This approach allows each student to add their own learning styles to the learning station. Thus, each student adapts to different learning styles. They can discover different modes in their own learning techniques. The LS model harmonizes the rapid technological advancement and changing processes in maritime operation. Traditional maritime education methods based on published content and on-board experience. The LS combines theoretical knowledge with practical implementation, allowing maritime students to be better prepared for modern maritime operation. As in the STCW standards, the LS model also encourages collaborative learning, the development of technical and non-technical skills. Thus, collaboration between students and teachers develops in the process of knowledge creation. Traditional MET universities teaching techniques often fail to utilize modern educational methods and technologies. To overcome these limitations, LS uses a modular, adaptable and scalable teaching design. The MAR-LSD (Learning Station Design for Maritime Education and Training) project of the IAMU Organizational Development Project FY2023 is an advanced training system designed to respond to the changing needs of the maritime sector. In this study, the content, scope and preparation of the LS model are explained. In addition, a sample Maritime Security Learning Station model prepared by maritime students and educators of the Maritime Security Course is shown.

Keywords: Learning Station (LS); Maritime Education and Training (MET); Active Learning, Digitalization in Education

1. Introduction

The Learning Station (LS) is a modular planning tool designed to integrate innovative teaching and learning methods across organizations, including higher education institutions. Operating on a flexible, chessboard-like framework, LS facilitates the use of Active Learning (AL) techniques independently or in combination. AL approaches range from simple classroom activities (e.g., think-pair-share, brainstorming) to advanced methods like project- and problem-based learning (Lord et al., 2012). These methods emphasize learner participation, critical evaluation of materials, independent thinking, and deeper understanding, thereby requiring active engagement (Børte et al., 2020).

In maritime education, it is difficult to align the curricula with the operational demands of rapidly changing needs of maritime engineers (Chatterjea, 2006). A traditional reliance on published content often means the learning material becomes outdated because of the fast pace of technological and operational changes at sea. Maritime education combines theoretical classroom training with exercises on simulators in creating the basic knowledge base before the trainees shift into the actual world of shipboard operations (Manuel, 2017). However, there are still few pedagogical approaches to Maritime Education and Training as integrating more advanced instructional methods and embedding advanced technology tools in the courses (Nazir et al., 2015).

Simulator-based training is one of the cornerstones of MET and helps link theoretical knowledge with practical application. However, several studies show that using a simulator often lacks appropriate orientation from a curricular perspective and instructional strategies, underlining the crucial importance of instructors in ensuring effective learning (Hontvedt & Arnseth, 2013; Sellberg, 2017). Although these are advancements in pedagogy, traditional ones dominate MET, while strong barriers persist against adopting modular and scalable instructional designs to fully harvest AL methods and digital tools (Türkistanli, 2023).

Digital innovation has the potential to bring about sweeping change in MET. VR, AR, and game-based learning are some of the tools responsible for improvements in student engagement, academic performance, and decision-making processes (Rajasekar & Aithal, 2022; Yuen et al., 2022). However, obstacles such as old regulations, lack of resources, and differences in user skills hinder wide implementation (Türkistanli, 2023). Initiatives such as MarEng and FlexiMod exemplify the significance of digital platforms in meeting the demands of language education and electronic learning; however, they also expose challenges related to accessibility and execution (De La Campa Portela & Bocanegra, 2007).

To overcome these challenges, the MAR-LSD project, part of IAMU's Organizational Development Project FY2023, proposes a shift from traditional instruction to a learning paradigm. It emphasizes modular, scalable tools to foster student discovery, collaboration, and knowledge construction, thereby advancing MET's alignment with industry needs and evolving pedagogical standards.

2. Methodology

The Learning Station (LS) Design Guide, developed by Istanbul Technical University Center for Excellence in Education (ITU-CEE, n.d), has been an essential framework in developing innovative Learning Stations (LS) for Maritime Education and Training (MET). The LS model assumes a catalog-based approach meaning that its components are designed either by instructors or created collaboratively by students under instructor mentorship. This approach goes beyond traditional pedagogical methods to offer a more integrated understanding of subjects through different learning modalities. The very process of development is framed around the so-called LS Catalog Form, which then becomes a sort of base framework in developing the learning experience.

The LS Catalog Form—just a few of the necessary components—are the LS Information Table, LS Matrix, learning objectives, outcomes, delivery methods, and assessment strategies. These components together define the structure and intent of the LS, guiding the collaborative educational undertakings. It is designed to meet the particular needs of LS developers and their audiences of interest, serving as a communications tool for stakeholders in the form of students, academics, administrators, alumni, and industry practitioners.

The LS Information Table gives an overview of the learning station in detail, covering content, complexity, objectives, results, links to the UN SDGs, assessment methods, teaching materials, and language prerequisites, as well as additional resources. This table will help stakeholders identify the learning station most appropriate to their needs. The LS Matrix is a crucial component; it organizes the learning experience into flexible modules that link learning outcomes, instructional strategies, assessments, and outcomes. The modules can be adapted for various activities and contexts, thus providing flexibility and scalability. Assessment components are imbedded in these modules so they can be used independently or sequentially, depending upon the subject matter.

The LS model emphasizes active learning pedagogies, encouraging students to engage with materials before formal instruction to enhance time management and learning quality. Learning objectives and outcomes are fundamental to the LS model, as they guide the design and implementation of the learning experience. Objectives define the aims and expected results of the learning activities, considering learner demand, roles, configurability, and instructional techniques. Clear and explicit outcomes, defined using the revised Bloom's Taxonomy, are helpful in ensuring effectiveness in the learning process since it allows instructors to assess whether goals are achieved. Bloom's taxonomy categorizes cognitive skills, allowing designers to evaluate student capabilities and encourage creative and active participation..

Content delivery modalities significantly enhance the learning system since it offers physical, digital, or hybrid alternatives designed specifically to meet defined learning outcomes. Such diverse approaches address different learning preferences, thereby raising the level of quality in educational experiences overall. Evaluation becomes very important in testing learners' understanding of the modules and if they have acquired the ability to successfully achieve the intended outcomes. Clear and quantifiable learning objectives direct educators and learners for smooth accomplishment of educational objectives.

By systematically integrating course content, goals, modules, delivery methods, and assessments, the LS model provides a comprehensive and adaptable framework. This methodology ensures that learning stations are effective, accessible, and aligned with the evolving needs of maritime education and training.

3. Preparing Learning Station for MET

The lecturer introduced the course's goals, outcomes, and the LS development process, including the LS Catalogue Form. Students selected their preferred learning methods, contributing to a tailored maritime course design. Instructors supported students by providing reliable resources and guidance. A LS Information Table for the pilot course, Maritime Security, was presented as below Figure 1.

MARITIME SECURITY LEARNING STATION

INFORMATION TABLE

Elements of a catalog form	Explanation
Code	• MARSEC
Initial design date	• 02/10/2023
Final revision date	• First Issue
Subject	• 1. Introduction • 2. Maritime Security Policy • 3. Security Responsibilities • 4. Ship Security Assessment • 5. Security Equipment • 6. Ship Security Plan • 7. Threat Identification, Recognition, and Response • 8. Ship Security Actions • 9. Emergency Preparedness, Drills, and Exercises • 10. Security Administration • 11. Security Training
Title	• Maritime Security Learning Station
Level	• Basic
Target audience (potential participants / learner profile/)	• Undergraduate Maritime Students
Short description	• This course aims to educate students who may be assigned the role of Ship Security Officer (SSO) as outlined in the ISPS Code and STCW Code. It focuses on the duties related to ship security, implementing and upholding a Ship Security Plan, and collaborating with the Company Security Officer (CSO) and Port Facility Security Officers (PFSOs). The updated Ship Security Officer course focuses on providing specialized training to tackle the issue of piracy and armed robbery against ships. The adjustments are based on Section A-VI/5 of the 2010 amendments to the STCW Code.
Learning objectives (LOs)	• LO1. Investigating incidents affecting maritime security. • LO2. Understanding terms used in maritime security and national and international policies. • LO3. Conducting routine security inspections aboard the ship to verify the maintenance of suitable security measures. • LO4. Conducting ship security risk assessment. • LO5. Overseeing and ensuring the execution of the Ship Security Plan, including any revisions to the plan. • LO6. Coordinating security procedures for handling cargo and ship's stores with onboard personnel and Port Facility Security Officers. • LO7. Suggesting changes to the Ship Security Plan. • LO8. Reporting any shortcomings and non-conformities found during internal audits, periodic reviews, security inspections, and compliance verifications to the Company Security Officer and taking necessary remedial steps. • LO9. Improving security awareness and vigilance on board. • LO10. Ensuring shipboard staff get sufficient training as needed. • LO11. reporting every security incident; • LO12. Coordinating the execution of the Ship Security Plan with the Company Security Officer and the appropriate Port Facility Security Officer. • LO13. Ensuring correct operation, testing, calibration, and maintenance of security equipment, if applicable.
Number of modules	• 11 Modules
Learning outcomes	• Learning Outcome 1. Encourage security awareness and vigilance; • Learning Outcome 2. Understand the policies and elements effective in ship security; • Learning Outcome 3. Assess security risk, threat, and vulnerability; • Learning Outcome 4. Ensure that security equipment and systems, if any, are properly operated, tested and calibrated; • Learning Outcome 5. Maintain and supervise the implementation of a Ship Security Plan; and • Learning Outcome 6. Undertake regular inspections of the ship to ensure that appropriate security measures are implemented and maintained.
Related SDGs	• Learning Station contributes to SDG 4 Quality Education target. • It contributes to the SDG 8 Decent Work and Economic Growth target by providing training to prevent maritime crimes. • It contributes to the SDS 9 Innovation, Industry and Infrastructure goal of preventing attacks against Maritime Critical Infrastructure. • It contributes to SDS 14 Life Below Water target to prevent IUU fishing crimes. • Fighting maritime crimes contributes to the SDG 17 Partnerships For The Goals target by establishing global partnerships.
Assessment methods	• Multiple Choices Test Method
Duration (hours)	• 28 hours
Prerequisites	• No requirements needed before course.
Learning materials / resources	• International Maritime Organization. (2003). International Ship & Port Facility Security (ISPS) Code, 2003 and December 2002 Amendments to SOLAS. London: IMO. (IMO-I116E). • SOLAS Chapter XI-1 • SOLAS Chapter XI-2 • ISPS Code Part A • ISPS Code Part B • International Maritime Organization. (2009). "Guidance to Shipowners, Companies, Ship Operators, Shipmasters and Crews on Preventing and Suppressing Acts of Piracy and Armed Robbery against Ships." MSC/Circ.623/Rev.3
Quota	• Minimum 8, Maximum 28 students
Language	• English
Notes	• A certificate should be provided to those who have completed this course, certifying that they have finished the training as a "Ship Security Officer" according to this specific model course.

Figure 1. Maritime Security Learning Station Information Table

Figure 2 below illustrates the LS Matrix section developed specifically for the maritime security course.

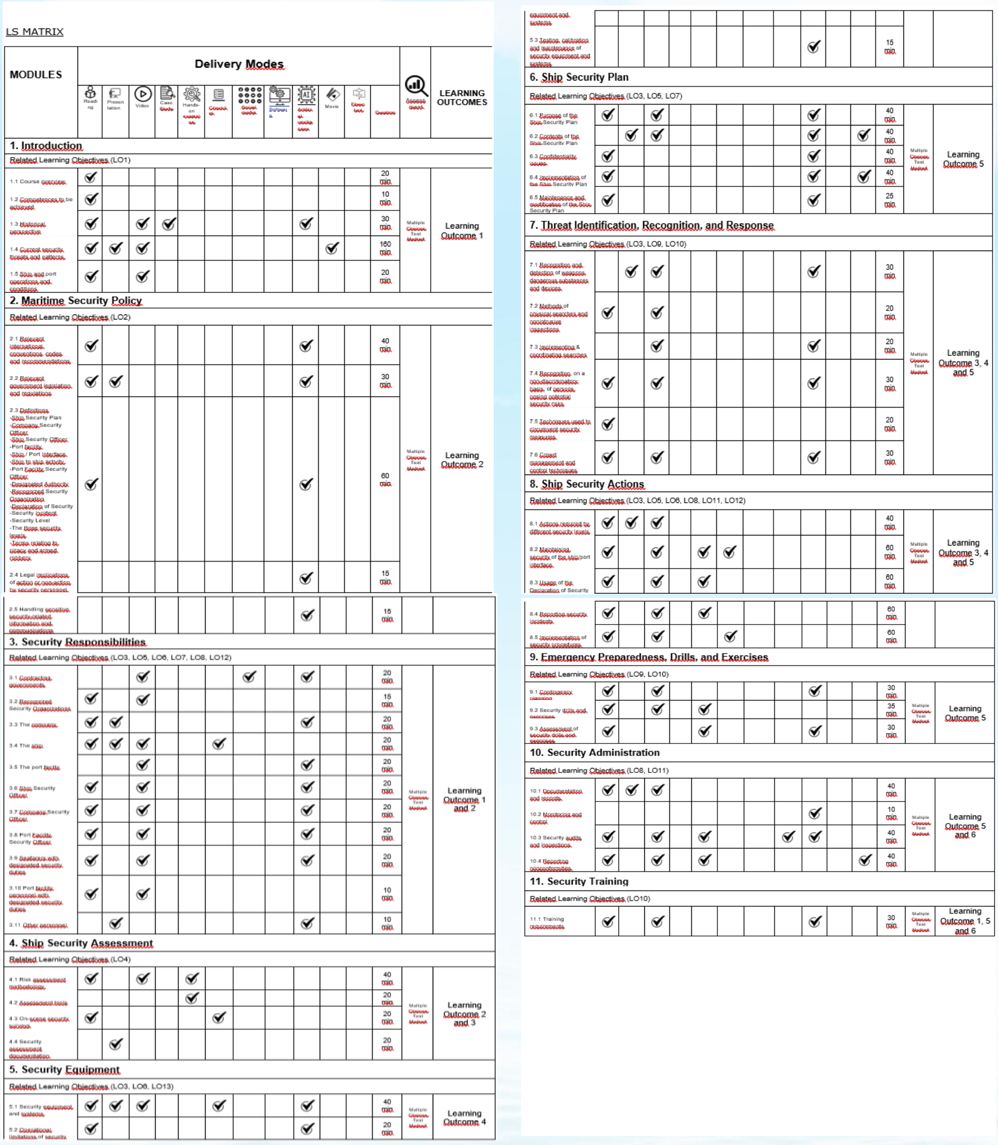

Figure 2. Maritime Security Learning Station Matrix

4. Conclusion

This project aims to bridge traditional maritime education with the evolving digital landscape by developing a collaborative co-learning platform. Designed to foster participation among IAMU member schools and stakeholders, the platform integrates course content, learning goals, results, modules, assessments, and delivery methods into a cohesive framework to enhance maritime education. The MAR-LSD portal serves as a centralized hub for knowledge exchange, showcasing LS model courses, and incorporating e-learning technologies to address the sector's educational needs. Continuous updates and collaboration among IAMU, universities, and trainers ensure the platform's alignment with international maritime standards, promoting the development of skilled seafarers in a digitalized environment.

Acknowledgements

The project discussed within the scope of this study is a project funded by The IAMU as Organizational Development Project FY2023's MAR-LSD (Learning Station Design for Maritime Education and Training). The

internet address of the MARLSD Project mentioned in the study is www.marlsd.com and the e-mail address is info@marlsd.com.

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INTERCULTURAL AWARENESS AND COMPETENCY OF CADETS

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Abstract: In today's world, we live in a global environment, therefore intercultural contact has become a crucial factor (Zhao, 2011). Since the profession of seafaring is to accomodate both multinational and global features, it is a crucial skill for all seafarers to have intercultural awareness and competence regardless their nationality and rank to ensure a thorough efficiency and effectiveness of labor force. Within the recent decades vessels are manned with crew with cultural diversity; seafarers are exposed to unfamiliar/ unexpected working styles, problems and problem solving strategies based on each other's different habits, beliefs, attitudes, while spending utmost effort and care to perform their duties with endurance and resilience. Intercultural competence seems to be the very soft skill to gain on behalf of ensuring the efficiency on board and meeting the essential requirement of being a global seafarer. Intercultural competence is the ability to function effectively across cultures, to think and act appropriately, and also to communicate and work with people from different cultural backgrounds. This qualitative study aims to reveal the present intercultural awareness and competency of cadets at ITUMF- Istanbul Technical University, Maritime Faculty via 17 itemed survey. We also seek and suggest ways, approaches, methods on behalf of intercultural awareness and intercultural competence progress of the future seafarers.

Key words: seafarers, cadets, global, intercultural awareness, intercultural competence

INTRODUCTION

Commencing from the year of 2020, days full of pandemic, fear of death, lock down have triggered all hands on the earth to focus and progress adaptation skill to be able to survive since conditions evolve swiftly by **a game changer**. Hence these radical changes reshaped the demands of requirements of employees/ companies from each employer regardless the sort of professions.

When focusing on the quality of seafaring it has always been a demanding profession throughout the ages, as seafarers had to perform their duty safely while navigating in different geography they have not been before; rapidly changing weather conditions mostly under average living standards on board, collaborate efficiently with colleagues having different working styles, nationalities both at port and on board. Within the last two decades it became quite obvious that specifically the requirements have rocketed up in terms of training and certification, they had to put utmost effort to upgrade, attain their brand version of themselves more than ever before.

On the other hand due to the innovation of Industry 4. 0 nowadays, development is simply a part of the procedure, seafarers' skillsets, jobs and roles will change along. Poulson (2018), Chairman of the International Chamber of Shipping, holding the motto of 'digitalization is a part of evolutionary change' points out:

> Nowadays, I surmise the enormous contrast is that we have a dis- cernment that mechanical change will be faster in the following 20-30 years than in the last 30, and I surely accept that. The coming of innovation and the models that we have seen of what it can do to different ventures will not avoid shipping.

Until all vessels are operating fully autonomously, most seafarers are likely to have a working atmosphere consisting these factors as;

*contracts lasting up to /more 6 months,

*high noise levels,

*physiological changes resulting from a three-shift work schedule, *the diverse and rapid changes to the natural environment,

*a highly stressful work environment and

*a significant degree of stress and fatigue

*operations with minor/major risks

*multinational /cultural colleagues

Zhao (2011) perceives the world as a global environment, therefore holds the view that intercultural contact has become a crucial factor.

Unless treated in time these factors are deliberately obstacles for efficiency and effectiveness on board thus seafarers are to be equipped with the skills of intercultural awareness and competence prior to starting their professional lives. Based on the similar context Kim and Jang (2018) observe and report the situation on board as "**cultural clashes** occur frequently due to the multinational workforce".

Sampson and Zhao (2003) enounce that today's sailors are regularly recruited from diverse worldwide regions through networks of crewing agents, and it has become increasingly common to find mariners of diverse national backgrounds working together.

The eminent shipping companies have revised and declared the skill-set for the next generation of seafarers as having the qualities of; auto didact, good seamanship, resilient, data analyst, emphathetic, interpersonal leadership skills, tech savvy, time management, emotional intelligence, culturally aware, ethical, problemsolver, commercial acumen.

Based on the rationale explained in the lines, in this study we are targeting on intercultural awareness and competency of cadets due to two reasons firstly; intercultural competency is interrelated with the qualities of; being a good seaman, problemsolver, having interpersonal leadership and empathy, secondly they are the future seafararers.

Provided that one has intercultural knowledge, attitude, skill and awareness; s/he is an intercultural competent person possessing the ability to understand other cultures, and communicate easily with people from those cultures.

As Byram (2000), Deardorff (2006) and Fantini(2000) highlighted that intercultural competence is comprised of skills, attitudes, knowledge, behaviour and comprehension about other cultures, which is important to live in today's globalised world.

Therefore it is possible to deduce that having international competence is an important competency in today's world, because the world has become smaller in recent years thanks to internet, social media, easier and cheaper opportunities for travelling from one country to another, and related to this, exchange programmes for students at universities. All of these require being interculturally competent for an individual to survive in such a world.

Acejo (2021) declares that officers in charge of supervising the crew are better equipped to implement management strategies that promote diversity at work and avoid stereotypes against different nationalities. Such a high level of cultural awareness enable them to re-establish and increase sailors' work involvement as well as preventing isolation. Failure of any of the crew members to adapt to the existing culture leads to deterioration of the social order of the ship and cultural conflict among the crew.

The cultural adaptability of seafarers helps seafarers of different cultures to understand how to react to an event. In a multicultural working environment, the most important factor for a successful team performance is the cultural adaptability of team members. The intercultural environment can help seafarers to increase their cultural competencies and awareness to develop their cultural intelligence, helping them to work better collaboratively in ship operations.

Cultural awareness is a conscious understanding of the target culture's role in language learning and communication in both native and target languages (Baker, 2012). If a language learner is culturally empathic, he/she becomes aware of the cultural values and beliefs of the people from the target culture without leaving his/her own culture (Zhu, 2011).

The terms of multiculture, cross-culture and interculture

Multicultural refers to a society that holds several cultural or ethnic groups. People live alongside one another, but each cultural group does not necessarily have engaging interactions with each other. For example, in a multicultural neighborhood people may frequent ethnic grocery stores and restaurants without really interacting with their neighbors from other countries.

Cross-cultural deals with the comparison of different cultures. In cross-cultural communication, differences are understood and acknowledged, and can bring about individual change, but not collective transformations. In cross-cultural societies, one culture is often considered "the norm" and all other cultures are compared or contrasted to the dominant culture.

Intercultural describes communities in which there is a deep understanding and respect for all cultures. Intercultural communication focuses on the mutual exchange of ideas and cultural norms and the development of deep relationships. In an intercultural society, no one is left unchanged because everyone learns from one another and grows together (https://springinstitute.org/).

Having an evaluation of these three listed above, the intercultural society seems to be the most favourable one to work in in terms of seafaring as everyone learns from one another and grows together.

STATEMENT OF THE PROBLEM

We seek to find out the responses to the questions of;

1. How do they feel/react / handle with problems when exposed to multicultural mates/ colleagues whilst on board training?
2. Does it impact their working style and discipline if so, to what extent?
3. Which attitude(s)/solution(s) they resort to handle with the unexpected situations related with intercultural interactions?
4. Do the cadets –prospective officers- have intercultural awareness?
5. Do they have intercultural competency?

DATA COLLECTION

The responses are collected from cadets attending both marine engineering, maritime transportation and management departments. 50 cadets completed the on line survey with multiple choice, open ended and semi controlled questions. The research tool is made up of 14 +3 different sort of questions and by all means designed in their L1- mother tongue (See Annex 1). The very pre-requisite is that all participants have already completed on-board training on multinational crewed vessels but have not STARTED their professional lives. Participants of 89.9 % are male, only 11.1 % of them are female cadets.

The responses are submitted via on-line survey with 17 questions, designed to see whether they have intercultural awareness, their intercultural competence by means of questions to evaluate how they feel and react when confronted with problems based on cultural diversity.

DATA ANALYSIS

Survey is made up of two sections, first of which has 14 items based on orientation and information on the culture of colleagues, communication skills, working styles/disciplines. The second section is patterned in three different hypothetical situations- scenarios- on most likely experiences encountered on board regarding working with colleagues from different cultures.

Overall we aim to collect cadets' reactions, emotions and detect their working styles and, problem solving strategies, to what extent they tolerate, understand develop empathy, comprimise or conflict when working in cultural diversity in terms of their working styles and problem solving strategies.

Q1 is whether they have been informed about the quality of crew by the company before joining vessel. Approximately all participants with the percentage of 94.4% state they were informed about their colleages which is quite reassuring to prepare cadets for their first experience on board; not leading having disturbance or discomfort, having trust on the company.

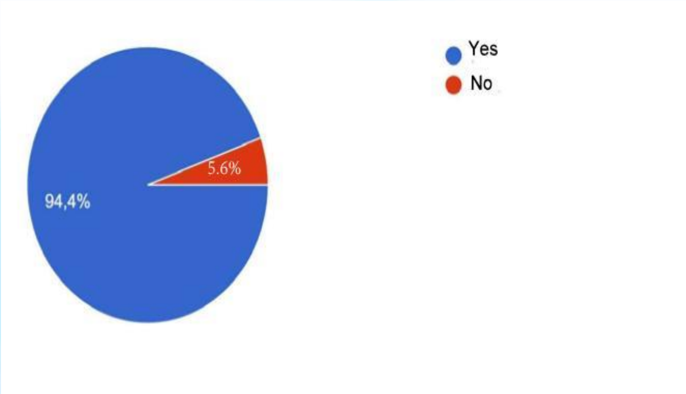


Figure 1. Before joining vessel I know I will be on a multinational crewed vessel

Q2 is about the cadets' communication; if it is easy /difficult to communicate with colleagues on board. Responses show 83.3% , nearly 2/3 of them communication did not constitute a problem.

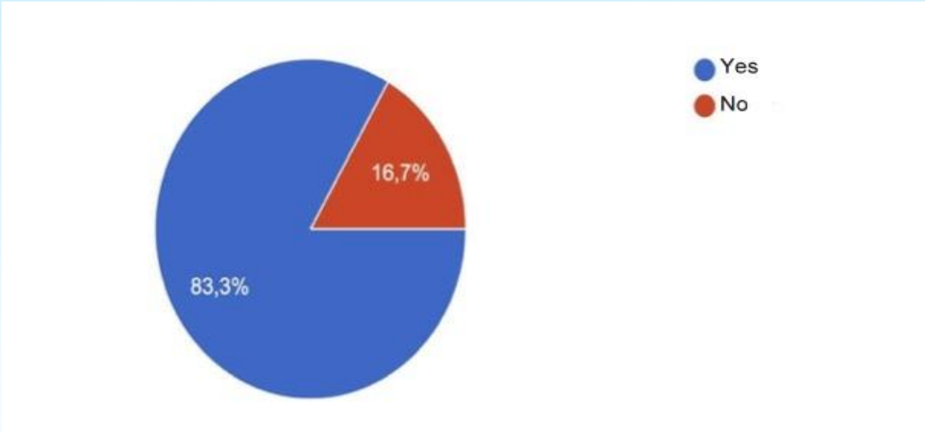


Figure 2. It is generally easy to communicate with my colleagues on board

Q3 is about orientation(by the companies)about different cultures before joining vessel, 2/3 of the population stated they were undergone orientation program /sessions.

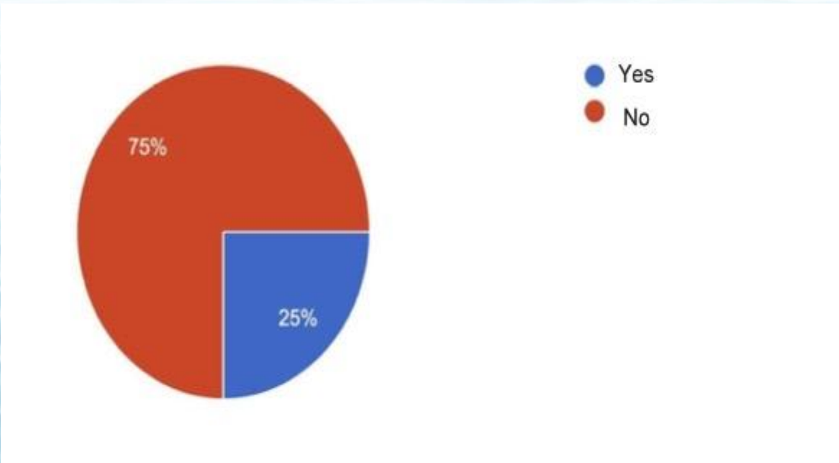


Figure 3. I have been oriented about working with different cultures prior to joining vessel.

Q4 is asked to see if they knew something about different cultures, 72.2 % agree having information whereas only 27.8 % did not. Responses to Q3 and Q4 indicate the cadets have cultural awareness in knowledge level.

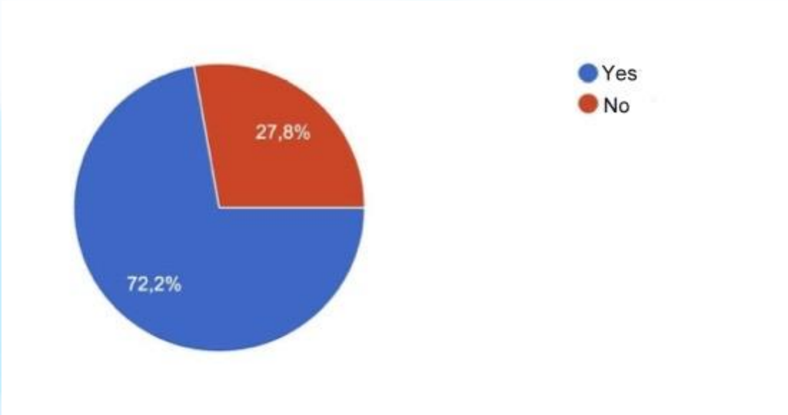


Figure 4. I have already had some information about other culture (European, Asian, the Far Eastern)

Q5 aims to find out if it would make a difference in terms of communication, effectiveness of journey, team work and mutual understanding, when you DO NOT KNOW / WERE NOT ORIENTED /INFORMED ABOUT THE OTHER CULTURE/s etc.

Here are the responses worth paying attention as in Figure 5 below.

* I do not think it will make a difference at work, but it is necessary to spend time together off work.
*As our cultures were different, we had FEW in common, spending time alone instead of getting socialised, this made me feel isolated, not good at all!
*Verbal communication was poor so the instruction for work was evetually given by someone else.
*The fact that the same gestures can have different meaningsin different cultures, which caused the problem
*In general, I learnt about their culture while chatting during off hours.
* It depends on your perspective, if you look positively, you will see the positive side or vice versa.
* I do believe a thorough dialogue opens up all solutions just like a remedy.
* After working with colleagues from different cultures, I think there are stereotypical beliefs for certain race, culture etc.
*Working in cultural diversity brightened up my point of view, my horizon.

Q6 is asked to see when and which conditions they have difficulty in communication 41.9 % of the responses find difficult to understand their colleagues' pronunciation most probably strong accents while speaking in English. 2nd problematic reason is the dominant culture (35.5%) ; they keep on talking in their mother tongue other than English which is the most encountered case when navigating with major nationality The other /s feel they are really stuck, alien leading to fatigue as they keep on talking in their own tongue, not even a single word means anything. Third reason is that they are aware they do not have sufficient English (19.4%) we are as educators, trainers and curriculum designers have responsibility to improvise the situation. Not only power distance (hierarchy) but also belonging to different cultures constitute problematic factors / obstacles to establish proper communication on board with the same percentage (16.1%).

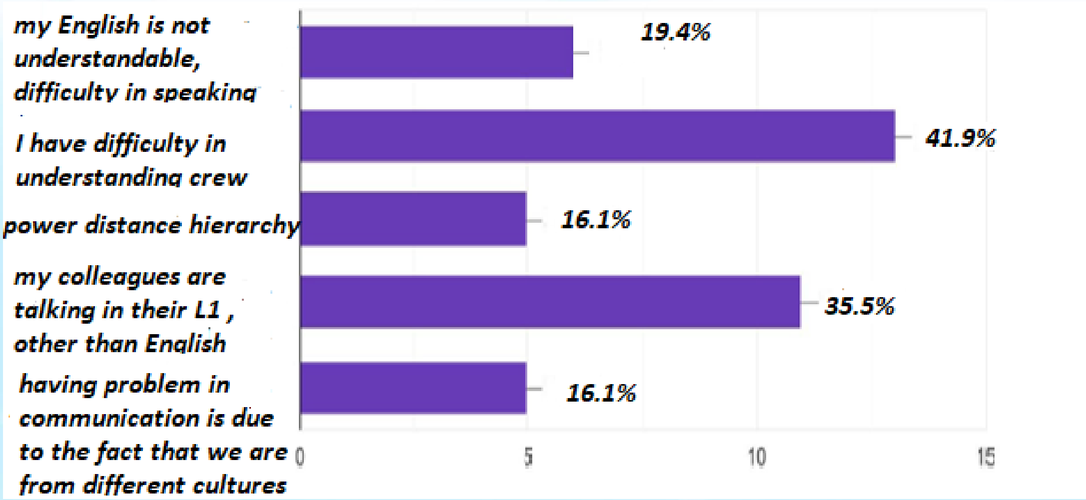


Figure 6. I have difficulty in communication because

Q7 aims to highlight cadets' preference of colleagues with same nationality, same religion, or different cultures, more than 2/3 of the participants (80%) prefer to sail with crew from diffirent cultures, only (19.4%) of them want to be with single nationality crew. This shows they are willing to work with crew from different cultures and self confidence towards working in cultural diversity.

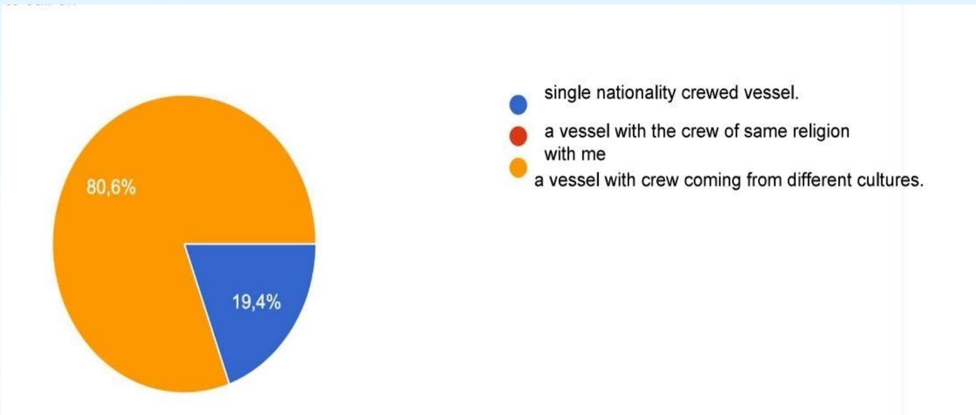


Figure 7. I would prefer to sail with crew ………..

Q8 has the purpose to check out their feeling of confidence with handling the issues well despite cultural bias; namely colleagues' different nationality/religion/culture, all of which indicate cultural diversity in one or other aspect. Almost all participants agreed on their competence even if they are surrounded with cultural diversity while working.

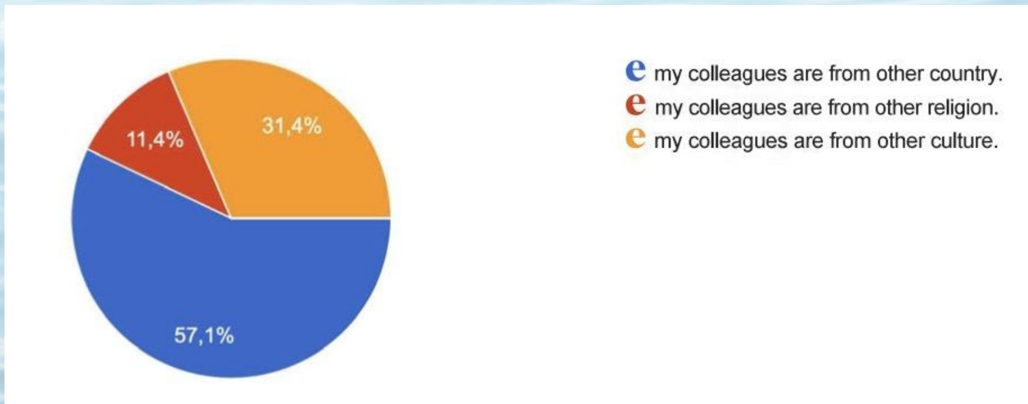


Figure 8. I think I have coped well even if my colleagues are from other country/religion/ culture.

Based on the rationale that 'food' and 'the Cook' are the most essential key factors for the seafarers regardless the nationality and rank, Q9 targets to reveal the reason why food did not constitute a problem; responses of 48.3 % explain as the food on board is tasty and delicous - the Company/Master considered all hands' common preferences which means they were fortunate. 31 % exemplify the situation because the Cook is good at his /her job, 20.7 % express that Cook is from my country.

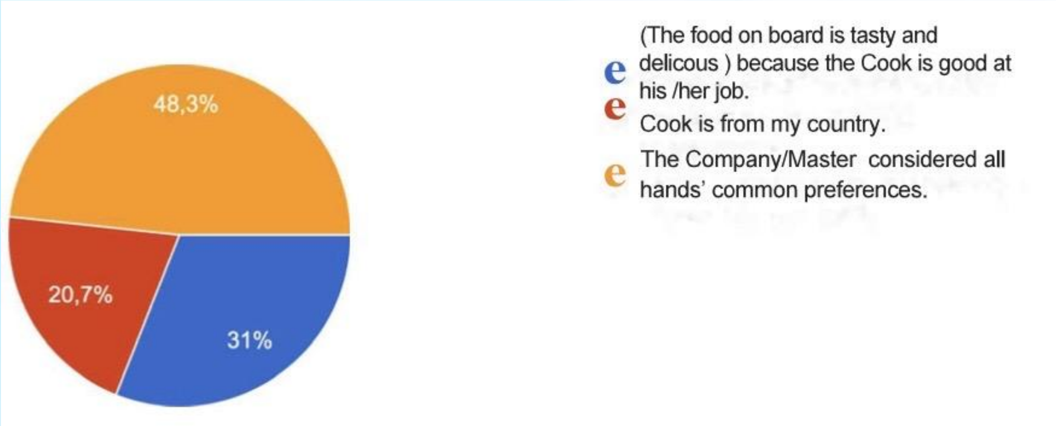


Figure 9. I liked the food on board.

Q 10 is for those who do not like the food on board. Reasons for the situation are distributed as For those 36.4% the Cook is bad at his /her job , 22.7% of cadets think this is due to the fact that Cook is not from their country. For 22.7% of the participants the Company/Master did not consider individual preferences 18.2% of them do not fancy with other cuisine.

Figure 10. I did not like the food on board because

Questions of 11 – 14 are designed to see their working style, whether they wish/ find easy/ difficult to work individually or making collaboration, also detect the reasons behind their preference.

As highlighted by Q 11, 59.4% of the cadets prefer collaboration, 40.6% of them are willing to work individually, which means they are open to make team work, cooperation and collaboration.

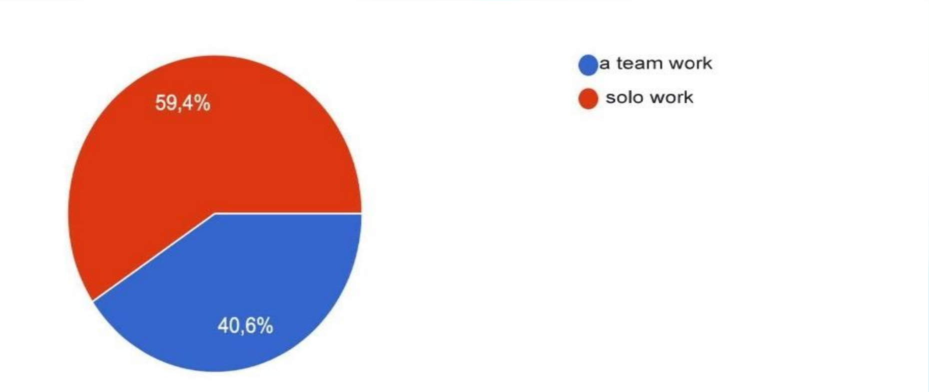


Figure 11. At work it is always difficult for me to make a team work/ individual work

Cadets count the reasons making team work difficult as while giving the responses to Q 12 ;

- exposure to bullying, mobbing, harrassment (52.2 %)
- mention if there is something else (34.8%)
- different working styles (21.7%)
- communicational problems (13.%)

More than half of the participants stated they encountered the cases of bullying, mobbing and harassment on training, which constitutes a severe problem which will definitely cause unpredictable outcomes. Therefore management on board and companies are to consider these issues seriously and immediately take edquate steps as preventive and measures and remedial actions.

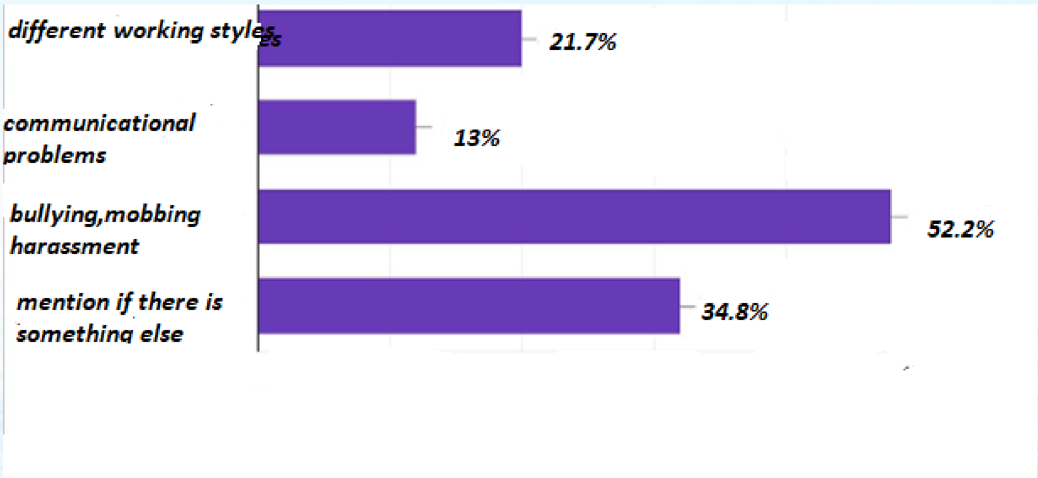


Figure 12. When in team work things get worse because of ….

Q13 requires why they do not prefer individual / pair work. Nearly 2/3; 70.8% of the participants agree that it will take longer to complete. 29.2% explain the reason as they need some more advices from other colleagues. It is quite obvious that the cadets are highly open to collaboration.

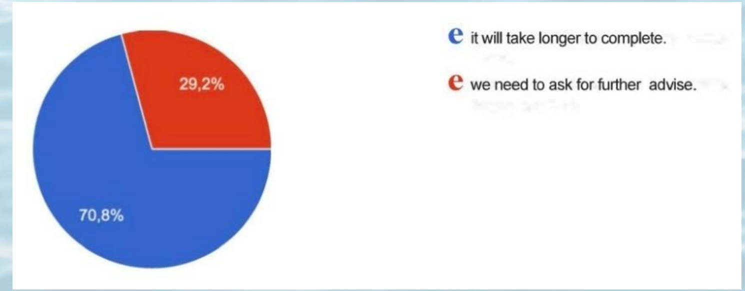
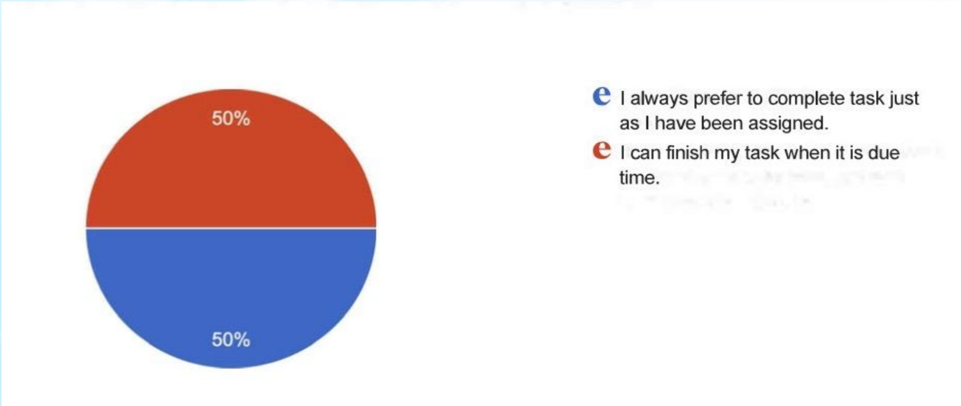


Figure 13.Things get worse when there is individual / pair work because

Q14 is asked to see whether they are punctual or dead line oriented when assigned a task. The result is fifty to fifty percent.



HYPOTHETICAL SITUATIONS

Scenario I, is designed to see their feeling , reaction when they are to work on their important day i.e.holy, religious day etc.; we want to see how they are prepared for the job as they are newcomers they are not professionals yet. It does not matter for more than half of cadets (55.9%). 35.3% state they did the task but unwillingly, 2% have frustration, 1% feel angry.

Figure 15. Scenario I

Scenario II is about cadet's attitude, solution when their colleagues' (dominant culture) communicate in their own language other than English permanently, ignoring the other person. 44.1 % solve the problem by warning the colleagues directly, saying s/he does not understand anything. 41.2% explain them their feelings and let them make an empathy. 29.4% prefer ignoring everyone, accept the situation and live in their own world. 5.9% of them find the solution by going to the Chief and reporting this situation.

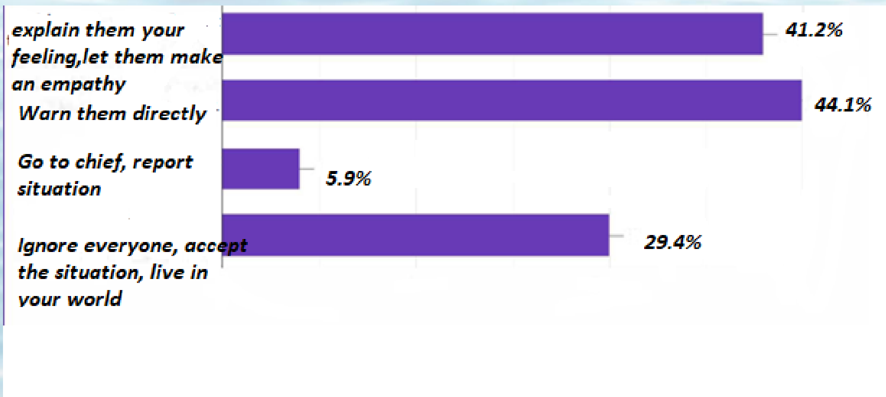


Figure 16. Scenario II

Scenario III is based on the how the cadet expressed himself when facing with officer's mistreatment/ unfair because of your gender/ nationality/being hardworking/ different from the dominant crew how would you express yourself;

48.6% prefer going to the C/E or the Master to make a complaint report,

45.6% of them see the solution by moving from the area, calm down and going back to explain what has been done which is unfair to them,

14.3 % of them take a short break and calm down, try to forget everything with the same percentage 14.3 % report to the Company (Figure 17).

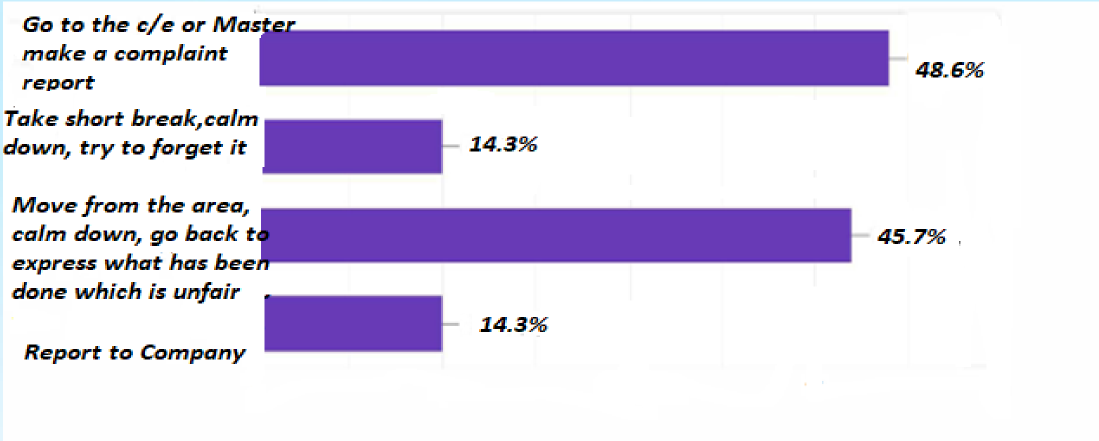


Figure 17. Scenario III

CONCLUSION

Thomas Tischhauser describes a global engineer - the engineer of the future that "s/he must be prepared to 'champion cultural diversity'" by understanding that "cultures are diverse" and that "diversity drives the best ideas." Engineering students will not only need "a good understanding of cultural differences," but also be able to "function smoothly in a complex social setting." (Vitto,2008)

In 2001 The European Council regarded and declared that 'language competence is no longer adequate for their students but rather a focus must be made on intercultural competence'. (Sercu)

As seen from the analysed data the future engineers of ITU MF have knowledge, understanding, respect empathy, adaptability, emotional intelligence when working in cultural diversity, these are the pre-requisite components to develop the skill of intercultural competency. The cadets have remarkable degree of cultural awareness and competence even if the curricula do not consist the lectures focusing on the issues. Nevertheless 28% of the population seem to have problems in expressing themselves when facing with unexpected situations based on injustice, unfair attitudes, discrimination, bullying, harassment. The language competency in terms of expressing themselves especially speaking skill and personal development skills are to be cultivated in order that the cadets will improve the ways and strategies to cope with the problems in working area.

Should we want the cadets, future seafarers to get more resilience and perseverance to be able to work for the pioneer shipping companies, these needs are to be taken into consideration seriously and tangible rules, practices are to be put into action by the authorities and practitioners.

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ANNEX I

Dear cadets,

We are making a research on the intercultural awareness of cadets working on multinational crewed vessels. The study aims to find out intercultural awareness and its effects at work. Your answers will definitely help us to design updated curriculum based on the needs of changing maritime sector, ensuring to train prospective officers equipped with high adoption skills so that they will be able work on pioneer fleets with self confidence, high motivation and endurance. We thank you for the time and care in advance.

Lecturer Müjgan ÖZENİR

Master Maria Kristina B. JAVELLENA

SURVEY FOR CADETS ON MULTINATIONAL VESSEL

Female Male Prefer not to say

1. Before joining vessel I know I will be on a multinational crewed vessel YES NO
2. It is generally easy to communicate with my colleagues on board YES NO
3. I have been oriented about working with different cultures prior joining. YES NO
4. I have some information about other culture (European, Asian, the Far East). YES NO
5. IF NO, how would it make difference in terms of communication, effectiveness of journey, team work and mutual understanding; mention them pls
6.I have difficulty in communication because ……..

a. my English is not understandable or I am struggling with expressing myself clearly in the conversations.

b. I am also struggling to understand my colleagues' English.

c. Power distance- (problems related with hierarchy)

d. My colleagues are talking in their own language other than English.

e. The reason why I have difficulty in communication is we are coming from different cultures.

7. I would prefer to sail on
a. single nationality vessel
b. crew with same religion with me
c. crew coming from different cultures
8.I think I have coped well even if
a. my mates are from other country
b. my mates are from other religion
c. my mates are from other culture.
9. I liked the food on board ………..
a. (The food on board is tasty and delicous) because the Cook is good at his /her job
b. Cook is from my country
c. The Company/Master considered all hands' common preferences
10. I did not like the food on board because
a. (The food on board is not tasty and I could not eat at all) because the Cook is bad at his /her job
b. Cook is not from my country.
c. I do not fancy with other cuisine.
d. The Company/Master did not consider individual preferences
WORKING STYLES
11. It is always difficult for me to make
a. a team work
b. individual work
12. When in team work things get worse because ……..
a. different working styles
b. communicational problems
c. mobbing, harrassmant
d. mention if there is something else
13. Things get worse when there is individual / pair work because …….
a. it will take longer to complete
b.we need to ask for further advise
c. mention if there is something else
14. Which one below describes you best at work?
a. I always prefer to complete task just as I have been assigned
b. I can finish my task when it is due time
15. We had courses / practices on understanding different cultures, coping with anxiety,stress at faculty. YES NO
SITUATIONAL QUESTIONS
I. Suppose that you have just joined vessel, it is Christmas /Bayram TOMORROW and you are JUST told to work at port operation / under inspection in the last minute, say how you feel and react
a. I get frustrated
b. I feel angry
c. No matter and continue my work
d. I will go to the Master and declare it is my right not to work now.
e. I know I have to do it but unwillingly
II. Suppose you are working on an Indian dominated crewed vessel, they keep on speaking in Indian and you do not understand even a single word! How would you react?
a. Explain them your feelings let them make an empathy
b. Warn them directly
c. Go to the Chief and report this situation
d. Ignore everyone, accept the situation and live in your own World.

III. Suppose that your officer treated you unfair because of your gender/ nationality/being hardworking/ different from the dominant crew how would you express yourself?

a. Go to the c/e or the Master to make a complaint report.

b. Take a short break and calm down, try to forget everything.

c. Move from the area, calm down go back to explain what has been done which is unfair to you.

d. Report to the Company

DEVELOPMENT AND ASSESSMENT OF THE SOFT SKILLS IN MARITIME EDUCATION AND TRAINING

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Abstract: Soft skills are crucial for personal and professional success and play an important role in different processes of life. These skills, also known as people or interpersonal skills, complement technical or hard skills. Soft skills mean to have the ability to communicate, work in a team, use numerical skills in an eventful manner, and have research skills. These skills, which increase people's cooperation and effective communication competencies, contribute especially to multidisciplinary studies. Today, businesses and industries need manpower donated with not only hard skills for the execution of the profession but also manpower with soft skills that will provide added value to them. Maritime Education and Training (MET) is a system consisting of science, law, economy, management, and maritime vocational courses, which are delivered through different methods. It is important to ensure the development and assessment of soft skills within the MET system to prepare students who will command complex systems in the future. This research aims to investigate the possible applications for developing and assessing the soft skills of cadets at maritime schools to prepare them to operate and command complex systems onboard. Inclusion of development and assessment of soft skills should be added in the Maritime Education and Training to assist students in meeting the new existing and future requirements of business and industry.

Keywords: Maritime Education and Training (MET); Development of Soft Skills: Assessment of Soft Skill; Common Skills,

1. Introduction

Nowadays two types of skills are expected from all professionals. These are Professional Skills that are necessary for the achievement of the vocational responsibilities and tasks related to the profession, and the Soft (Common) Skills that enable the person to use his/her capacity more effectively. Today, Soft Skills are as important as professional skills in being recruited and promoted, and the importance of those skills is increasing gradually The College of Central London [1] defines soft skills as advised by BTEC (Business and Technician Education Council) [2] standards, as follows:

- Managing and developing self
- Working with and relating to others
- Communicating
- Managing tasks and solving problems
- Applying numeracy (Using math abilities)
- Applying technology (Using technological devices and systems)
- Applying creativity and design

Soft skills are crucial for personal and professional success, playing a significant role in various aspects of life. These skills, also known as interpersonal or people skills, complement technical or hard skills and contribute to effective communication, collaboration, and overall success. Employers are not looking only for vocational skills but also soft (common) skills when they select, retain, and promotion of their employees. Soft skills are highly important for management-level employees for better management and business development of the organization in a challenging environment.

Vocational and academic education and training in schools may be sufficient for the start of a profession. However, to develop both in the profession in the later years of the profession, people need to have skills beyond this. These skills are defined as soft or common skills today. These skills are essential, especially for those who will work at the management levels of the profession. These soft skills cover the main features of management, such as organizing tasks, communicating, working as a team, using numeric skills, personal development, and creativity.

As far as the Seafaring officer profession, the professional skills and competencies are clearly defined in the STCW (Standards for Training, Certification, and Watchkeeping) Code of IMO (International Maritime Organization) [3] and deeply described in the various IMO Model Courses 7.01, 7.02, 7.03, and 7.04 [4] [5] [6] [7] which define fundamental requirements of seafarer's education standards.

As a result of some investigation and lessons learned at the practices, it has been evaluated that a certain part of the pieces of training conducted in line with STCW can be used for the development of soft skills as well as professional skills. Especially the simulator pieces of training in the form of teamwork constitute the best example of that. Many MET institutes also use these pieces of training to develop and evaluate students' soft skills.

The expected purpose of this training is to increase the task efficiency of the seafaring officers working on the bridge and in machine control as a team. Qualified maritime companies send the officers working on the bridge and machinery control to the training institutions to ensure that they improve their professional as well as soft skills. They also request MET institutions to send an objective evaluation. In this type of training, soft skills are expected to be evaluated besides professional skills.

2. Research Method

2.1. Aim of the Research

This research aims to investigate the possible applications for developing and assessing the soft skills of cadets at maritime schools to prepare them to operate and command complex systems onboard.

2.2. Objectives

The objectives of this study are:

- To evaluate the suitability of soft skills development considering aim, objective content delivery methods, and assessment methods

- To make an overall assessment of the suitability, applicability, and acceptability of the courses for the development and evaluation of soft skills

- Make some proposals on including soft skills development and assessment in the programs.

2.3. Steps of Study

The study starts with a literature review of previous studies on the design consideration and characteristics of MET (Maritime Education and Training) programs and requirements for the development and assessment of soft skills. It continues with an expert group study to evaluate the suitability of soft skills development considering aim, objective content delivery methods, and assessment methods. Then AHP method will be applied to evaluate the suitability, applicability, and acceptability of the courses considering development and assessment for soft skills. At the end of the research, the findings will be evaluated and as a result of the study, suggestions will be presented for the planning and execution staff in the MET institutions. of the simulator training at the schools.

3. Research

3.1. Definition of Soft Skills and their Outcomes

Soft skills are incredibly valuable in all industries, workplaces and roles. These skills and qualities enable you to be a productive and communicative team member, which is why employers often seek these skills just as often as hard or technical skills. Understanding what soft skills can help you identify and improve upon your own, helping you become a more well-rounded candidate and employee. In this article, we explore 10 important soft skills you can include in a CV and ways to showcase them in the recruiting process [8].

Development and assessment of soft skills are important for all levels of education in particular for tertiary education. Cashian [9] examined the BTEC (Business and Technician Education Council) skills and core themes approach to common skills in the context of higher education. He concluded that the assessment of such skills could take various Doctorate in Education forms and identifies two particular methods that may be deemed suitable. He states: “The assessment could be merely formative, the Performance Criteria used as a guide to the student as to the behavioural characteristics that are desirable, and for feedback on performance, but with no formal grading of skills as a separate entity from the subject content.”

The BTEC [2] definition of soft skills and their outcomes are introduced in Figure 1.

Common Skills	Outcome
Managing and Developing Self	1. manage own roles and responsibilities
	2. manage own time in achieving objectives
	3. undertake personal and career development
	4. transfer skills gained to new and changing situations and contexts
Working with and Relating to others	5. treat other's values, beliefs and opinions with respect
	6. relate to and interact effectively with individuals and groups
	7. work effectively as a team member
Communicating	8. receive and respond to a variety of İnformation
	9. present information in a variety of visiual forms
	10. communicate in writing
	11. participate in oral and non – verbal communication
Managing Tasks and Solving Problems	12. use information sources
	13. deal with a combination of routine and non – routine problems
routine	14. identify and solve routine and non- Problems
Applying Numeracy techniques	15. apply numerical and skillsand
Applying Technology	16. use a range of technological equipment and systems
Applying Design and Creativity	17. apply range of skills and tecniques to develop a variety of ideas in the creation

Figure 1. The soft skills and their outcomes [2]

3.2. The importance of Soft Skills for Operational and Management Seafaring Officers

The expert group consists of maritime lecturers holding ship master or chief engineer certificates and experienced in MET issues and mostly holding Ph.D. degrees has discussed the importance of soft skills for the operational and management level of seafaring officers. The group reached a decision on the importance of soft skills for the operational level (Officer of the Watch) and Managerial level (1st Officer and Master) are discussed by the expert group and their considerations are introduced in Table 1.

Table 1. The importance of Soft Skills for Operational and Management Seafaring Officers

Soft Skill	Operational Level	Managerial Level
Managing and developing self	Required	Important
Working with and relating to others	Required	Important
Communicating	Required	Important
Applying numeracy (Using math abilities)	Required	Required
Managing tasks and solving problems	Required	Important
Applying creativity and design	Required	Required
Applying technology (Using technological devices and systems)	Required	Required

As it is shown in Table 1, all soft skills are required for operational-level officers who will be team leaders or a part of a team. The management level requires more skills and qualifications to assume management functions and roles. Managing and developing self, Working with and relating to others, Communicating and Managing tasks, and solving problems are highly important to achieve managerial tasks.

3.3. Higher Level Skills and Abilities

Sanghvi [10] use the terms 'high level skill' and 'low level skill' in this article to differentiate between two classes of skills:

Low level skills are abilities which pertain to a specific task or a process and are rarely transferable between industries. A common example would be a programming language, knowledge of a specific manufacturing process or a specific lab test and so on.

High level skills are abilities which pertain to broad ideas and are often transferable between industries. Common examples would be a spoken language used in the geography you want to work in, soft skills like leadership, adaptability, resilience, the ability to negotiate and a basic knowledge of finance and a cursory understanding of supply chains (the ones that concern your industry). Learners will be expected to develop the following skills during the programme of study:

- analyse, synthesise and summarise information critically
- read and use appropriate literature with a full and critical understanding
- think independently, solve problems and devise innovative solutions
- take responsibility for their own learning and recognise their own learning style
- apply subject knowledge and understanding to address familiar and unfamiliar problems
- design, plan, conduct and report on investigations
- use their knowledge, understanding and skills to evaluate and formulate evidence-based arguments critically and identify solutions to clearly defined problems of a general routine nature
- communicate the results of their study and other work accurately and reliably using a range of specialist techniques
- identify and address their own major learning needs within defined contexts and to undertake guided further learning in new areas
- apply their subject-related and transferable skills in contexts where the scope of the task and the criteria for decisions are generally well defined but where some personal responsibility and initiative is required.

3.3. The importance of Soft Skills for Career Planning for Seafaring Officers

The European Union SAIL AHEAD [11] project provides an online guidance tool for a second career for seafaring officers. It covers a report with transferable skills and competencies.

The outcomes of this project are a mapping of competencies and profiles required for at least 10 alternative career paths ashore and an online tool to be used by students or captains that will help them assess the possibilities to work on shore. Proposed job profiles suitable for deck officers at the shore are as follows:

Coast Guard Officer, Chief Executive Officer (CEO), Operations Manager, Designated Person Ashore (DPA), Quality Manager, Occupational Health and Safety Manager, Maritime Lecturer, Maritime Auditor, Maritime Surveyor (Inspector – Auditor), Marine Advisor/Consultant, Port Authority officer, Pilot, Arbitrators. Stevedore Manager, Lashing Manager, Cargo Handling Manager, and Port Facility Security Officer (PFSO).

Many shipping companies also started to operate as logistics companies and/or have a logistics component. So, logistics jobs became a significant occupation for seafaring officers [12].

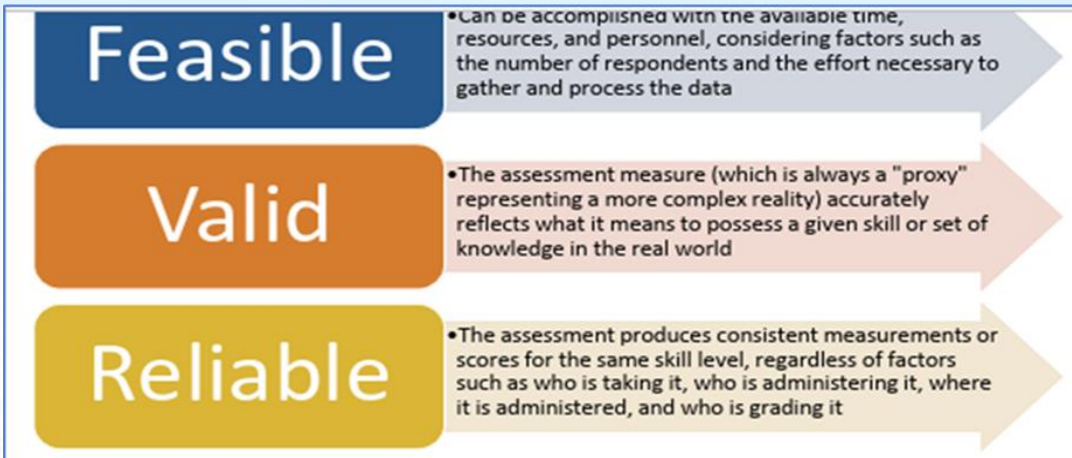
The above-mentioned posts are managerial positions that require advanced level soft skills to communicate with diverse groups with a high-level rhetoric capability and work as a leader or a part of a team to demonstrate creative capability using numerical skills for sounding solutions. It is clear that shore-based duties require having advanced levels of soft skills.

The importance of low level skills is very high when you are applying to and starting your first job. The low level skills are highly important to adapt someone learning of business ethic and operations methods as well as prepares the worker to high level skills. The high level skills are important for promoting upper positions and transferring a new profession. The content of the high level skills is in line with the aim of the graduate studies.

4.3. Assessment of Soft Skills

4.3.1. Assessment Guidance

Assessment should be Feasible Valid and Reliable. The figure below explains these principals and methods of assessments [13].



Different assessment methods present different strengths and weaknesses along these three factors.

Method	Feasibility	Validity	Reliability
Observation: Assess how people behave in everyday situations, or in response to a particular task.	↓ Feasible only for smaller numbers of respondents, since observation requires more time and direct attention from the assessor.	↑↑ With a well-designed rubric defining the behaviors to be observed and their scoring, observation comes closest to measuring the skill itself in practice.	→ Achieving reliability requires a well-designed rubric and significant training of assessors to ensure that they score observed behaviors in similar ways.
Project: Measure the successful completion of a project that requires the use of certain skills.	→ Soft skills assessment can be integrated as part of the achievement of other course objectives, but completing/grading projects takes time.	→ Can be a highly authentic assessment method—but measurement may be unclear if the project requires other skills or resources that some youth do not have.	→ Achieving reliability requires a clear rubric of skills to be assessed and assessor training to ensure consistent scoring across projects reflecting similar skills levels.
Written or oral assessment: Pose questions that test for certain knowledge, attitudes, and skills.	↑ Relatively easy to accomplish with many people when closed (multiple choice) responses are used.	↓↓ Soft skills do not easily translate into words. Self-reported measures are unreliable. Literacy/language skills may also get in the way of accurate measurement.	↑ Reliability is fairly easy to test and improve through piloting.

Figure 2. Assessment principles and Methods (Source: World Learning [13])

Measuring soft skills can be challenging, especially as these skills are naturally expressed in action, in complex social environments [14]. Determining an appropriate assessment method depends on many factors, including the purpose of the assessment. In many contexts, it can be important to help participants set goals and assess themselves. Some projects also require collecting assessment data for purposes of monitoring and evaluation.

4. Discussion

4.1. Working Group Study

A working group was established to evaluate the development and assessment of soft skills in the MET. In this working group, 4 maritime lecturers holding shipmaster/chief engineering certificates, and 3 lecturers teaching foundation and science courses who are currently teaching in the MET institutions took part. 4 maritime lecturers were experts in maritime transport operations, with maritime backgrounds and 3 of them had PhD. They started the work by analysing the following issues

- The aim, content, delivery methods, and assessment procedures of courses delivered
- Suitability of each course for the development and assessment of soft skills
- Importance of soft skills for future deployments of cadets

4.1.1. The aim, content, delivery methods, and assessment procedures of courses delivered

Firstly, the group decided to classify courses into 6 groups Foundation, Engineering, Vocational, Ancillary courses, Sea Training, and Research. There are close relations between Maritime Transportation Engineering and Marine Engineering programs with some differences in vocational courses. It is decided to start the study on the Maritime Transportation Engineering program. A follow-up study may be conducted for the Marine Engineering program base on this study.

The aim, objective, content, delivery methods, and assessment procedures of courses delivered are discussed in the following matrix.

Table 3: The Results of Suitability Research

COURSES	AIM	OBJECTIVE	CONTENT	DELIVERY	ASSESSMENT	TOTAL	PRIORITY
Foundation	1	2	1	1	2	6	**6**
Engineering	1	1	2	2	2	8	**5**
Vocational	2	3	3	2	2	12	**1**
Ancillary	2	2	2	3	2	11	**2**
Sea Training	2	3	3	1	1	10	**3**
Research.	3	2	2	1	1	9	**4**

Grading: 1. Low 2. Medium 3. High

When these issues were reviewed, it was concluded that the following priorities are defined

Vocational 1

Ancillary 2

Sea Training 3

Research. 4

Engineering 5

Foundation 6

4.2. Assessment of the Working Group concerning soft skills

The group decided to evaluate courses into courses in the 6 groups (Foundation, Engineering, Vocational, Ancillary courses, Sea Training, and Research) considering soft skills. Application of soft skills for each individual courses are evaluated in the following matrix (Table 3).

Table 3: Matching Soft Skills to MET Navigation Engineering Programs

NO	GROUPS	COURSES	Managing and developing self	Working with and relating to others	Communicating	Managing tasks and solving problems	Applying numeracy	Applying technology	Applying creativity and design
1.1	Foundation Courses	Mathematics	1	1	1	1	3	1	1
1.2		Physics	1	1	1	1	3	1	1
1.3		Chemistry	1	1	1	1	2	1	1
1.4		Probability and Statistics	1	1	1	1	3	1	1
1.5		Introduction to Computers	1	1	1	1	3	3	3
2.1	Engineering Courses	Mechanics	1	1	1	1	3	1	1
2.2		Stability	2	2	1	2	3	2	2
2.3		Ship Construction	2	2	1	2	3	2	2
2.4		Marine Engineering Sys.	1	1	1	1	2	1	1
2.5		Electricity/Electronics	2	2	1	2	3	2	2
3.1	Vocational Courses	Navigation	3	2	2	3	3	2	1
3.2		Navigational Watch	3	3	3	3	3	2	1
3.3		Cargo Handling	2	2	2	2	3	2	2
3.4		Communications	3	3	3	3	2	3	1
3.5		Maritime Management	1	1	2	2	2	2	2
3.6		Ship Handling	3	3	3	3	3	2	3
3.7		Maritime Law	1	1	1	1	1	1	1
3.8		Shipmaster Business	2	2	2	2	2	2	2
4.1	Ancillary Courses	Fire Fighting	2	3	2	2	2	1	2
4.2		Medical First Aid	2	2	2	2	2	1	1
4.3		Lifesaving	2	3	2	2	2	1	1
4.4		Safety Security Awareness	1	1	1	1	1	1	1
4.5		Personal Safety & Social	1	1	1	1	1	1	1
5	Sea Training		2	3	2	2	2	2	2
6	Research		3	2	3	3	3	3	3

This table has been analysed and suitability of each group of courses for each type of soft skill has been evaluated This evaluation is introduced as follows.

Managing and developing self

Vocational Courses and Research

Working with and relating to others

Vocational, Ancillary Course, Sea Training, and Research

Communicating

Vocational, Ancillary Course, and Research

Applying numeracy (Using math abilities)

Vocational Courses and Research

Managing tasks and solving problems

Vocational and Research Courses

Applying creativity and design

Foundation (Introduction to Computers) and Vocational Courses (Communications, Research)

Applying technology (Using technological devices and systems)

Foundation (Introduction to Computers) and Research Courses

4.3. Assessment of Soft Skills

All effective education and training institutions use ongoing assessments to determine their students' ability levels in various academic areas and to guide their instruction. In the realm of special education, the assessment process is absolutely essential. Parents, teachers, specialists and counsellors depend on multiple assessments to identify a student's strengths, weaknesses and progress.

To define assessment methods a special expert group should be established based on the three principals (feasible, reliable and valid) for assessment. Internationally recognised accreditation institutions have competent on this issue. There are many certificate programmes which train international verifiers such as Oxford, Cambridge and RSA (OCR). MET institute are generally accredited by internationally recognised accreditation organizations and may request inclusion of their soft skill assessment criteria and procedures in their course syllabus.

4. 4. AHP Application

4.4.1. Starting Strategy

The evaluation was based on three main criteria (Suitability, Applicability, Acceptability). The comparison of the criteria is illustrated in Figure 3.

PRIORITIES OF CRITERIA			
	SUITIBILITY	APPLICIBILITY	ACCEPTIBILITY
SUITIBILITY	1	2	3
APPLICILABILITY	0,5	1	2
ACCEPTIBLITY	0,333	0,5	1
SUM	1,833	3,5	6

PRIORITIES OF CRITERIA					
	SUITIBILITY	APPLICIBILITY	ACCEPTIBILITY	SUM	PRIORITIES
SUITIBILITY	0,545	0,571	0,500	1,616	0,538
APPLICILABILITY	0,273	0,285	0,333	0,891	0,297
ACCEPTIBLITY	0,182	0,143	0,167	0,493	0,165
SUM	1,000	1,000	1,000	3,000	1,000

Figure 3. Comparison of three main criteria

Inconsistency rate based on comparison of the main criteria is 0.03112. this value shows that the comparison of the main three criteria has the accuracy to be used for AHP analysis.

4.4.2. Comparison of Alternatives concerning 3 criteria.

Alternative have been introduced in 6 groups courses:

ALT-1: Foundation

ALT-2: Engineering

ALT-3: Vocational

ALT-4: Ancillary

ALT-5: Sea Training

ALT-6: Research

Priority Matrix of Alternatives and Priorities of Criteria are shown in the Figure 4

PRIORITY MATRIX OF ALTERNATIVES			A
ACCEPTIBILTY	SUITIBILITY	APPLICIBILITY	ACCEPTIBILITY
ALT 1	0,119	0,062	0,165
ALT 2	0,245	0,266	0,077
ALT 3	0,356	0,168	0,123
ALT 4	0,121	0,056	0,049
ALT 5	0,086	0,102	0,313
ALT 6	0,073	0,346	0,273
SUM	1,000	1,000	1,000

PRIORITIES OF CRETERIA B

SUITIBILITY	APPLICIBILITY	ACCEPTIBILITY
0,538	**0,297**	**0,165**

Figure 4. Priority Matrix of Alternatives and Priorities of Criteria

NORMALIZATION

SUITIBILITY	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	SUM	PRIORITY
ALT 1	0,086	0,046	0,099	0,235	0,138	0,072	0,712	**0,119**
ALT 2	0,421	0,230	0,198	0,235	0,276	0,214	1,473	**0,245**
ALT 3	0,335	0,458	0,394	0,398	0,276	0,214	2,140	**0,356**
ALT 4	0,029	0,076	0,079	0,079	0,207	0,285	0,722	**0,121**
ALT 5	0,430	0,114	0,099	0,029	0,069	0,143	0,525	**0,086**
ALT 6	0,086	0,076	0,131	0,024	0,034	0,072	0,428	**0,073**
SUM	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**6,000**	**1,000**

Figure 5. Comparison alternatives according to "**Suitability**" criteria

APPLICABILITY	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
ALT 1	1	0,25	0,333	1	0,5	0,25
ALT 2	4	1	3	4	3	0,5
ALT 3	3	0,333	1	5	2	0,333
ALT 4	1	0,25	0,2	1	4	0,5
ALT 5	2	0,333	0,5	0,25	1	0,333
ALT 6	4	2	3	4	3	1
SUM	15	4,166	8,033	15,25	13,5	2,616

NORMALIZATION

APPLICABILITY	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	SUM	PRIORITY
ALT 1	0,067	0,061	0,042	0,070	0,035	0,096	0,372	**0,062**
ALT 2	0,267	0,242	0,373	0,260	0,224	0,191	1,595	**0,266**
ALT 3	0,200	0,078	0,124	0,324	0,148	0,127	1,007	**0,168**
ALT 4	0,066	0,061	0,026	0,070	0,297	0,077	0,334	**0,056**
ALT 5	0,133	0,078	0,062	0,016	0,072	0,127	0,611	**0,102**
ALT 6	0,267	0,480	0,373	0,260	0,224	0,382	2,080	**0,346**
SUM	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**6,000**	**1,000**

Figure 6. Comparison alternatives according to "**Applicability**" criteria

ACCEPTIBILITY	ALT 1	ALT 2	ALT 3	ALT 6	SUM	PRIORITY
ALT 1	0,123	0,222	0,226	0,098	0,987	0,165
ALT 2	0,042	0,074	0,057	0,098	0,457	0,077
ALT 3	0,062	0,148	0,114	0,146	0,735	0,123
ALT 4	0,031	0,038	0,038	0,074	0,299	0,049
ALT 5	0,371	0,296	0,339	0,292	1,88	0,313
ALT 6	0,371	0,222	0,226	0,292	1,642	0,273
SUM	1,000	1,000	1,000	1,000	6,000	1,000

NORMALIZATION

ACCEPTIBILITY	ALT 1	ALT 2	ALT 3	ALT4	ALT 5	ALT 6	SUM	PRIORITY
ALT 1	0,123	0,222	0,226	0,250	0,098	0,098	0,987	0,165
ALT 2	0,042	0,074	0,057	0,125	0,074	0,098	0,457	0,077
ALT 3	0,062	0,148	0,114	0,187	0,098	0,146	0,735	0,123
ALT 4	0,031	0,038	0,038	0,063	0,146	0,074	0,299	0,049
ALT 5	0,371	0,296	0,339	0,125	0,292	0,292	1,880	0,313
ALT 6	0,371	0,222	0,226	0,250	0,292	0,292	1,642	0,273
SUM	1,000	1,000	1,000	1,000	1,000	1,000	6,000	1,000

Figure 7. Comparison alternatives according to "**Acceptability**" criteria

Matrix Multiplication of Matrix **A** (Priority of alternatives) and Matrix **B** (Priority of Criteria) **A x B (see Figure 4)** is in the Figure 8.

ACCEPTIBILITY	SUITIBILITY	APPLICIBILITY	ACCEPTIBILITY	PRIORITIES	ORDER	ALTERNATIVES
ALT 1	0,064	0,018	0,027	0,109	5	*FOUNDATION*
ALT 2	0,132	0,079	0,012	0,222	2	*ENGINEERING*
ALT 3	0,191	0,049	0,020	0,260	1	*VOCATIONAL*
ALT 4	0,065	0,019	0,009	0,089	6	*ANCILLARY*
ALT 5	0,045	0,032	0,051	0,127	4	*SEA TRAINING*
ALT 6	0,039	0,103	0,045	0,186	3	*RESEARCH*
SUM				1,000		

Figure 8. Matrix Multiplication of Matrix A (Priority of Alternatives)/& Matrix B (Priority of Criteria) AxB

Based on AHP results 1st priority is the Vocational, the 2nd is Engineering, and 3rd is the Research, 4th is Sea Training, 5th is Foundation and 6th is Ancillary courses are assessed for soft skills development and assessment.

5. Conclusion

Soft skills are crucial for personal and professional success and play an important role in different processes of life. These skills, also known as people or interpersonal skills, complement technical or hard skills. Soft skills mean to have the ability to communicate, work in a team, use numerical skills in an eventful manner, and have research skills.

These skills, which increase people's cooperation and effective communication competencies, contribute especially to multidisciplinary studies. Today, businesses and industries need manpower donated with not only hard skills for the execution of the profession but also manpower with soft skills that will provide added value to them.

As a result of a group study and AHP application, the following course groups are proposed for soft skill development and assessment in priority order: Vocational, Engineering, Research, Sea Training, Foundation and Ancillary courses considering soft skills development.

MET institute will decide which group of courses would be suitable for soft skill development and assessment considering the above-mentioned criteria. In this respect each institute should rearrange their courses syllabuses to cover assessment criteria for soft skills.

Inclusion of soft skills with assessment criteria should be discussed in the future revision of the STCW and IMO Model Courses 7.01, 7.02, 7.03 and 7.04. Table 3 (Matching Soft Skills to MET Navigation Engineering Program) may assist the MET planners to consider each group of courses selecting for soft skill development and assessment [14]. It is also required to include soft skills in ISF On Board Training Record Book for Deck Cadets [15] and. On Board Training Record Book for Engineering Cadets [16].

MET institutes may request assistance from internationally recognized accreditation institutions which have many experts on assessment procedures.

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SHIP COMMUNICATION WITH BRIDGE SIMULATOR: A MARITIME ENGLISH INTEGRATED SKILLS APPROACH

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Abstract: Ship communication is a crucial foundation for effective maritime safety. Timely and clear information enables the officer in charge to make decisions and quickly responses to the navigational challenges encountered. Real-life situations encountered at sea can be simulated simultaneously using a bridge simulator. Ship simulators offer an immersive and interactive environment that can enhance the learning of ship communication by providing learners with realistic scenarios and authentic language use opportunities. Bridge simulators offer opportunities to practice using language authentically and responding to similar situations experienced during voyages. This research combines three main components: Maritime English-ship communication, bridge simulators, and integrated skills approach. This approach combines four language skills simultaneously: listening, speaking, reading, and writing in one lesson activity. This approach is an interesting and revolutionary phenomenon in learning Maritime English because it uses a method that combines the above three components. This approach has been known for a long time but combining the approach, Maritime English-Ship Communication and bridge simulator has not been widely implemented at Maritime Polytechnic. This research analyses how to combine ship communication, bridge simulator, and integrated skills approach through sailing scenarios and determines the significant impact of using this method in maritime education and training. The research develops a framework so that teaching guidelines are prepared for teachers to apply the integrated skills in teaching Maritime English-Ship Communication. The guidelines contain sailing scenarios based on Collision Regulations 1972, ship communication, and forms for recording ship movement information or navigation details. Using a qualitative descriptive approach, it is known that this approach provides an in-depth learning experience for learners. In addition to improving ship communication skills, learners also gain a better understanding of instructions, procedures, and overall shipping situations. Integrating ship communication skills with ship navigation simulation experiences can train learners' abilities in a context similar to the real work environment. This approach also allows learners to see the interrelationships between various aspects of Maritime English-Ship Communication and apply them directly in relevant contexts.
The research concludes that the application of an integrated skills approach in learning Maritime English-Ship Communication through a bridge simulator proves significant benefits and great potential in improving learners' ship communication competence. Combining aspects of listening, speaking, reading, and writing, provides a comprehensive and relevant learning experience for learners. Through bridge simulation, learners not only deepen their understanding of Maritime English-Ship Communication but also improve their communication and adjustment skills in real situations at sea. An integrated skills approach in learning Maritime English using a bridge simulator is an effective and efficient step in preparing learners to face challenges in the diverse and dynamic maritime world. This approach provides a strong foundation for strengthening learners' language competencies and practical skills, thereby strengthening learners' position in the global maritime industry. This research provides crucial recommendations for implementing the Maritime English-Ship Communication integrated skills approach with a bridge simulator at Maritime Polytechnic.

Keywords: Ship communication, integrated skills, ship simulator.

1. Introduction

Learning in maritime education is not merely an activity to understand a specific concept but rather about how to interpret and apply that concept to competencies that can be used in real life, specifically in commercial ship navigation. A good, creative, and dynamic teaching method significantly influences the achievement of learning objectives. An appropriate method can facilitate the attainment of educational goals. Teaching methods involve a series of activities that can serve as a guide to ensure that the competencies targeted in the learning process are achieved optimally. A good teaching method clearly states the tasks and functions, how to implement them, and where the learning activities will take place. This includes Maritime English learning with a bridge simulator.

Joyce et al. (2014) described that by specifying tasks and functions clearly, educators can enhance instructional coherence and ensure that learning activities are purposeful and aligned with educational objectives. Specifying tasks and functions clearly in learning can be done using a bridge simulator. This learning tool allows students to practice in a safe and controlled environment, replicating real conditions that may be encountered in navigation. Simulations on the simulator can sharpen navigation skills, ship maneuvering, and responses to emergencies without risk. Additionally, the bridge simulator enables instructors to provide evaluations and feedback, helping students understand their mistakes and correct them effectively in subsequent simulations. Thus, using a bridge simulator not only enhances technical skills but also builds students' confidence and mental readiness to face maritime challenges.

Moreover, navigation with the bridge simulator can simultaneously be used for teaching Maritime English in the form of ship communication. Ship simulators offer an immersive and interactive environment that can enhance the learning of ship communication by providing learners with realistic scenarios and authentic language use opportunities. Bridge simulators offer opportunities to practice using language authentically and responding to similar situations experienced during the voyage. The International Maritime Organization's model course on Maritime English includes using simulators as a key component of training, recognizing their value in providing realistic practice environments and improving communication skills. IMO Model Course 3.17 (2015).

Realistic scenarios and authentic language use at the bridge simulator can be effectively utilized for teaching Maritime English through the Integrated Skills Approach (ISA), which combines speaking, listening, reading, and writing skills in realistic and practical contexts. In simulations, students can practice authentic maritime communication, such as giving navigation commands, interacting with shore stations, and responding to emergencies. Through these scenarios, they will become familiar with maritime terminology and standard phrases used in maritime communication. Additionally, participants can listen to conversations and instructions given by the instructor, and then respond either verbally or in writing, which hones their listening and speaking abilities. Integrating activities like reading operational manuals and writing reports or logbooks within the simulation also helps enhance maritime literacy skills.

Although the standards for Maritime Education and Training (MET), including assessments, have been implemented, Maritime English learning at Maritime Polytechnics has not yet utilized bridge simulators. The learning is typically conducted in classrooms and language laboratories. This situation clearly does not meet the MET standards as specified in the STCW (Standards of Training, Certification, and Watchkeeping). Currently, Maritime English education is delivered through memorization and not through simulation, focusing on explaining and conveying information about concepts. This reality further leads to the consideration of the need to develop a teaching method for Maritime English with the Integrated Skills Approach using a bridge simulator.

2. Troubleshooting

Based on the background stated earlier, the troubleshooting of this research primarily focuses on the descriptive analysis of Maritime English learning with the ISA using a bridge simulator.

3. Maritime English

The primary objective of seafarer education and training is to develop seafarers who possess competencies that meet standards, thereby ensuring safety, security, a cleaner ocean, and efficient navigation. Maritime English is one of the competencies that a seafarer must possess since the IMO (International Maritime Organization) established the STCW 1978 as the standard for education, training, and certification. Maritime English encompasses all aspects of the English language utilized as a communication tool within the global maritime community, aiding in the safety of navigation and the promotion of seaborne trade.

To ensure uniformity of procedures, phrases, and terminology in communication among multicultural seafarers, the IMO established standards compiled in the SMCP (Standard Marine Communication Phrases). The SMCP is required as an anticipation of the multicultural phenomenon because, without standardized communication, misunderstandings that threaten navigation safety, loss of ships, lives, cargo, and marine pollution could occur. This is in line with the research conducted by Sarinten et al. (2020) on the "Evaluation of the Implementation of Standard Marine Communication Phrases in Ship to Shore Communication." The research found that the use of SMCP, including phrases to start and end communication, data communication, ship situations, and message markers, falls into the moderate category or does not fully follow SMCP standards. Additionally, some sentences were identified as using general English instead of SMCP-based English. Furthermore, communication was conducted with repeated sentences due to misunderstandings. This kind of communication has the potential to cause miscommunication that can threaten the safety of navigation.

The basis of the SMCP is English, which is structured simply and is a simplification of Maritime English to reduce grammatical, lexical, and idiomatic aspects. Changes in language structure in the SMCP are made solely for communication functionality. Simplifications in verbal communication, for instance, are expressed by not using articles like "the," "a," or "an," and auxiliary verbs like "is" or "are." Some principles used in the formulation of the SMCP are: do not use synonyms, do not use formal structures, use sentences that can be answered with "yes" or "no" questions, and use "one phrase for one event."

4. Bridge Simulator

Simulators have dramatically transformed the maritime education process from traditional learning to training with real-life situations. Both students and instructors benefit from the use of simulators in this process. The shipping industry, as the employer of seafarers, gains competent and responsible resources according to their level of competence. Currently, several manufacturers specialize in the research, design, and production of simulators. Each simulator has different technical specifications, but the STCW does not specify or recommend any particular type of simulator. The STCW only establishes the competency standards that participants must possess after completing education and training with a simulator. Golam and Zakirul (2021) and Hjelmervik et al. (2018) in Maghoromi, B. E. (2023) stated that emerging technologies like virtualization and simulator technologies provide convenience and flexibility, improving the ability of learners to personalize their learning schedules and behaviors to their distinct circumstances and needs. In addition, Yushan et al. (2021) found that novel simulator technologies provide trainees with essential skills for stress coping and incident management.

Although the use of simulators in maritime education has faced criticism from some quarters, particularly the perspective that simulators, at a certain level, are still considered unable to fully represent real conditions on board, the reality is that many seafarers have not had the opportunity to demonstrate their abilities in facing certain situations on board. If used effectively, simulators can easily visualize such conditions without risk. It can be assumed that the use of simulators in maritime education impacts the increasing skill levels of participants and subsequently enhances navigation safety.

Regulation I/12 of the STCW outlines how simulators should be used in the training and assessment of seafarers' competencies. The STCW 1978 amendment 2010, Annex. (2010) states: "The performance standard and other provisions outlined in section A-I/12 and such other requirements as are prescribed in part A of the STCW Code for any certificate concerned shall be complied with in respect of (1) all mandatory simulator training, (2) any assessment of competency required by part A of the STCW Code which is carried out using a simulator, and (3) any demonstration, using a simulator, of continued proficiency required by part A of the STCW Code" (STCW, 2010).

From the perspectives of MET and STCW, bridge simulators are crucial in enhancing navigation safety and security. Bridge simulators are essential tools for training and assessing seafarers' abilities as they can simulate all navigation situations. MET emphasizes the importance of effective, efficient, and realistic training, and bridge simulators provide an ideal platform to meet these training needs. Bridge simulators not only play a crucial role in the training of prospective seafarers but also in achieving the navigation safety goals globally advocated by the IMO. Several subjects in the Navigation and Marine Engineering Department at Maritime Polytechnics have already utilized simulators; thus, the teaching of Maritime English, as one of the competence subjects, should also use bridge simulators. Using bridge simulators allows the simultaneous teaching of a subject and Maritime English. This requirement is stated in the STCW 1995 amendment 2010, Table A-II/1, regarding the specification of minimum standards of competence for officers in charge of a navigational watch on ships of 500 gross tonnage or more; methods for demonstrating competence. To ensure that training using bridge simulators runs perfectly, a learning stage is prepared as a reference for instructors. An example of a learning stage for training using a bridge simulator based on the Collision Regulation 1972 (Colreg) is outlined in Table 1 below:

Table1. Learning stage with bridge simulator.

Stage	Instroctors	Students
Briefing	a. Refreshing on Colreg Regulations 13-18 and ship communication according to SMCP. b. Providing motivation and appreciation. c. Students are divided into heterogeneous groups. Each group consists of students act as master, officers on watch and helmsman. d. Communicating the indicators to be achieved and how to evaluate students' performance in navigation with the simulator.	a. Paying attention to refreshers on Colreg Regulations 13-18 and ship communication according to SMCP. b. Motivating oneself using SMCP. c. Coordinating with other members of the bridge team regarding their respective tasks. d. Understanding the success indicators of the sailing activity using bridge simulator.
Simulation	a. Guiding communication by acting as another ship. b. Assessing the performance displayed by each student.	a. Navigating during voyages according to Colreg. b. Communicating with other ships using SMCP.
Debriefing	Encouraging student officers to summarize the presented material.	Providing review and feedback on navigation using the bridge simulator.

Table 2 of the learning activities conducted by students on the bridge simulator. Ship movement simulations displayed on the simulator adhere to the following predefined scenarios:

Table 2. Navigation and communication with other Ships.

Own ship (S1)	Another ship (S2)	Bridge team activities
Sailing from A to B	a. S2 moves in a head-on position. b. S2 moves in an overtaking position. c. S2 moves in a crossing position	The bridge team communicates with S2 about: 1. Ship's heading 2. Ship's position 3. Ship's speed 4. Standard wheel orders 5. Standard engine orders The bridge team communicates with S2 about: 1. Head on situation 2. Overtaking 3. Crossing

Table 3 below is the logbook students use to record communications they hear or conduct themselves when communicating with "another ship crew" or among themselves. Only sentences and maritime terminology impacting navigation activities are recorded.

Table 3. Logbook for writing.

Sailing time (minutes)	Action taken/Colreg regulation number	Phrases/Terminologies used in ship communication
Minute ± 0 – 10		
Minute ± 11 – 20		
Minute ± 21 – 30		
and so on		

5. Sailing Scenario

The bridge simulator and navigation scenarios are used to ensure the creation of real-life situations and conditions in ship operation and maneuvers within port areas and at sea. Through scenarios applied in the bridge simulator, navigation situations and conditions can be easily and repeatedly presented to students. These scenarios train students while providing feedback to instructors on the knowledge and skills acquired and areas that still need

training. Utilizing scenarios presented in simulators enables the integration of various skills, allowing learners to simultaneously practice multiple skills.
Simulators enable students to practice multiple skills simultaneously, allowing for repetition and the opportunity to correct actions deemed inadequate until learning objectives are fully achieved. Scenarios can simulate navigation in narrow waters with complex navigation and strong currents, requiring careful decision-making in ship maneuvers. Simultaneously, scenarios can simulate adverse weather conditions, communication disruptions, or heavy ship traffic. Moreover, emergencies such as fires or near misses can also be included to prepare students to respond quickly and effectively to critical situations. One scenario that can be used to assess competence in ship communication using Maritime English in SMCP format is a navigation situation based on Collision Regulation 1972.

Concerning onboard and ship-to-ship communication, navigation simulations are structured in scenarios displayed on the bridge simulator using Collision Regulation 1972 Part B, Regulations 13 to 18. These rules are chosen because the conditions stipulated in these articles require a student to have competence in communicating using SMCP based on Maritime English. These situations under Regulations 13 to 18 are illustrated in Figure 1 as follows:

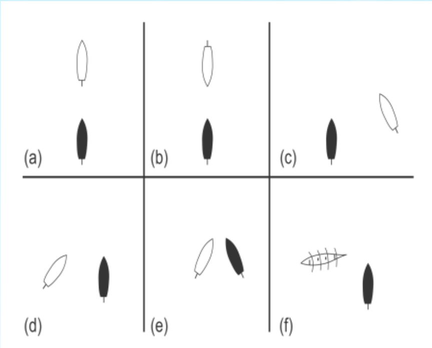

Figure 1. Own Ship position and other ship.

Collision Regulation 1972 is used as a maneuvering guide. Furthermore, SMCP is utilized as a verbal communication tool to communicate ship positions and maneuvers. Each ship will maneuver according to regulations to ensure safe positioning.

6. Variables

To ensure accurate and consistent assessment activities during testing, an assessment descriptor is formulated. According to Sugiyono (2013), an operational definition of a variable provides dimensions by which to measure that variable. The following operational definitions are outlined:

6.1. Ship and related terminology

A compilation of usage ship terminology and terminology in communication.

6.2. Ship Maneuvering and Collision Regulation (Crossing, Head-On, Overtaking)

Procedures based on Collision Regulation for maneuvering in three ship positions relative to others: Crossing, Head-On, and Overtaking.

To ensure that assessment activities in testing are accurate and consistent, descriptor assessments are developed. Through descriptor assessments, examiners can easily carry out consistent evaluations regarding students' knowledge and skills. The use of rubrics and descriptors in the educational assessment process ensures that evaluations are conducted objectively and consistently. These descriptors help examiners to have the same standards in assessing various aspects of student performance or learning outcomes, making the assessment results more accurate and reliable. Mulyasa (2014) stated that through the use of descriptor assessments, examiners can easily carry out consistent evaluations. Descriptors in the assessment rubrics provide clear and structured guidelines on the assessment criteria, thus reducing subjectivity and increasing the reliability of the assessment result.

The assessment descriptor must be effectively communicated and socialized among all assessors. This enables them to understand the expected outputs and outcomes that students should achieve. The descriptor should be easily modifiable based on the type of assessment or the desired level of student competence. Three considerations in developing assessment descriptors: First: Range statement: Specifies the context, activities, processes, and equipment to which the descriptor applies and in which competence is to be developed. Second: Actual competence: Describes the learning outcomes. Third: Performance criteria: Statements specifying how evidence should be gathered to demonstrate that competence has been acquired.

Furthermore, the assessment system must be carefully considered as it determines whether a student possesses the required competence. In assessing students' proficiency in using SMCP with Maritime English based on given situations and assignments, the assessment descriptor is structured as follows:

Table 4 Assessment descriptor

Criteria	Incompetent	Less competent	Competent	Expert
Procedure	The procedure is inappropriate and threatens safety	The procedure does not match the situation at hand.	Procedure according to the situation at hand.	Procedure according to the situation at hand.
Action	Taking action outside the procedure and threatening safety.	Take no action. Performance is less convincing and less meaningful.	There is an error in the sequence of procedures.	Action in the order of the procedure.
Communication	Inconclusive and meaningless performance.	Not using standard.	Communication using standards.	Communication is well done.

7. Integrated Skills Approach

Maritime English learning involves enhancing four main competencies: listening, speaking, reading, and writing. This approach is based on the understanding that in real communication situations, these skills are rarely used in isolation but rather complement and strengthen each other. By integrating these skills, students can more effectively develop communicative competence holistically. This approach not only improves practical language use but also enhances student motivation and engagement as they directly see the relevance and practical application of what they learn in maritime communication contexts.

This approach mirrors the natural and comprehensive use of language in daily life, where different language skills are employed concurrently and support each other. By presenting language skills in a meaningful context, this method aids students in understanding the connections between various aspects of language and applying their knowledge in practical situations or bridge operations in this context. Besides improving learning efficiency, the ISA can also increase students' motivation and involvement, as diverse and interactive learning activities are generally more engaging. This approach also addresses skill deficiencies by reinforcing weaker skills through activities involving stronger ones. With authentic assessments that measure multiple skills at once, the ISA offers a more accurate assessment of students' overall language abilities.

Ahmadzai (2020) emphasized that the ISA combines listening, speaking, reading, and writing within a unified instructional framework. According to Ahmadzai, this approach not only enhances overall linguistic abilities but also facilitates the application of English in diverse real-life communication scenarios. Compared to teaching these skills separately, the integrated approach is considered more effective as it fosters a dynamic and contextual learning environment.

Moreover, research indicates that the ISA approach can enhance students' cognitive abilities and promote more natural and contextual language mastery. In this context, bridge simulators and maritime scenarios play a crucial role in presenting and implementing learning activities, providing constructive feedback to support comprehensive learning processes. "The integrated skills approach in language teaching allows students to develop language abilities holistically by combining listening, speaking, reading, and writing skills in a single instructional activity." (Celce-Murcia at al. 2014).

8. Study Result

The data processed in this study includes assessments of speaking, listening, and reading skills, with performance measured based on Table 1 and Table 2 above. Additionally, the writing performance data is obtained from Table 3. All these data are analyzed using qualitative descriptive statistics, and the results are presented in Table 4 below:

Table 4. Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean	
ME	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
Valid N	20	11	79	90	1664	83.20	.899
(listwise)	20						

	N	Range	Minimum	Maximum	Sum	Mean	
ME	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
Valid N	20	4.021	16.168	.555	.512	-1.492	. 992
(listwise)	20						

Based on the data provided, there were 20 students, with the smallest student score (Minimum) being 79 and the highest score (Maximum) being 90. The average score among the 20 respondents was 83.20, with a standard deviation of 4.021.

The average score among the 20 students was 83.20, with a standard deviation of 4.021. This indicates that while the typical score centered around 83.20, individual scores varied by about 4.021 points from this mean value. The relatively small standard deviation suggests that most respondents' scores were fairly close to the average, falling within a range that is approximately 4.021 points above or below 83.20. Specifically, this means the majority of scores were likely between 79.179 and 87.221, reflecting a moderate level of consistency in the performance of the respondents. The data thus provides a clear picture of the central tendency and the spread of the scores, illustrating both the typical performance and the degree of variation among the students.

To determine whether the student learning outcomes using the Bridge Simulator are normally distributed or not, we can examine the Kurtosis and Skewness values. From the given data, the Skewness value is 0.555, and the Kurtosis value is -1.492. Therefore, it can be concluded that the student learning outcomes using the Bridge Simulator are normally distributed. Based on this data, it can be inferred that the use of the Bridge Simulator in Maritime English learning processes has a significant impact on student competencies.

9. Conclusion

The bridge simulator provides direct experience in operating ships, handling emergencies, and communicating in dynamic maritime environments. Training using a bridge simulator also covers non-technical aspects such as time management, leadership, and interpersonal skills, all of which are crucial for maintaining effective performance in maritime operations. Maritime Education and Training (MET) not only imparts technical sailing skills but also instills discipline, responsibility, and teamwork essential for crew safety and the maritime environment as a whole.

To meet the education and training standards set by the STCW amendment 2010, particularly concerning Maritime English, there is a need for the development of new teaching methods. This development involves enhancing Maritime English learning methods using a bridge simulator. The bridge simulator, as a learning and testing tool, is one of the solutions aimed at meeting the established education standards. Maritime English education should focus on enhancing three main competencies: listening, speaking, and writing. Current Maritime English learning should provide ample opportunities for students to develop these abilities to their fullest potential.

Based on the research, it is evident that there is an urgent need to develop educational and training facilities. The findings indicate that although the use of bridge simulators in teaching Maritime English can enhance students' communication skills, there is still room for improvement through teaching methods. The development of more advanced educational facilities and more effective training methods is crucial to ensure that each student can optimally master maritime communication skills. The use of bridge simulators and innovative pedagogical approaches will help students face real-life communication situations on board.

The research proves that the use of bridge simulators and the application of ISA in teaching Maritime English significantly improve students' speaking, listening, reading, and writing abilities. Data processed through qualitative descriptive statistics show that this method is effective in enhancing the communication competencies required in the maritime environment.

Acknowledgments

This research was funded by Politeknik Pelayaran Barombong (Barombong Maritime Polytechnic) supporting the investigation into Ship Communication With Bridge Simulator: A Maritime English Integrated Skills Approach. Their financial support has been instrumental in advancing the understanding of Maritime English learning with the Integrated Skills Approach using a bridge simulator. We acknowledge their contribution in facilitating this study and the dissemination of its findings.

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HOT TOPICS AND FACETS OF GREEN SHIPPING RESEARCH BASED ON THE LDA TOPIC MODEL

Xian Wang, Wenxiang Si, Fang Liu, Chunchang Zhang, Penghao Su, Xiangming Zeng, Shuye Xue, Zhihuan Wang, Qiuhang Wang

Abstract: Responding to climate change has become an impelling issue for the maritime industry prior to 2050, which contributes its share by adaption to green shipping (GS). GS is challenging as it has gone through many upgrades and upticks, but its orientation that forecasts the developmental trend in the academic community has not been researched. This paper examines the abstracts and keywords of 1563 articles extracted from the Web of Science Core Collection under the GS theme, covering a period from 2005 to 2022. We use an improved method and segment the period into three stages, and then analyze the number of topics and their topic words in each stage using the Latent Dirichlet Allocation (LDA) topic model. The results show that 4, 5, and 6 topics can be defined in three stages respectively; GS has incorporated GS-related technologies more than ever in the past six years, which emphasizes the transition from the GHG emission model to ship operation and green fuel. These findings can help the shipping industry and regulatory organizations to keep up with the development trend and make strategic planning in advance, in the hope of meeting the revised IMO GHG Reduction Strategy.

Keywords: green shipping; LDA topic modeling; life cycle hypothesis

1.Introduction

In 2023, IMO revised its GHG emission strategy, which claims to reach net-zero GHG emissions from international shipping near 2050 (UN NEWS, 2023). The shipping industry contributes its share to climate change, though it is the least area that emits GHG into the air (UNCTAD, 2023). The EU includes the shipping industry in the European Emissions Trading System (ETS), a kind of market mechanism under the European Green Agreement (EU, 2023; Huang et al., 2023). Major countries, such as China, Denmark, and USA, etc., have adopted national strategies to cut emission from ships (COP 27, 2022; COP 28, 2023; Freda & Barbara, 2020). These actions underscore the common goal of achieving green shipping (GS). GS, a concept developed based on sustainable shipping, is referred to as using the least energy (Tadros, et al, 2023) to move goods by ships. GS has become an effective tool and momentum for emission control.

To date, GS has been researched as a shadowed part of a bigger theme under shipping. For example, Liquefied natural gas (LNG), biofuels, ammonia, and hydrogen are regarded as potential low-carbon and even zero-carbon ship fuels (Mallouppas & Yfantis, 2021; Huang et al., 2023). Wang (2019) argued that electric ships powered by batteries or supercapacitors are the main short-distance shipping transportation, featured by green and intelligent technology and clean fuels. GS is researched in the context of port and terminal carbon emission reduction. Wang et al.(2019) focused on the optimization of port operations like berth allocation and quay crane-yard truck assignment to reduce carbon emissions. In addition, regulations or policies began to monitor and supervise the impact of GS. Jiang (2022) analyzed the development process of China's green shipping laws and policies, and proposed ways to promote the decarbonization of the shipping industry and green shipping governance. GS policies in the European Union put forward new requirements for China to participate in the formulation of international shipping emission reduction rules (Chen & Zhao, 2022). In summary, from the perspective of maritime transportation, GS is dwarfed by other shipping issues, such as policy, port, and other ships. Our findings underscore a correlation between GS and technological advancements, highlighting the field's progressive intertwining with technology and GS.

Among the research of GS, the orientation of GS (OGS) has been on the rise for recent years. Romano and Yang (2021) study 294 papers covering from 2000 to 2020 under ship decarbonization with the method of bibliometric analysis. Tadros, M., et al, (2023) visualize the technologies of GS by the co-citation of the full paper based on VOSviewer (3.0) and provide a relative discussion of main topics by the issues under the IMO MEPC

(Marine Environment Protection Committee). Shi et al. (2020) comprehensively analyzed 213 papers published in the SSCI database from 1988 to 2017 and found, in terms of publication numbers, GS-related studies increased significantly since 2012 and peaked at 77.5% during 2012-2017. Lan & Li (2022) rely on Citespace to analyze the literature data on WOS and CNKI between 2001 and 2021. In sum, the OGS can not be made without the use of the text mining tool called Citespace or VOSviewer, which mainly deals with such citation-marked data of keywords and title words only. Though fairly effective, citespace or VOSviewer may not point out the quantity of emerging hot topics from the article text for understanding the thematic landscape.

To make up the gap, the Latent Dirichlet Allocation (LDA) topic model, a mining tool in Natural Language Processing, has been widely utilized in scientific literature (e.g., papers, patents) to seek the hot topics under a theme and further the development trend (Wang et al., 2015; Guan & Wang, 2015; Liao et al., 2017;). In technology evaluation and blockchain, it is used to identify the main technologies and future trends (Zhang et al., 2021; Sharma et al, 2022). In social networks and logistics, scholars use this method to mine text to figure out the research frontier (Wei & Le, 2023; Zhou & Huang, 2024). Social media platforms such as Weibo, Twitter, etc introduced the LDA topic model to monitor hot topics in user-generated content in real time (Du et al., 2023; Yang et al, 2024). The LDA topic model is used to track hot issues in policy documents and news reports, and provide timely public opinion insight and decision support for policymakers and media analysts (Hali & Hector, 2021; Pamula et al., 2023; Qin, 2023;). In line with the research mentality, this study is based on the life cycle hypothesis and analyzes research literature data about green shipping published in the Web of Science Core Collection Database from 2005-2022. Using the LDA topic model, we offer a novel understanding of the shifting focus within GS, backed by LDAvisualization, which enables us to identify the optimal number of emerging hot topics in OGS as 4, 5, and 6. Also, to enhance comprehension and facilitate interpretation, we employ visualization tools such as LDAvis, enabling dynamic representations of theme interconnections and their temporal evolution. This visual narrative empowers us to intuitively grasp the dynamics and trends within the OGS domain.

The sections of the paper are organized as follows. The second section is dedicated to a literature review, focusing on the LDA topic model and its applications produced by some scholars. The third section details the methodology and database utilized in this study. The results are presented in the fourth section, including the identified hot topic words related to GS, as well as the correlations between these topics. The fifth section delves into discussions regarding the contents of green shipping and provides insights into the future direction of the field. Finally, the last section offers a comprehensive conclusion.

2. Literature Review

2.1 Topic Model using LDA

Latent Dirichlet Allocation (LDA) is a generative probabilistic model that forms the backbone of topic modeling, a technique in natural language processing and text analysis aimed at discovering hidden thematic structures within large collections of text documents (Yao, et al., 2011). Developed by David Blei (2003), Andrew Ng, and Michael Jordan in 2003, LDA has become a cornerstone method for unsupervised learning in text data, offering a principled way to extract meaningful topics from unstructured text corpora without explicit human annotations or labels (Wang, et al, 2013, Guan & Wang, 2015).

At the heart of LDA lies the notion of topics as probability distributions over words (Blei, et al., 2003). Each topic represents a cluster of semantically related words that frequently co-occur within a specific context. Conversely, each word in the vocabulary is associated with a distribution over topics, indicating its likelihood of belonging to different themes. This dual representation allows LDA to capture the polysemy of words, which can have multiple meanings depending on the context in which they appear.

Figure 1 is the topology structure of the LDA topic model. Its basic idea is to regard a document as a stochastic mixture distribution of latent topics, with each topic being a probability distribution over the words (Blei, et al, 2003). In LDA, a document is modeled as a mixture of topics, where each word in the document is generated by first sampling a topic from this mixture and then sampling a word from the chosen topic's word distribution (Blei, et al, 2003). The document-topic distribution, also known as the "theta" distribution, reflects the relative importance or prevalence of different topics within the document (Griffiths & Steyvers, 2004). This probabilistic formulation enables LDA to account for the fact that documents often discuss multiple topics simultaneously, with varying degrees of emphasis. (Sun & Chen, 2023).

The process as shown in Figure 2, shows how the model generates the probability distribution of "document-topic" and "topic-word" through unsupervised learning. The parameters α define the document collection layer of the LDA topic model. Then α generates θ which is the document layer of the LDA topic model. And β represents the probability distribution of the topic corresponding to the word. z and w are the parameters at the feature words level, where z represents the distribution of a topic, while w is the feature word vector within a document. z is generated by θ, and w is generated by z and β. While w is an observed variable, θ, z, and β are hidden variables that can be analyzed from Wang et al, (2014).

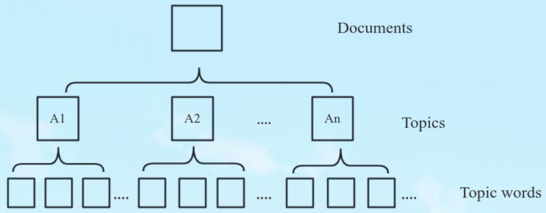


Figure 1. Topology structure of the latent topics in the LDA model

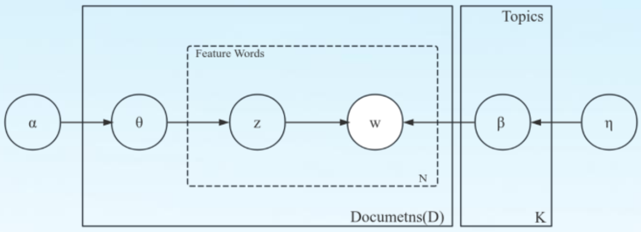


Figure 2. Structure of the LDA topic model

2.2 Applications of the LDA Topic Model

LDA has been tailored to various domains by incorporating domain knowledge, constraints, or specialized models, such as incorporated sentiment information (Sentiment LDA) (Lin & Bilmes, 2011; Hamed, et al., 2019), modeling temporal dynamics (Dynamic Topic Models) (Blei, & Lafferty, 2006), considering word dependencies (Correlated Topic Models), or integrating additional metadata such as authorship (Author-Topic Models) (Liu et al., 2018) or geographic information (GeoFolk) (Bahrehdar & Purves, 2018).

In computer science, the LDA extension models focus on algorithm improvement to ensure optimized solutions to topic problems. For example, some scholars proposed an interactive Latent Dirichlet allocation (iLDA) model to handle the problem of low-quality topics whose meanings are confused (Liu, et al, 2020; Kim, 2020). George, et al (2023) combined the LDA topic model with BERT to mine a set of meaningful topics. In addition, some highlight the performance differences among different topic modeling techniques. Egger & Yu (2022) use Instagram textual data to evaluate the effectiveness of different topic modelling algorithms. Weisser et al (2023) compare the performance of LDA, GSDMM, and GPM.

The LDA Topic model has been adopted in political science to analyze political attention, particularly in the context of government and public administration. It enables the government to identify priority areas and key issues for policymaking. Cheng, et al (2022) analyze a number of coronavirus literature to explore the research themes for giving support to the health and medical community. Pamula, et al (2023) explore the key thematic areas by mining the titles of the public procurement documents at Polish universities from 2020 to 2022 to offer insight into sustainable procurement and energy efficiency strategies. In social media, the LDA topic model is utilized to collect online reviews to enhance customer service by providing a deeper understanding of the opinions expressed by customers. Park, et al. (2021) collected a total of 4714 queries about mental disorders to help design educational programs for the community. Çallı & Çallı (2023) analyze the online consumer complaints about airline companies to improve the service process in this industry.

Bibliometrics is another newly applied domain to explore the trends and patterns prevailing in certain fields (Wang, et al, 2015). For instance, the trends in smart cities and blockchain technology (Sharma, 2022), and the developmental trend of green logistics (Ma & Kim, 2023); the hot topics and the evolution of information behavior in China (Sun & Ma, 2023). The evaluation of the effect of LDA hotspot tracking mainly includes subject quality evaluation, text similarity calculation, and hotspot life cycle model verification (Ma & Kim., 2023; Zhang, et al.,2021).

It is of special interest that some scholars use the LDA topic model for specialized domains and disciplines to figure out the number and content of hot topics. Zhang, et al (2023) analyzed the development of research between 1979 and 2019 and argued that, among the 16 research topics in China's container terminal development, there are 6 emerging topics while 3 diminishing topics. In emergency logistics, it is found that there are 3 hot topics (Zhou & Huang, 2023), while in green logistics, there are 4, 5, and 7 topics in three stages respectively. Nonetheless, the LDA topic model has not been used in the shipping industry, especially green shipping (GS).

Table 1. Application of LDA topic model

Authors	Year	Application	Dataset	Field
Liu et al	2020	interactive latent Dirichlet allocation (iLDA) model; low-quality topics whose meanings are confused	two real-world text corpora: Reuters corpus and Weibo corpus	Computer Science
Kim	2020	a user–topic model based on the latent Dirichlet allocation (LDA); topic modeling and user analysis.	collected articles with attached comments from three online communities (Reddit, Slashdot, and PGR21)	
Egger & Yu	2022	To evaluate the effectiveness of different topic modeling algorithms.	Instagram textual data.	
George et al	2023	a unified clustering-based framework using BERT and LDA; a study for mining a set of meaningful topics from the massive text corpora.	the COVID-19 Open Research Dataset	
Weisser	2023	compare the performance of LDA, GSDMM, and GPM,	Covid-19 related tweets	
Cheng et al	2022	mine the themes in information science to support the health and medical community during COVID-19.	A mass of coronavirus literature	government and public administration
Pamula et al	2023	public procurement document at Polish Universities for sustainable procurement and energy efficiency strategies.	a corpus of the titles of the public procurement documents from 2020 to 2022	
Park et al	2021	examine the contents of the queries regarding mental disorders that were posted on online inquiry platforms	A total of 4,714 relevant queries from the two major online inquiry platforms	Social media
Çallı	2023	consumer complaints with new travel regulations and a hygiene-centric lifestyle.	Consumer complaints from an airline website in Turkey.	
Sharma et al	2022	recent trends for IoT in smart cities	The corpus of 8320 articles published in Scopus from 2010 to 2022	Bibliometrics
Sharma et al	2022	current trends in Blockchain technology to help the researchers select an area to carry out future research.	The paper about blockchain technologies from IEEE, Springer, ACM, and other digital databases	

Ma & Kim	2023	green logistics development trend and doing research facing the international frontier	The papers about green logistics from Web of Science.
Sun & Ma	2023	evolution of information behavior in China and the hot topics.	The papers about information behaviour from CNKI between 2018 and 2023.
Zhang et al.	2023	development of China's container terminals research in the past 30 years	The papers about container terminal from CNKI over 30 years.
Zhou & Huang	2024	To explore the future evolution direction of research topics in the field of emergency logistics	The paper about emergency logistics from the past decade on the China National Knowledge Infrastructure (CNKI) platform was selected

Table 1 catalogs the diverse applications and advancements of LDA across various fields, demonstrating the model's versatility and adaptability to a wide range of text analysis tasks and non-textual domains. It showcases how LDA has been integrated into complex information extraction, multimedia processing, geospatial data analysis, political discourse, software engineering, audio/music analysis, healthcare research, and NLP tasks, contributing to improved understanding, decision-making, and innovation in these areas.

Methodology

To figure out the general situation of emerging topics under GS, this paper adopts the following method (Figure 1). The first step is to collect paper about GS on the World Wide Web of Science(WoS). The second step is to divide the database into three corpora based on the life cycle hypothesis and slope formula. The third step is to pre-process the three corpora through R programming. The fourth step is to build the LDA topic model so that we can get OGS of the shipping industry.

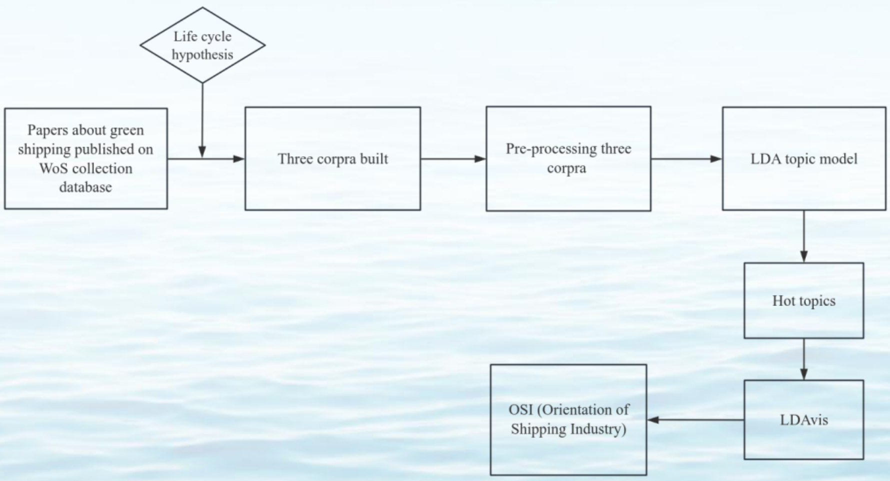
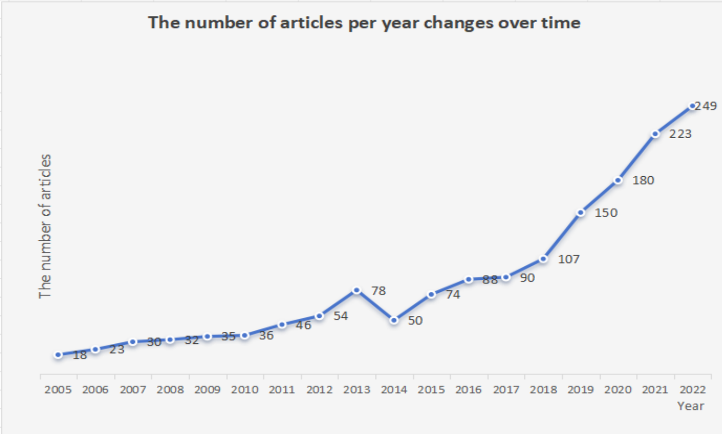


Figure 3. Method of orientation of the shipping industry

One of the difficulties for OGS is to determine the evolution period. Based on the life cycle hypothesis, we use the slope formula to determine the optimal division of GS. Life cycle hypothesis is a fundamental concept in the development of entities, illustrating the process from birth, growth, and maturity to decline (Sablik, 2016). Guan and Wang (2015) use the life cycle hypothesis and effectively reveal the journey of academic fields from the emerging stage, slow growth stage to the rapid growth stage. Rong, et al (2023) analyzes the evolution of the medical informatics discipline with the life cycle hypothesis. Applying the slope formula ($k=(y2-y1)/(x2-x1)$), we are able to separate the time window objectively. The slope ranging from 2005 to 2013 is at 7.5, 10 for a span from 2014 to 2018, and 35 for a span from 2019 to 2022. Thus, the research time window is divided into an emerging stage (2005-2013), the stable stage (2014-2018), and the rapid growth (2019-2022).

Based on the three stages, we build a data set into three corpora. We input the term "Green into the source of the World Wide Science Core Collection, then get 1563 articles in total. Next, export the titles and abstracts. These abstracts and titles are set to three corpora according to the time window. Then we preprocess the corpora, in which we remove numbers, stopwords, and stemming. Further, we apply the LDA topic model for hot topic mining and LDAvisual to visualize the evolution of green shipping by means of the SnowballC dataset in R programming. The Gibbs sampling method is utilized in the LDA topic model, which is relatively faster and more stable compared with other approaches in parameter estimation in the LDA model, like variational algorithms.



The most crucial parameter of the LDA topic model is the number of topics in each dataset. Usually, there are several methods to ascertain the number of topics. The first one is the subjective judgment (Ma & Kim, 2023), which relies on the recurrent trial of topic number based on experience and the nature of the corpora. The second one is the perplexity calculations (Wei & Le, 2023; Leng, 2024; Zhang et al, 2023), which can optimize a number of topics within varying time frames. The third one is the marginal likelihood function (Griffiths & Steyvers, 2004), which may determine the number of topics by comparing them to the previous. The fourth one is the Hierarchical Dirichlet Process (HDP) method, proposed by Teh et al,. (2005). The fifth one is the Cv coherence (Sun & Ma 2023; Zhou & Huang, 2024), which may figure out the optimal number of topics by calculating cosine similarity between topics. In this study, we use subjective judgment because the OGS is limited based on the size of our corpora. We set the topic number of each stage from 2-10, and figure out the number of topics by trial test, according to the prominence of topics. If the number of topics is few, the topics may not be enough to describe the status quo of GSs; if the number of topics is many, there may arise the complexity of topics, or may need to condense the topics for analysis and research(Sun & Ma, 2023). As a result of this method, we obtain the number of topics for three stages, which are 4 for Phase I, 5 for Phase II, and 6 for Phase III. That is, 4 topics for the emerging period, 5 topics for the slow growth period, and 6 topics for the rapid growth period.

After we acquire the words of hot topics, we use LDAvis to visualize the correlation of the words under hot topics. Because ChatGPT can generate structured reports and written texts (Lock, 2022; Wu et al., 2023), we input the words under each Phase into ChatGPT to put on the label for the topics.

Subsequent to the selection of the number of hot topics, we get the frequently used words under each hot topic. ChatGPT can generate structured reports and written texts (Lock, 2022; Wu et al., 2023), we input the frequent words under each hot topic into ChatGPT, which is able to interpret the hot topics in the form of a sentence. Finally, we use LDAvis to visualize the correlation of the words under hot topics, which tells the correlation and proximity of hot topics.

4.Results

4.1 Hot topics and words under shipping

Applying the LDA topic model, we get the top 10 frequently used words under a certain hot topic (Table 2). In Table 2, the Topic number shows the varied topic number for three periods, the Stem of Words shows the stem words most frequently used for a certain topic, and the Label of the Topics shows the descriptive statement that summarizes the hot topic with the assistance of ChatGPT.

Table 2. Hot topics and GPT interpretation

Stage	Topic number	Stem of Words	Label of the Topics by GPT	Label of GPT
Stage I	1	ship, green, water, wave, use, surfac, develop, effect, environ, model	Sustainability of Maritime Development and its Environmental Impact	developing the maritime sector while considering and minimizing its environmental effects, promoting sustainability, and utilizing technological advancements to achieve a greener future for our oceans.
	2	mean, equat, veloc, harvest, intern, need, optim, dynam,amplitud, assess	Efficiency and Analysis in Dynamic Systems	importance of quantitative analysis, process optimization, and understanding the changing states of systems to maximize efficiency and resource management in various fields, from engineering to economics
	3	fruit, phase, four, protect, featur, decrea, focus, coff, contamin, relationship	Sustainability and Quality Assurance in maritime protection	multifaceted challenges and opportunities in producing high-quality, safe, and environmentally sustainable fruit, focusing on protection, optimization, and the intricate relationships within the agricultural ecosystem.
	4	materi, dri, action, basi, although, carbon,crab, stage, toxic, remov	Environmental Impact and Remediation of Aquatic Ecosystems	the need for action, understanding the basics, and employing removal strategies to mitigate the toxic impact on both the biological life (like crabs) and the overall environment, while acknowledging the challenges and complexities involved.
Period II	1	ship, green, environ, water, model, effect, emiss, system, use, develop	Sustainable Shipping and Its Environmental Impact Mitigation	understanding and mitigating the environmental effects through innovative models, reduced emissions, and responsible use of resources, all aimed at preserving the global environment and the waters they navigate
	2	free, sen, nation, biofoul, expo, seakeep, full, affected, calssif, gap	Marine Environmental Challenges and Mitigation Strategies	marine environments face multiple challenges (e.g., biofouling, pollution), requiring sophisticated sensing technologies, comprehensive strategies involving nations, and a thorough understanding of the issues to bridge knowledge and implementation gaps
	3	ghg, charact, particip, harbor, henc, last, realiz, different, defin, drift	Assessing and Addressing GHG Emissions in Harbor Environments	the collaborative effort required to understand, quantify, and mitigate GHG emissions in harbor environments, underlining the importance of tailored strategies, stakeholder engagement, and a long-term vision for sustainable maritime activities.
	4	day, evid, ari, liquid, deep, land, behaviour, fix, geometri, institut	Investigating and Managing Earth's Resources and Processes	the multidisciplinary efforts involved in understanding and managing the earth's natural resources, from exploring the depths of the oceans to managing arid lands, studying behaviors of liquids and solids, and the this institutional frameworks that facilitate knowledge and its application.

	5	place, code, yard, cultur, slover, conver, outsid, stess, upon, atmosph	Urban Planning, Cultural Integration, and Environmental Design	designing and managing urban environments that are not only physically well-structured but also culturally sensitive, environmentally sustainable, and supportive of mental wellbeing.
Period III	1	green, ship, energi, model, system, port, emiss, environ, develop, use	Green Shipping and Sustainable Port Operations	the various aspects of transitioning the maritime industry towards sustainability, focusing on reducing emissions, adopting clean energy, optimizing systems and infrastructure, and fostering a greener environment for shipping and port operations
	2	ship, green, emiss, numer, oper, contain, simul. effici, speed, propul	Green Shipping Technologies and Efficiency Improvements	transforming the shipping industry to become more sustainable through the adoption of green technologies, operational optimizations, and advanced analytical tools, all aimed at reducing emissions, increasing energy efficiency, and maintaining or improving operational speed and flexibility.
	3	transport, speci, fish, marin, product, antifoul, logist, sufac, turtl, process	Marine Transportation and Aquatic Conservation Efforts	the intricate relationship between marine transportation, the logistics of moving aquatic products, and the conservation efforts necessary to protect marine ecosystems and species like fish and turtles from the impacts of human activities.
	4	habitat, protein, river, environ, charact, coal, landscap, ccus, pest, sediment	Ecological and Environmental Interactions in Natural and Human-Altered Landscapes	the need for sustainable practices and careful management to maintain ecosystem health, balance resource extraction with conservation, and mitigate the impacts of climate change.
	5	applic, black, caught, highqual, submerg, fumig, tsm, chainm, coastlin, stakehold	Environmental Management and Coastal Zone Activities	the interdisciplinary nature of managing coastal environments, including issues related to pollution control, water quality, fisheries management, and sustainable development practices.
	6	arriv, match, agr, incent, csfs, obvious, sampl, strict, marina, attain	Marine Conservation and Sustainable Fisheries Management	managing marine resources, emphasizing the importance of cooperation, regulation, and innovation in achieving sustainability in fisheries and marine conservation

From Table 2, we can see that in Stage I, there are four topics, which emphasize the sustainability of the shipping industry by means of harmony with the environment, where GS is described as an expectation (a greener future) and much related to the aquatic creatures. In Stage II, the five topics continue to be the sustainability of the shipping industry while delving into GHG emission and mitigation. In Stage III, six topics focus on GS and GS technologies while giving consideration to resource management. Strikingly, GS does not appear as an independent concept until Stage II, which records the emergence of a new conception and its significance.

4.2 The correlation and proximity of hot topics under shipping

With the related stemming words of each topic, we use the LDAvis package in R programming to visualize the LDA topic model in each period. According to LDAvis, the topic of each hot topic can be presented and numbered in circles. The salience of a topic is shown in size by the diversity and extensiveness of words contained in that topic. And the difference of topics is distinguished by the distance between topics. If the topics are remarkably different, they usually stay far away from each other; if the topics are related to some degree, they may be close or proximate to each other in distance.

Figure 4 shows the correlation and proximity of all hot topics in stageI. Topic 1 (Sustainability Maritime Development and its Environmental Impact) covers a larger area than other topics, namely, topic 2 (Efficiency and Analysis in Dynamic Systems), 3 (Sustainability and Quality Assurance in maritime protection) and 4 (Environmental Impact and Remediation of Aquatic Ecosystems). Topic 2 and 3 are somewhat overlapped in content.

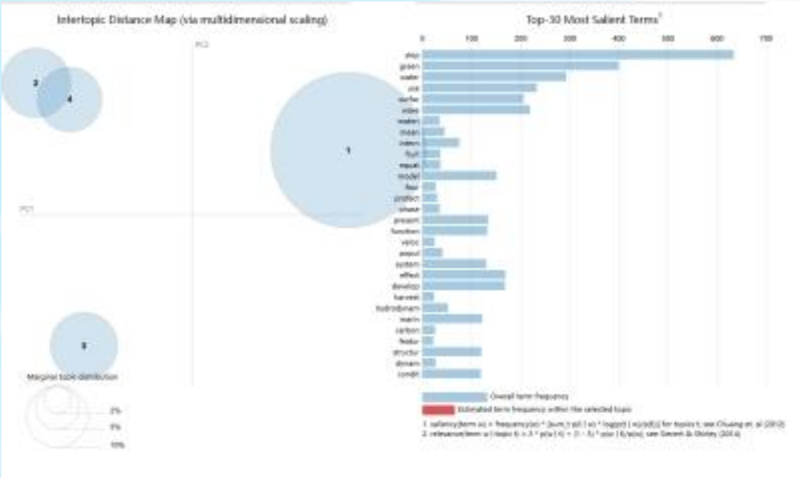


Figure 4. LDA topic model in Stage I (2005-2013)

Figure 5 demonstrates there are five topics, with Topic 1 (Sustainable Shipping and Its Environmental Impact Mitigation) as the dominant topic. Topic 2 (Marine Environmental Challenges and Mitigation Strategies) and Topic 3 (Assessing and Addressing GHG Emissions in Harbor Environments) are in the two extremes, implying that the general GHG emission has not been related to GHG emission in Harbor). Topic 4 (Investigating and Managing Earth's Resources and Processes) and Topic 5 (Urban Planning, Cultural Integration, and Environmental Design) are somewhat overlapped.

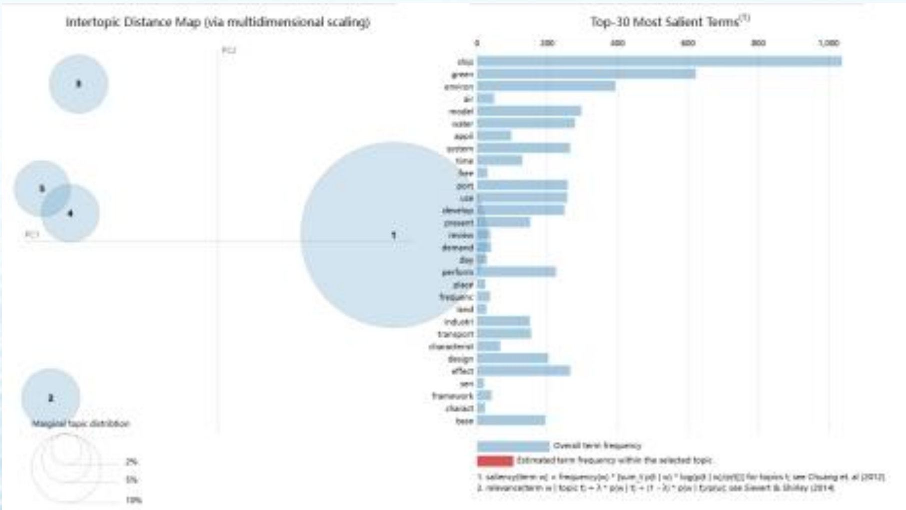


Figure 5. LDA topic model in Stage II (2014-2018)

Figure 6 shows that there are six topics in Stage III, with Topic 1 (Green Shipping and Sustainable Port Operations) as the dominant topic. Different from Stage I and II, it is amazing to find that Topic 2 (Green Shipping Technologies and Efficiency Improvements) appears to be on the same side of Topic 1, implying that Topic 2 and Topic 1 fall into one common direction. Also, Topic 4 (Ecological and Environmental Interactions in Natural and Human-Altered Landscapes), 5 (Environmental Management and Coastal Zone Activities), and 6 (Marine Conservation and Sustainable Fisheries Management) are overlapped, indicating that they share the issue of ecological protection.

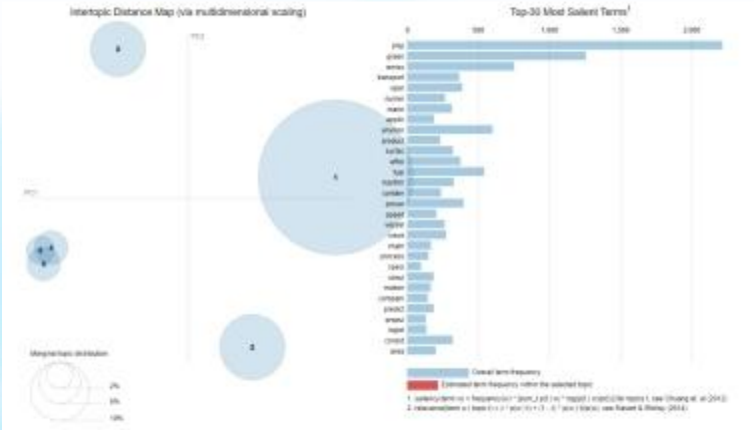


Figure 6. LDA topic model in Stage (2019-2022)

4.3 The deepened GS

In order to identify the content of GS, we compare the 5 hot topic words of the three periods and find that 1) the increase rate of the conception "green" is nearly 50%, from 400 in Stage I to 610 in Stage II, and soars to 140% if Stage II is compared to Stage III (1500). This shows GS has been the hot topic in the period.

Starting with the third word, differences arise. the top two words in the three periods are 'ship' and 'green'. The word 'water' presents in Stage I implies the attention given to the health of marine ecosystems. Maritime activities must reduce their impact on climate, ecosystems, and coastal territories, in order to prevent exacerbation of global environmental issues (Prokopenko & Miśkiewicz, 2020). And the word 'esmission' appears in both Stage II and Stage III. In Stage II, the word 'air' and 'model' are also listed, showing that the scope of gases emitted is broadened to all kinds of gases emitted by ships rather than GHG, and the corresponding solution is to implement technological innovations for vessels (Zheng et al. 2020). But in Stage III, the fact that the word 'transportation' and 'operation' appear after 'emission' suggests that OGS points to the in-process decarbonization mehtod, such as carbon taxation, carbon emissions trading, and carbon finance, which are the main means of reducing emissions (Lan &Li, 2022).

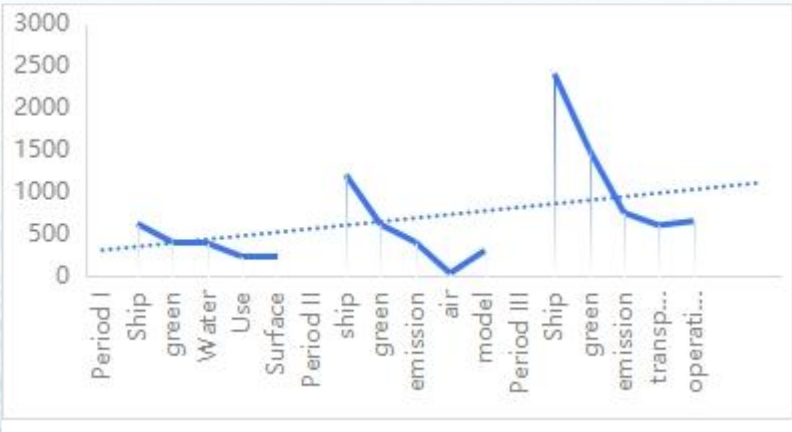


Figure 7. 5 topic words of the three period

5. Discussion

The first question this study deals with is the orientation of green shipping (OGS). GS is the evolutionary result of the response to climate change. Maritime industry is one of the sectors that hail measures to respond to climate change (Zheng et al., 2020; Chen & Zhao, 2022). Previously, a few studies use bibliometric analysis (VOSviewer and Citespace) to forecast the OGS, which can not be achieved if there is no fixed terms. For example, Tadros, M., et al, (2023) and Shi et al. (2020) and Lan & Li (2022) are the only few who research the OGS. Shi et al. (2020) point out that GS is a new trend of development, but can not go into which technology falls into the GS. Lan & Li (2022) make some progress by subjectively mentioning new concepts like green fuel and trimming optimization, etc, which are already recognized by the shipping industry. Tadros, M., et al, (2023) make further progress that introduce the new technologies with the latest technology by the authority of MEPC. All in all, these progresses are dependent on the human judgment of the topic, which differs only in the degree of authority. In other words, non-subjective methods to discuss the OGS, especially the technologies under OGS are not provided yet. This study, in line with the approach of the LDA topic model, is able to figure out the hot topic numbers under GS are 4, 5, and 6 for three periods in a more objective manner.

One of the challenges to making out the number of hot topics is to set the window frame. We introduced the slope formula to the scholarly articles in GS research and scientifically divided the development period into 3 Periods. In practice, life cycle hypothesis is usually used as a theoretical basis to support the segmentation of development trend (Guan & Wang, 2015; Ma & Kim, 2023; Rong et al., 2023, etc), which was introduced by Karman in 1966. But these application of the life cycle hypothesis does not clarify how the time window of the development period is calculated and segmented. For example, Ma & Kim (2023) set the time window as the emerging stage (1993-2003), the slow growth (2004-2014), and the rapid growth stage (2015-2021), which, superficially, is the result of the average mean. Du, et al (2020) segmented the evolution of micro-blogs into four phases by the appearance of the peak. Thus, there is a large amount of suspicion that the time window is set coincidentally with the average mean of 10 years, rather than with a sound base. In light of the imperfection, we use the slope formula to measure the increased rate of scholarly articles, which can separate the period with a better precision. In this study, the period is divided into three periods, namely, an emerging stage (2005-2013), the slow growth period (2014-2018), and the rapid growth (2019-2022).

Another challenge is the process of labeling. This study uses GPT to label hot topics. GPT is good at text generation tasks such as in-context learning and question answer, especially the topic generation by previous knowledge (Wu, et al, 2023), which is more accurate. Previous methods to label hot topics are 1) subjective method based on stem words; 2) borrowing the label from other sources, including the argument of some academic authors. Ma & Kim (2023) generalize the hot topics with their own words, which may be specially focused or may subjectively lead to the predetermined hot topics. Bastani et al (2019) label the topic words with one keyword rather than a cluster of words or phrases. In a nutshell, the traditional way of labelling the hot topic is largely dependent on subjective judgment and textual competence, which inevitably may lead to the unpinned theme as expected. The labeling of hot topic words in Table 2 provides the reason for the choice of theme words, which we find more objective and focused compared to our own subjective summary.

After overcoming the challenges, we are able to pinpoint the facets of GS alters in sequence and content. The significance of a topic is shown by the size and position in LDAvis. As for the number of prevailing topics, Figure 4 and Figure 5 have one dominant topic while Figure 6 has two topics. Topic 2 of Figure 6 (Stage III) is the adoption of green technologies. And such difference implies that GS technologies are increasingly taking a bigger role and integrated with GS research. One of the key development trends of maritime shipping in Stage III is the enhancement of the technical and operational efficiency of in-service vessels (Peng, 2022). From the difference of keywords in each Stage (Figure 7), we can see that the GS in Stage I (ship, green, water, use, surface) gives priority to the water environment and aquatic biology. Attention is given to green shipping strategic planning and management practice (Wu & Zhang, 2016). The GS in Stage II gives rise to emission and air pollutants, and the GS in Stage III focuses on emission and operation in the context of transportation. In sum, though GS has been an unchanging topic since 2005, the content of GS has altered. Most importantly, we can see that GS puts much emphasis on emission control, which expands from GHG (CO2) emission in Stage II to air emission in Stage III. For example, Bouman et al. (2017) systematically sorted out feasible technological means for reducing shipping carbon dioxide emissions while green shipping research primarily focuses on air pollution issues (Zheng et al., 2020). Besides, the solutions of GS are changing from model in Stage II to ship operation in Stage III, which matches with the latest development of IMO meetings, especially MEPC from 2019 to 2024. MEPC from 79 to 81 has given rise to handling climate change by ship operation management. To date, it is believed that there are two major solutions to climate change: reducing the greenhouse gas and adapting to climate change. (NASA, 2024) This study makes a contribution to the present literature that GS will take the approach to reducing emissions by capping the operation. Such capping measures may include renewable fuels, biofuels, etc. For instance, shifting from non-renewable to renewable fuels and cleaner technologies and improving energy efficiency are possible ways to control the global average temperature and minimize carbon emissions (Ritchie and Roser 2020). The use of biofuels has the most significant reduction effect on carbon emissions (Chen et al, 2023). In the alteration, GS technologies are emphasized.

6. Conclusion

Green shipping is the ongoing effort of the global maritime industry to curb climate change. It is important to understand the orientation of the shipping industry in this green context. This study, based on the academic research under the GS from 2005 to 2022, analyzes the OIS of GS by means of the LDA topic model. We find that GS has been substantiated by two major upticks and improvements. One is the understanding of emission control upgraded from GHG emission to Air emission. Another one is the technology-based solutions, which shift from a model of a single approach to a comprehensive approach like green fuel and ship operation.

The research and innovation of shipping technology are the key to realizing the goal of green shipping (Zhen et al, 2020). With the improvements in the labeling method and life cycle hypothesis, this study is able to figure out the correlation of hot topics by their size and significance, which showcases the change of GS in terms of theme content change. We find that GS technologies are much oftener linked to specific solutions to maritime climate change, rather than an unpinned and broad statement. In particular, green fuel and ship operation have become the main solutions to achieve the objective of GS.

To combat climate change, we need not only the concerted efforts from governments and the international organizations (Zhang, et al, 2024), but also the clear and effective path to carbon reduction. In the context of climate change, there are various paths leading to carbon reduction, such as biofuel, LNG, ETS, shipping building, etc, but which is the most effective facet will determine the development orientation of the shipping industry. Grasping the OGS can be useful to the shipping industry's development in the future. The green requirements for new, y-built vessels need effective measures to keep up the trend, for example, such as mandatory shore power usage for docked ships (Peng, 2022). Shipping companies can take a strong hold in the future shipping industry if the emission trade system and the cost are implemented in the next 2 decades (Wang et al., 2021).

Limitation

The limitation of this study is as follows. Firstly, we collect data only from the Web of Science, which needs to be expanded in the future. Secondly, the Green and intelligent direction in the future may influence the global marine industry (Wei et al, 2023). Therefore, some minor hot theme that may greatly influence the future shipping industry is not identified, which should be given special attention in future research.

Author Contributions

Conceived and designed the experiments: Xian Wang, Wenxiang Si.

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Analyzed the data: Chunchang Zhang, Shuye Xue, Zhihuan Wang, Qiuhang Wang

Original draft preparation: Wenxiang Si, Fang Liu

Organization and Writing: Xian Wang

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GENDER EQUALITY PROMOTION FOR EFFECTIVE GLOBAL MARITIME EDUCATION CONCEPT

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Abstract: Maritime Education and Training policy shall be implemented in line with the current and prospective trends of shipping industry development. Promotion of gender equality, aimed to reach the goals of the United Nations (UN) 2030 Agenda for Sustainable Development, was initiated by the International Maritime Organization (IMO) via Gender programme in 1988. But despite the establishment of the network of female supporting organizations, launching capacity building programmes, access to study at higher Maritime Education and Training (MET) institutions and other activities, female seafarers present a minority of the total number of seafarers. The 103rd Session of the IMO Maritime Safety Committee (MSC) noted importance of correct terminology development among the priorities for further introduction of Maritime Autonomous Surface Ships (MASS). Thus, the aim of the presented research is to detect gender inadequate terms and definitions in the key maritime codes, conventions, instruments or educational resources and to propose the ways of their further correct replacement.

Keywords: gender; artificial intelligence; analysis;

Introduction

In Old English, the noun "man" meant a human being irrespective of age or sex. But currently, according to the latest edition of the Oxford English Dictionary, seventy-eight definitions of man-derived terms are explained as only male-describing terms, e.g. dockman – dock male employee, newsman – media male employee, etc. (20).

At the same time the analysis of modern media resources detect active application of gender neutral terms "businessperson", "chairperson", "firefighter", "police officer", "salesperson" replacing "man"-based "businessman", "chairman", "fireman", "policeman", "salesman" (21).

The air and space navigation industries therefore take appropriate measure to be in line with the modern trends of gender equal society. The analysis of air and space navigation fields shows the following linguistic tendencies. The Drone Advisory Committee of the United States Federal Aviation Administration recommends to develop gender-equal glossary and to apply the term "uncrewed" instead of "unmanned", "technician" instead of "repairman", "aviator" instead of "airman", "manufactured" instead of "man-made" and promotes gender-equal language adoption in all future speeches, documents, etc. (22)

The same trends are encouraged by the United States NASA's History Program Office Style Guide, according to which, all terms related with space program should be gender equal, promoting "human" space program instead of "manned" space program, and "piloted" instead of "manned". (23)

Thus, considering gender-balanced terminological policy of air and space industries, lets track gender issues reflected in maritime terms. Despite an old tradition to refer a ship as "she" (due to women figureheads, protecting the crews at sea in the ancient times) currently there is a real gap of gender-neutral maritime terminology. Evidence of need for gender-balanced terminology is even resulted from our interaction with the OpenAI - based Generative Pre-trained Transformer 4 (GPT-4) Artificial Intelligence system, which directly offered to replace all man-ending maritime terms into person-ending ones. But the process of relevant terminology formation requires detection of the terms' sources, reasons of their introduction, analysis of their content application and further introduction of corrected terms.

The Analysis of Male-Female and Human-Artificial terminology balance in key Maritime Documents

Thus, at the first stage of the implemented research we identified the International Labour Organization (ILO) Convention "On Seafarers' Hours of Work and the Manning of Ships", 1996 and the IMO resolution "On the

Principles of minimum safe manning" as the major sources of masculine terminology spread in active maritime documents. The content analysis of both documents shows promotion of man-derived terminology, e.g. "manning of ships", "safe manning document", "manning levels" (1), and "manning arrangements" (2) which furtherly is applied in below analyzed texts. Consequently, as the next step of the studies, we present the content analysis of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW). Resolution 14 of the STCW declares "Promotion of the participation of women in the maritime industry" and provides the opportunities for female seafarers and supports women admission in all sectors of the maritime industry (3).

But the analysis of the terminology, used in the STCW Resolution 7 "Promotion of technical knowledge, skills and professionalism of seafarers", Resolution 12 "Attracting new entrants to, and retaining seafarers in, the maritime profession" and Resolution 13 "Accommodation for trainees", results in detection of gender unequal terms, repeatedly presented with "effective manning" of the vessels (3).

A "man" dominating terminology is also widely presented in the rest parts of the STCW, e.g. "man-machine interfacing" in training and assessment of the use of electronic chart display and information systems (ECDIS), "safe manning" in watchkeeping-related issues, "manned" or "unmanned" marker is widely applied to define conditions, spaces, facilities or watches (3).

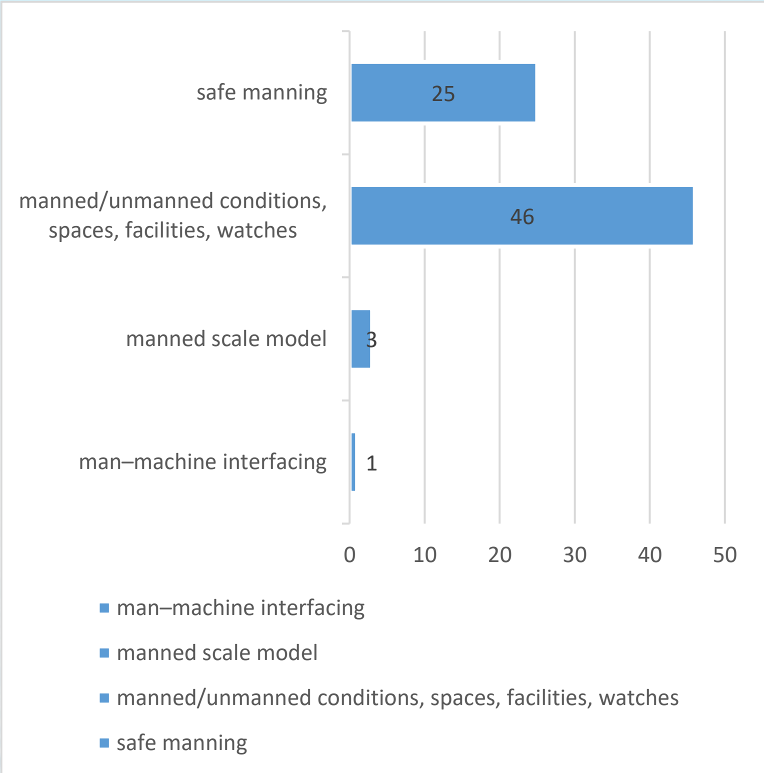

Figure 1. Distribution of "man"-derived terms in the STCW.

The further step of our analysis deals with the context of International Convention for the Safety of Life at Sea (SOLAS), 1974. Similarly to the STCW, the SOLAS content analysis also results in "man"-focused term, such as "manned central control station", "manned watch station", "manned supervision", "manned machinery spaces" and "unmanned navigating bridge". Crew provision is also represented by "safe manning" of ship and parties. The elements of ship equipment are described as "man-rope" and "manhole", crew members are identified as the "fireman" and "helmsman", but it shall be noted that the last one is once mentioned as the "helmsperson" (4).

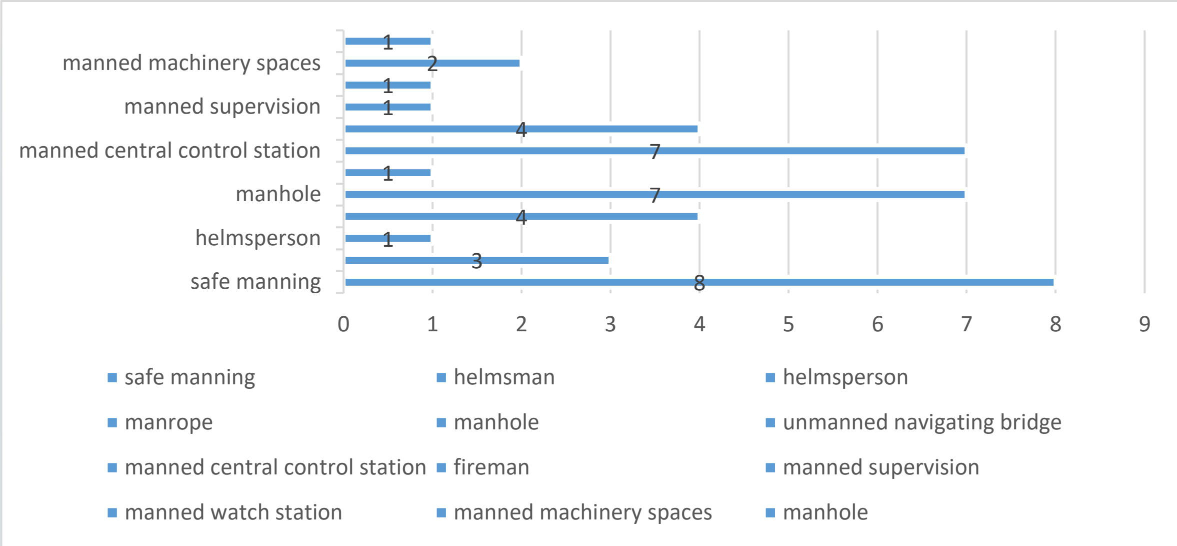

Figure 2. Distribution of “man”-derived terms in the SOLAS.

Effective education and further safe marine communication depend on inclusion of the IMO Standard Marine Communication Phrases (SMCP) into maritime education and training and their application in ship to shore, ship to ship and onboard communication procedures. But, the analysis of the conventionally required teaching aid the IMO SMCP reflects man-derived terms, such as the “helmsman”, “lifeboatman”, “man overboard”, “man overboard alarm”, “man overboard drill”, “man overboard station”, “man overboard lookout”, “man rope”, “manhole”, “manned bridge”, “manned engine-room”, “manned lookout”, “manning of damage control team”, “manning of firefighting team”, “pumpman” and “unmanned (engine) room/space” (5). The research of the Annual Overview of Marine Casualties and Incidents 2022, published by European Maritime Safety Agency also contains “man/machine interaction” as one of the accidents contributing factors (6). The text analysis of the Bridge Procedures Guide of the International Chamber of Shipping, detected application of “manned mooring station”, “manned bridge”, “un-manned machinery space”, “manned means of pilot embarkation/disembarkation”, “manned boarding equipment” and “seaman-like action” (7).The study of the NAVGUIDE - Marine aids to navigation manual, developed by the International Association of Marine Aids to Navigation and Lighthouse Authorities, revealed the “man”- made features, objects, structures, hazards, dangers, navigation marks, “man-machine interface” and “manned lighthouse” (8).

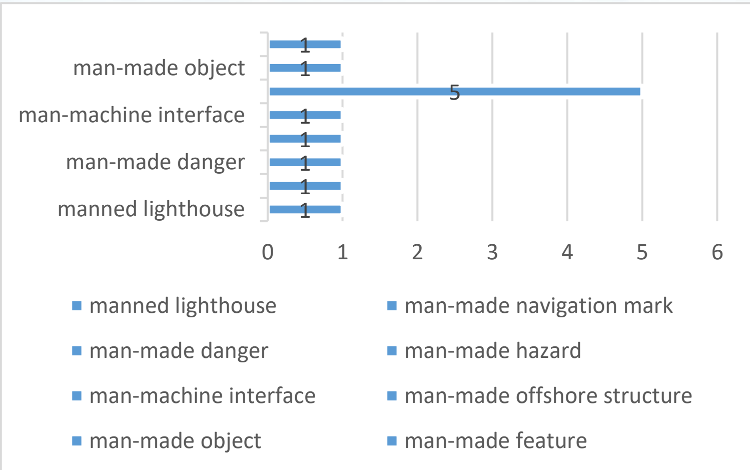

Figure 3. Distribution of “man”-derived terms in the NAVGUIDE.

The analysis of the glossary of the British Admiralty Mariner's Handbook (Nautical Publication 100) disclosed a number of obsolete only man-based explanations, e.g. boulders and cobbles are explained as the stones larger than a “man’s head”, gravel is described as the stone equal to the diameter of a “man’s thumb”. According to the Mariner’s Handbook definition, a light-vessel is a “manned vessel”, a production platform is a “permanently-manned” offshore structure, a radiobeacon is a station not “necessarily manned” (9).

The analysis of the content of the International Aeronautical and Maritime Search and Rescue Manual detects the following gender balance breaking terms – "unmanned aircraft", "man overboard" and "man overboard buoy" (10). A number of masculine terms and definitions is also presented in the "Sea Legs Glossary", developed by the United States Coast Guard. According to the glossary, boatswain's mate of the watch obligations foresee a "proper manning" of the watch. The terms "Coast Guardsman" and "ombudsman" are also the examples of man-derived terminology (11) The Glossary of Terms, developed by the International Transport Workers' Federation contains a "manning agent" (12). The next stage of the analysis deals with data, ensured by the US National Geospatial-Intelligence Agency and National Imagery and Mapping Agency. An example of gender unequal terms are detected in the U.S. Chart No. 1 Symbols, Abbreviations and Terms used on Paper and Electronic Navigational Charts, where "unmanned light" and "unmanned light-vessel" are detected (13). The review of Sailing Directions (Planning Guide) Publication 120, developed by the National Geospatial-Intelligence Agency, detected existence of the following irrelevant terms – "unmanned fish raft", "manned and unmanned production platform" and "unmanned fish aggregating device" (14). The research showed that the International Code of Signals for Visual, Sound, and Radio Communications defines letter and flag "O" as the "Man overboard" (15). The research detected "manned or unmanned submersibles" in Radio Navigational Aids, Publication No. 117 of National Geospatial-Intelligence Agency (16). "Radar manning" is displayed in Radar Navigation and Maneuvering Board of the National Imagery and Mapping Agency (17). The research of the glossary of Publication No. 9, American Practical Navigator shows that descriptions of the buoys, light-float, light stations, offshore light stations, spacecrafts, major and minor lights are based on their manned or unmanned principle. A "man-made artificial magnet" and "man-made noise" are detected in line with a range of man-derived terms, presented in above mentioned examples (18). Sequence of man-based terms is displayed in the content analysis of Publication No. 9, American Practical Navigator, provided by the National Geospatial-Intelligence Agency. Dealing with the different issues related with marine navigation, the publication text contains a totally man-oriented terms, such as "man/machine interface", "one-man watch", "man-overboard rescue maneuver", "man-made changes", "man-made obstruction", "man-made noise", "man-made ambient electronic noise", "man-made structure", "man-overboard device", "man after steering", "man-made object", "man-based explanations" (18).

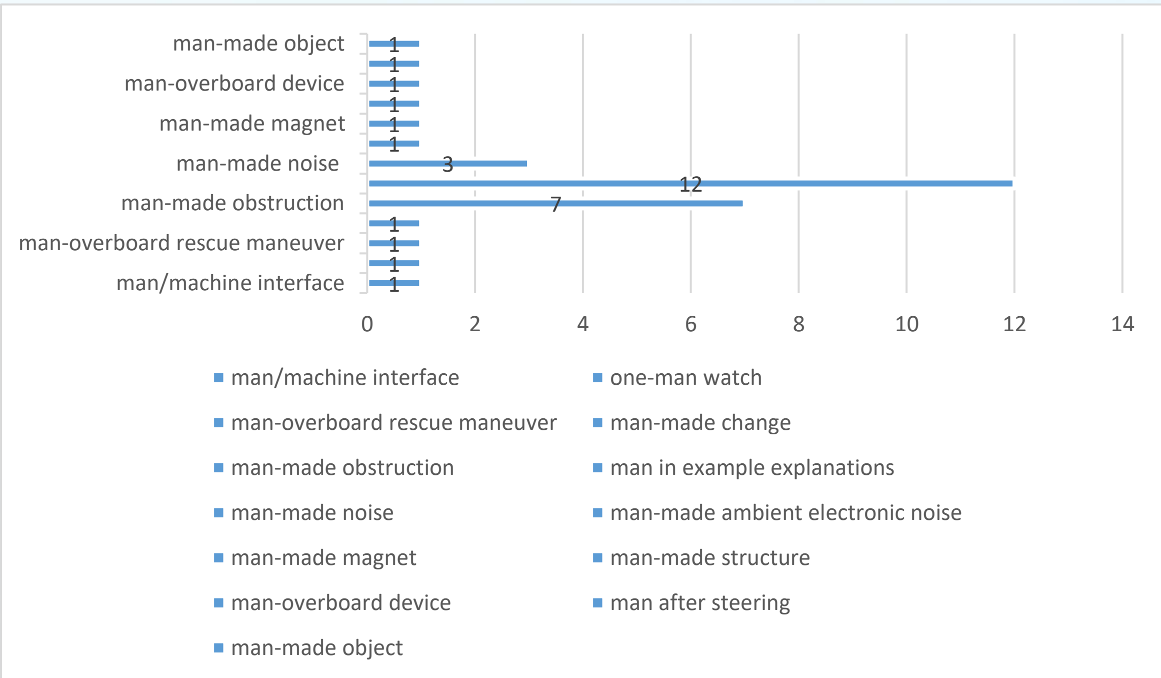

Figure 4. Distribution of "man"-derived terms in American Practical Navigator.

Conclusion

Therefore, mentioned above frequently used man-focused terms impede gender balance of maritime industry. At a glance it appears easy to change man-overboard alarm, -buoy, -drill, -lookout, -device, -rescue maneuver and -station to person-overboard terms. If we follow Artificial Intelligence offered approach, guardsperson, fireperson, helmsperson, lifeboatperson and person after steering will replace Coast Guardsman, fireman, helmsman, lifeboatman and man after steering. It also seems logical to alter "man"-made changes, dangers, features, hazards, navigation marks, noises, objects, obstructions and structures to people-made ones. Staffing-based terms shall interchange all manning-derived terms. Therefore, the gender balance will be kept and vocabulary of key maritime documents including teaching aids will promote equal opportunities for both male and female seafarers.

But such an automatic simplified replacement of "man" to "person" is not enough in relation with the trends of development of the Artificial Intelligence and the Maritime Autonomous Ship Systems (MASS).

Therefore, our analysis is prolonged with the content research of the "Maritime Autonomous Ship Systems (MASS) UK Industry Conduct Principles and Code of Practice A Voluntary Code" (Version 5 November 2021). The study resulted in detection of man-focused terminology presented with "Man overboard (if vessel manned)", "partial manned operations", "manned interface", "manned vessel", "manned contact", "manned operation", "manned ground control station" and "manned transit" (19).

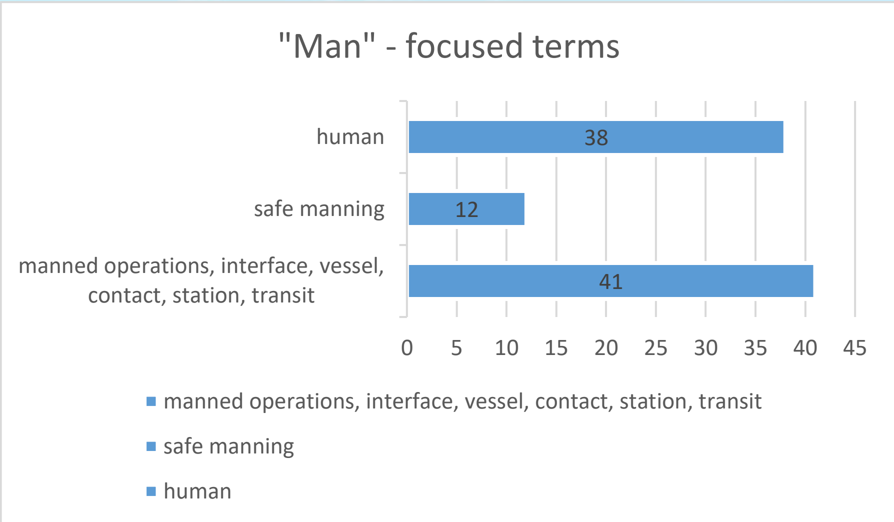

Figure 5. Distribution of "man"-derived terms in the MASS UK Industry Conduct Principles and Code of Practice.

Accordingly, taking MASS and AI into consideration, we propose to introduce not only gender balanced terminology, equaling male and female seafarers, but also to offer human-derived terminology, clearly differing human and artificial intelligence participation in shipping. Thus, it seems correct to use human-attended watch, space, station, facility and bridge instead of manned ones. Therefore, in order to make a clear difference between human and artificial activities, we offer the following "human/AI" emphasizing terms: human/AI-involved operation, human/AI-involved lookout, human/AI-involved contact, human/AI-involved conditions, human/AI-involved operation, human/AI-involved transit. Introduction of MASS in the near future will also require putting of the following terms: human-operated/AI-operated boarding equipment, human-operated/AI-operated bridge, human-operated/AI-operated central control station, human-operated/AI-operated engine-room, human-operated/AI-operated facility, human-operated/AI-operated lighthouse. Taking the research results into consideration, effective implementation Global Maritime Professional concept shall be backed by appropriate terms. The whole pack of the legislative database and teaching aids shall be provided with the relevant terminology. In our opinion, three major directions of terminology correction and formation shall be implemented. The first direction of a small number of man-derived words (e.g. man-rope, manhole), due to their low frequency of application, do not require immediate replacement and shall be gradually changed with appropriate gender equivalents. The second direction of obsolete man-derived terminology shall be as soon as possible replaced with appropriate gender equal terms – the examples are "manning"-derived and "man overboard-derived terms, describing physical involvement of male or female seafarers. The third direction of the terms, related with human/AI-involved operations, contact, spaces, and facilities shall be shaped due to the future trends of shipping development, providing the future Global Maritime Professionals with clear terminology exactly mirroring gender balanced and human/AI involved navigation in the 21st century. Finally, as our contribution to relevant Maritime English development we submitted a term "seafarership" as a gender-neutral definition of skill in sailing a boat or ship to the Oxford English Dictionary.

As the prospective trend of gender-neutral terminology development we offer a short glossary of gender tuned terms:

Coast Guardsman -s coast guardperson

Dockman – dockperson

Effective manning – effective staffing

Lifeboatman – lifeboatperson

Man after steering – person after steering

Man machine interface – person machine interface

Man overboard alarm – person overboard alarm

Man overboard drill – person overboard drill

Man overboard lookout – person overboard lookout

Man overboard station – person overboard station

Man-machine interaction – person-machine interaction

Man-machine interface – person-machine interface

Man-made ambient electronic noise – person-made ambient electronic noise

Man-made artificial magnet – person-made artificial magnet

Man-made danger – person-made danger

Man-made feature – person-made feature

Man-made hazard – person-made hazard

Man-made navigation mark – person-made navigation mark

Man-made noise – person-made noise

Man-made object – person-made object

Man-made obstruction – person-made obstruction

Man-made offshore structure – person-made offshore structure

Man-overboard alarm - person-overboard alarm

Man-overboard buoy – person-overboard buoy

Man-overboard device – person-overboard device

Man-overboard rescue maneuver – person-overboard rescue maneuver

Man’s head – person’s head

Man’s thumb – person’s thumb

Manned bridge – staffed bridge

Manned central control station – staffed central control station

Manned engine-room – staffed engine-room

Manned facility – staffed facility

Manned lighthouse – staffed lighthouse

Manned machinery spaces – staffed machinery spaces

Manned means of pilot embarkation/disembarkation – staffed means of pilot embarkation/disembarcation

Manned mooring station – staffed mooring station

Manned production platform – staffed production platform

Manned scale model – staffed scale model

Manning agent – staffing agent

Manning levels – staffing levels

Manning of damage control team – staffing of damage control team

Manning of ship – staffing of ship

Manning of the watch – staffing of the watch

One-man watch – one-person watch

Permanently-manned – permanently staffed

Pumpman - pumperson

Safe manning – safe staffing

Seaman-like action – seaperson-like action

A short glossary of AI-related terms:

Human-operated boarding equipment vs AI-operated boarding equipment

Human-operated bridge vs AI-operated bridge

Human-operated central control station vs AI-operated central control station

Human-operated engine-room vs AI-operated engine-room

Human-operated facility vs AI-operated facility

Human-operated lighthouse vs AI-operated lighthouse

Human-involved conditions vs AI-involved conditions

Human-involved contact vs AI-involved contact

Human-involved lookout vs AI-involved lookout

Human-involved operation vs AI-involved operation

Human-involved transit vs AI-involved transit

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REMOTE OPERATIONS SIMULATION: THE ROC SIMULATOR AND THE FUTURE OF SIMULATOR TRAINING IN MARITIME EDUCATION AND TRAINING

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Abstract: The introduction of modern technology and digitalization in the shipping industry created the concept of Maritime Autonomous Surface Ships (MASS). Remote control of vessels involved in coastal voyages are now creating a demand for a new generation of maritime professionals that must be equipped with the knowledge, understanding, and proficiency in remote control operations and robotic navigation. In order to address the gap between common core competencies required of traditional Seagoing Officers and Shore-Based Navigating Officers, trainings on operating autonomous vessels with the use of Remote Operations Center (ROC) Simulator is fast becoming an emerging necessity. Maritime Professionals who are engaged either in sea-based or land-based services must possess key skills as indicated in the STCW and the skill-set requirements of the emerging technologies used in modern shipping. The key goal of this study is to provide insights on how the Maritime Academy of Asia and the Pacific is able to come up with its latest state-of-the-art ROC Simulator and how it utilizes this facility to impart the necessary skill sets to its students and trainees in order to prepare them for Remote Vessel Control Operations.

Keywords: Innovation in Simulator Technologies, Specialized Simulator Trainings, Emerging Technologies in Maritime, Maritime Autonomous Surface Ships, Remote Vessel Control Operations, Remote Control Operations Simulator

1. Introduction

As the maritime industry continues to evolve with technological advancements, the need for specialized training programs has become more critical than ever. The Maritime Academy of Asia and the Pacific (MAAP) has responded to this demand by introducing the Remote Operation Center (ROC) Simulator Course, a pioneering initiative designed to enhance the competencies of maritime professionals by providing work opportunities ashore operating ships remotely. This course aims to bridge the gap between traditional maritime operations and the emerging trends of remote and autonomous vessel operator management. With a goal of providing manpower with skills ready for technology, MAAP integrates state-of-the-art simulators and a comprehensive curriculum to prepare officers and students for the complexities of modern maritime control centers. This program not only emphasizes the importance of safety and efficiency in remote operations but also positions MAAP as a leader in maritime education and innovation.

2. Related Work

2.1 Advancement of Technology in the Maritime Industry

The advancement of technology in the maritime industry, especially in the area of autonomous shipping, is a subject that is gaining relevance and attention. Maritime Autonomous Surface Ships (MASS), another name for autonomous ships, have the potential to completely transform the maritime industry by utilizing cutting-edge technology like automation and artificial intelligence (AI) (Zhu, Zhou, & Lu, 2022). These developments are anticipated to lead to substantial transformations, presenting both opportunities and challenges for maritime industry stakeholders (Kim, Sharma, Gausdal, & Chae, 2019).

The integration of autonomous shipping into the maritime industry signifies a move towards digitalization and smart technologies, providing improved safety, efficiency, and environmental advantages (Olapoju, 2022) (Wennersberg, Nordahl, Rødseth, Bolbot, & Theotokatos, 2020). The development of autonomous ships is considered as a significant step forward in addressing issues such as marine accidents and environmental impact

(Wennersberg, Nordahl, Rødseth, Bolbot, & Theotokatos, 2020). Furthermore, it is expected that the use of autonomous technologies would result in cost savings, pollution reductions, and operational flexibility, revolutionizing current shipping operations (Osaloni & Ayeni, 2022). Moreover, the education and training of seafarers are experiencing major transformations to accommodate the integration of autonomous technologies, bringing both challenges and opportunities for the maritime sector workforce (Towards the development of a dynamic reliability tool for autonomous ships: A bayesian network approach, 2023).

2.2 Significant Transformations in Maritime Education and Training: Addressing Challenges and Opportunities for the Workforce

The adoption of autonomous technologies in the maritime sector is revolutionizing the industry, creating both challenges and opportunities for seafarer education and training (Meštrović, Pavić, Maljković, & Androjna, 2024). With the rise of autonomous shipping, it is important to reevaluate the skills needed to be a competent seafarer, highlighting the necessity of updating education and training programs to equip a new generation of maritime professionals (Popoola, Akinsanya, Nzeako, Chukwurah, & Okeke, 2024). This transformation in skill requirements calls for specialized and improved training and development tailored to the maritime sector's new demands, highlighting the critical role of advancing the skills of seafarers (Ajayi & Udeh, 2024).

The emergence of Maritime Autonomous Surface Ships (MASS) leads to critical changes in maritime education and training. As MASS technologies progress, it becomes necessary to reevaluate conventional methods of educating and training seafarers to align with the evolving nature of work on autonomous ships (Meštrović, Pavić, Maljković, & Androjna, 2024). The shift towards partially or fully autonomous vessels in commercial operations will require significant changes in the education and training of crew members (Lušić, Bakota, Čorić, & Skoko, 2019).

Moreover, the advancement of MASS is anticipated to deeply influence maritime education and training by integrating new training methodologies into current curricula to prepare seafarers for the autonomous shipping era (Tang, Liu, Cheng, & Li, 2024). These significant shifts in education and training profoundly affect simulation-based training, as simulators are essential tools for the effective training and development of marine professionals (Emad & Kataria, Challenges of simulation training for future engineering seafarers - A qualitative case study, 2022).

2.3 Simulation-based Training

Simulation-based training is essential for educating and training seafarers, as simulators are becoming increasingly crucial in improving the skills and competencies of maritime professionals (Benedict, Baldauf, Felsenstein, & Kirchhoff, 2006). Live-action training simulations led by expert facilitators are regarded as the pinnacle of training environments, underscoring the importance of practical, hands-on training experiences (Shubeck, Craig, & Hu, 2016).

Furthermore, simulation-based training for Maritime Autonomous Surface Ships (MASS) is vital for ensuring the safe and effective operation of autonomous vessels (Sumic, Males, & Rosic, 2021). These simulators are essential for offering hands-on experience and providing Officers to handle the complexities of operating autonomous ship (Meštrović, Pavić, Maljković, & Androjna, 2024). Incorporating simulators into education and training programs for MASS is vital for preparing maritime students and officers for careers in the autonomous shipping industry. As MASS technology progresses, the demand for skilled operators and seafarers capable of efficiently navigating these vessels grows increasingly important. Simulators are recognized as indispensable tools for training future operators of autonomous ships (Emad & Ghosh, 2023).

3. Acquisition and Utilization of Remote Operations Center (ROC) Simulator

3.1. Research

The need to acquire ROC Simulator is a strategic response to the evolving needs of the maritime industry, as highlighted in "Future Skills Set for a New Generation of Competent, Highly-Skilled Seafarers [1]," presented by MAAP at IMLA 28. This research underscores the growing gap between traditional core competencies and the emerging skills required in today's digitalized and green shipping landscape. By providing hands-on training in remote vessel control operations, the ROC Simulator directly addresses the need for maritime professionals to be proficient in digital technology, green shipping, and soft management skills. The study emphasizes the impact of disruptive technologies such as IoT, Blockchain, Data Analytics, Digital Twins, and Decarbonization on the maritime industry. The ROC Simulator serves as a practical platform where these technologies can be applied and understood in a maritime context, ensuring that students and trainees are not only theoretically knowledgeable but also practically skilled in using these cutting-edge tools.

3.2. Curriculum Development and Targeted Audience

The initiatives of MAAP in establishing its program for a course in MASS and providing a Remote Operation Center Simulator under an Innovation Laboratory is in support of the Philippine Government's Maritime Industry Development Plan (MIDP) for 2019-2028. The specific programs under the MIDP that are supported by these enhancements are Program 8: Establishment of Maritime Innovation and Knowledge Center, and Program 9: Development of Competitive and Highly Skilled Filipino Maritime Professionals. The courses and the underlying modules are designed to be more inclusive and responsive to the current and future challenges of the global maritime industry by providing knowledge-base on science, technology, and innovation in shipping, as well as operating modern technologies that are incorporated in modern vessels. The overall impact of this innovation program is to promote knowledge, understanding, and proficiency of the Filipino Maritime Professionals in terms of operating remote and autonomous ships, and yield increases in the number of qualified seafarers for the operation and management of modern vessels, thus improving the stakeholder/client satisfaction and increasing the chances of employment retention in the future.

The MAAP Remote Operation Center (ROC) Course is a specialized program tailored for maritime officers undergoing the Management Level Course (MLC) as well as familiarizing students under the Baccalaureate Program. For the Advanced ROC Course, its primary goal is to prepare maritime officers with the necessary skills and knowledge to effectively manage and operate remote control centers. For the Basic ROC Course, the modules are designed to familiarize MAAP students on the latest technology trends in the seafaring industry, particularly focusing on the use of cutting-edge simulators that simulate real-world scenarios. One of the key objectives of the ROC Course is to promote safety and efficiency in maritime operations, especially handling of remote operation centers. By equipping officers with the right skills and knowledge, the course contributes to creating a safer and more efficient operational environment in the maritime industry.

The course structure incorporates both theoretical instruction and practical exercises. The theoretical component covers a range of critical topics, including an Introduction to Maritime Autonomous Surface Ships (MASS), Implementation of Unmanned Vessels, Key Elements of MASS, and proposals for IMO Regulations in MASS. By the end of the course, trainees are expected to explain the interconnectivity of sustainable shipping, MASS, and Digital Twin technologies and sub-technologies in the context of autonomous shipping, providing them with a holistic understanding of the industry's future. Specifically, enumerated below are the approved course outcome and topics of the MDT Course:

Course Outcome: Explain the inter-connectivity of Sustainable Shipping, MASS and Digital Twin in respect to autonomous shipping.

Topic 1: Introduction on MASS

1.1 Concept of autonomy

1.2 Degree of Autonomy

1.3 Recent Development in MASS

Topic 2: Implementation of unmanned vessel

2.1 Safety of navigation

2.2 Shortage of seafarer

2.3 Harmful exhaust emission

2.4 Operation of unmanned vessel

2.5 Vulnerabilities and risks

Topic 3: Key elements of MASS

3.1 System of Systems

3.2 Remote and Autonomous Operations Models

3.3 Remote Operation Center Architecture Overview

Topic 4: IMO Regulation in MASS

4.1 Legal aspect of management & operation of SCC

4.2 Support of the International Maritime Organization (IMO)

3.3 MAAP Remote Operation Center Simulator (ROC)

Complementing theoretical learning is simulator-based training through practical exercises with the use of an ROC Simulator (see Figure 1 and 2). ROC Simulator Trainees engage in scenarios where they apply their knowledge in real-time decision-making, crisis management, and operational control within a remote set-up. These exercises aim to simulate various challenging situations that maritime officers may encounter in their roles as remote vessel operators, thereby enhancing their operational capabilities and sharpening their decision-making skills.

Figure 1. MASS Bridge Simulator and ROC Simulator Room

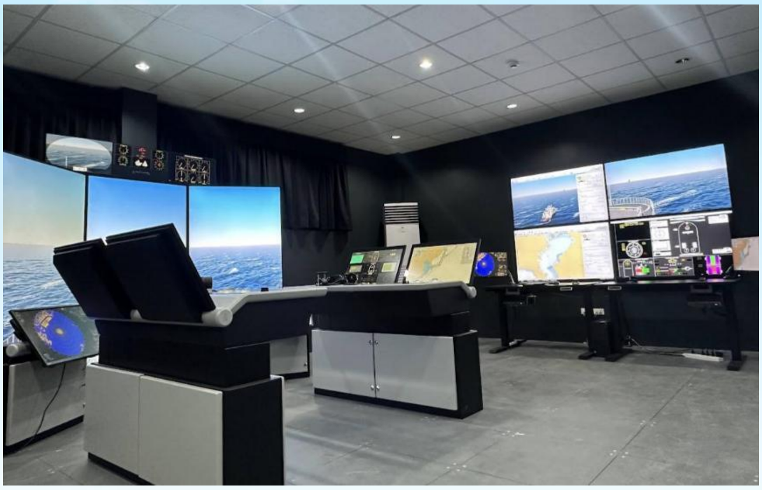

Figure 2. M/V Yara Birkeland Model in MASS Bridge Simulator

3.4. Academic Collaboration with University of South-Eastern Norway (USN)

The Maritime Academy of Asia and the Pacific (MAAP), in collaboration with the University of South-Eastern Norway (USN) and Kongsberg Digital AS, has established a Memorandum of Understanding (MOU) aimed at advancing maritime innovation, education, training, and assessment. The agreement emphasizes MAAP's leadership in utilizing simulators, cloud-based technologies, and Virtual Reality for enhanced training methodologies, as well as developing standards for Remote Operations Centers and Remote Vessel Operations. It facilitates joint research projects, regular meetings chaired by MAAP, and the exchange of expertise and students between institutions. This partnership highlights MAAP's commitment to fostering technological advancements and educational excellence in the maritime industry particularly in the emerging technology of autonomous shipping.

3.5 *Recommended Competency Mapping for Future Maritime Autonomous Surface Ship Officers*

In the absence of an existing approved standards in MASS training, the author developed a competency mapping for future Maritime Autonomous Surface Ship officers that serves as guide to ensure that students and trainees are adequately prepared to operate autonomous vessels. In this mapping, required proficiencies and technical skills are defined, such as (1) monitoring vessel conditions using data analytics and remote measurement, (2) using on-board redundancy systems to ensure continuous vessel operation, (3) using on-board sensors and data transmission, (4) utilizing artificial intelligence and digital twins, (5) use of modern digital technology, and (6) interacting with shore control centers for the safe and efficient operation of the vessel. Table 1 contains the details of the competency mapping, also providing the class of simulation needed for each specific competence.

Table 1. Recommended Competency Mapping for Future Maritime Autonomous Surface Ship Officers

COMPETENCE	KUP	ASSESSMENT OUTCOME	PERFORMANCE CRITERIA	PERFORMANCE STANDARD	SCORING PROCEDURE	LEVEL OF SIMULATION	CLASS OF SIMULATION
Monitor Vessel Condition using Data Analytics and Remote Measurement	Knowledge of Data Analytics Software for Vessel Speed, Maneuvers, Position, Fuel Consumption, Cargo Condition	At the end of the assessment, the candidate must be able to monitor vessel condition by remote means	Achievement of Remote Monitoring of Ship's condition in accordance with Ships Safety Management Plan or other documents and established safety rules and regulations	Monitor Vessel Condition to ensure compliance with international regulations on remote measuring of vessel parameters such as: 1.) Vessel Speed; 2.) Manoeuvring; 3.) Position fixing by remote means; 4.) Remote Fuel Consumption monitoring; 5.) Cargo loading condition	Checklist	Operational/ Functional	Data Analytics Software / Automatic Database equipment
	Ability to analyze data for use in fleet optimization	At the end of the assessment, the candidate must be able to use and interpret data for use in fleet optimization	Effectiveness of fleet optimization report	Ensure proper application of relevant data obtained using Voyage Management System - Vessel Condition in the preparation of fleet optimization report	N/A	N/A	N/A
Use of on-board redundancy systems to ensure continuous vessel operation	Knowledge of the capability and limitations of on-board redundancy systems operations including: .1 a thorough understanding of fail-over systems and change-over mechanisms	At the end of the assessment, the candidate must be able to use on-board redundancy systems to ensure continuous vessel operation	Usage of on-board redundancy systems control functions, fail-over, and change-over mechanisms to ensure continuous operation of on-board facilities	Executes within five (5) minutes the following: 1. Turn power on to a cold standby unit 2. Synchronize incoming standby unit output to primary unit output 3. Engage change-over switch to stop primary unit and connect secondary unit to main operation	Penalty / Reward	Management / Operational	Full Mission / Special Task Engine Room Simulator
	.2 the dangers of over-reliance to automatic control			1. The limitations of on-board redundancy systems; 2. potential risk of improper functioning of the system; 3. system limitations; 4. potential risk of human errors	N/A	N/A	N/A

COMPETENCE	KUP	ASSESSMENT OUTCOME	PERFORMANCE CRITERIA	PERFORMANCE STANDARD	SCORING PROCEDURE	LEVEL OF SIMULATION	CLASS OF SIMULATION
	.3 familiarity with the functions of redundancy systems required by performance standards in force			Emphasized during the assessment are the following factors: 1. performance standards of the equipment; 2. difference between cold standby and hot standby; 3. levels of redundancy; 4. concepts of reliability, availability, failure, and MTTF	N/A	N/A	N/A
Use of on-board sensors and data transmission	Knowledge of the different types of measurement, transmission, and control of sensor data from on-board integrated machinery systems for transfer to shore centers	At the end of the assessment, the candidate must be able to use on-board sensors for use in the measurement, transmission, and control of integrated machinery systems information to shore centers	Usage of on-board sensors for measuring process and control parameters, and achieve remote transmission of control information to shore centers	Emphasized during the assessment are the following factors: 1. performance standards of the equipment; 2. basic concepts and theory of remote measurement, transmission, and control; 3. levels of redundancy; 4. concepts of reliability, availability, failure, and MTTF	N/A	N/A	N/A
Use of Artificial Intelligence and Digital twin	Knowledge of the capability and limitations of Artificial Intelligence and Digital Twin	At the end of the assessment, the candidate must be able to know the basic concepts of AI and Digital Twins	Use of Artificial Intelligence and Digital Twins in the four levels of autonomy	Emphasized during the assessment are the following factors: 1. relevant performance standards; 2. applications of AI in the four levels of autonomy; 3. applications of Digital Twins in the safe and efficient management of MASS; 4. concepts of reliability, availability, failure, and MTTF	N/A	N/A	N/A
Use of modern digital technology	Knowledge of digital applications, Internet of Things (IoT), and use of Block Chain Technology	At the end of the assessment, the candidate must be able to know the basic concepts of digital applications used on board MASS, including IoT and Block Chain technologies	Use of Internet of Things (IoT) and Block Chain technologies in shipboard operations and processes	1. The limitations of digital applications and risks of over-reliance; 2. potential risk of improper functioning of the system; 3. system limitations; 4. potential risk of human errors	N/A	N/A	N/A
Interact with Shore Control Center for Safe and Efficient	Ability to interact and work with Shore Control personnel to ensure safe and efficient	At the end of the assessment, the candidate must be able to perform safe and efficient transfer of tasks	Achieve seamless transfer of tasks between on-board and shore control through effective	Ensure proper coordination and communication with shore control personnel through effective use of on-board resource management	Penalty / Reward	Management / Operational	Full Mission / Special Task Bridge and Engine Room

COMPETENCE	KUP	ASSESSMENT OUTCOME	PERFORMANCE CRITERIA	PERFORMANCE STANDARD	SCORING PROCEDURE	LEVEL OF SIMULATION	CLASS OF SIMULATION
Operation of the Vessel	vessel operations	from on-board to shore control using effective communications between on-board and shore personnel	communications in accordance with Ships Safety Management Plan or other documents and established safety rules and regulations				Simulator with Shore Control Center Simulator (could be instructor station)

4. Conclusion

The integration of the Remote Operation Center (ROC) Simulator Course by the Maritime Academy of Asia and the Pacific (MAAP) marks a significant milestone in maritime education and training, showing the industry's shift towards digitalization and innovation. This pioneering initiative is a strategic response to the evolving demands of the maritime industry, addressing the critical need for specialized skills in operating remote and autonomous vessels. By bridging the gap between traditional maritime practices and the emerging trends of remote and autonomous vessel management, MAAP ensures that its students and trainees spearhead technological advancements.

The ROC Simulator Course offers comprehensive modules that combines theoretical instruction with hands-on practical exercises with the use of simulators. This dual approach not only imparts essential knowledge about Maritime Autonomous Surface Ships (MASS) and their implementation but also provides trainees with real-world scenarios to enhance their decision-making and operational control skills. The course covers a wide range of critical topics, including sustainable shipping, digital twin technologies, and the key elements of MASS, thereby providing a holistic understanding of the advancements in the maritime industry.

By implementing the ROC Simulator Course, MAAP not only supports the Philippine Government's Ten-Point Maritime Industry Development Plan (MIDP) but also contributes to the global maritime workforce's competence and readiness for future opportunities and challenges. The course's emphasis on safety, efficiency, and the integration of modern technologies prepares maritime professionals to meet the industry's evolving demands. As the maritime sector continues to embrace digitalization and automation, the ROC Simulator Course establishes MAAP as a leader in maritime education and training, ensuring that its graduates and trainees are well-equipped to navigate modern maritime operations.

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QUALITATIVE CASE STUDY OF LECTURER'S ADAPTIVE SKILLS TOWARDS FUTURE MARITIME SPECIALISTS

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Abstract: This study portrays the adaptive skills of a higher-education lecturer striving to train future maritime industry specialists. The paper presents a case study of Maritime University of Szczecin (Poland) lecturers engaged in specialized English language training. This research focuses on adaptability as a key skill of a foreign language lecturer's competences range. The authors intend to bring attention to major concerns related to the idea of language courses customization. It stems from continuous development of maritime industry. Moreover, the specificity of seafaring business poses numerous challenges that require continual adjustment of syllabuses, teaching contents, aids, and resources, thus, inducing a constant need for teaching staff's improvement. The authors propose an approach based on interdisciplinary cooperation between teachers, lecturers, and marine professionals leading to successful networking opportunities. The approach stands in need of mutual support in order to ensure the highest quality of marine training. The authors are willing to open a multilateral discourse and encourage experts in various fields related to the industry since cooperation and exploitation of complementary skills lies at the core of adaptability.

Keywords: adaptability; adaptive skills; maritime industry; maritime training

1. Introduction

The maritime industry is a cornerstone of global trade and transportation, encompassing the movement of goods, passengers, and services across the world's both external and inland waters. This sector is continuously evolving due to technological advancements, regulatory changes, and environmental considerations. As such, the education and training of maritime professionals must adapt to these dynamic conditions to ensure that future specialists are well-prepared to meet the industry demands.

Lecturers in maritime education play a crucial role in this adaptive process. They are tasked with imparting not only foundational knowledge and technical skills but also the critical thinking and problem-solving abilities necessary for the students to thrive in a complex and continuously changing environment. This study focuses on understanding how lecturers in maritime education adapt their teaching strategies and skills to prepare future maritime specialists effectively.

2. Objectives

The primary objectives of this study are to identify and examine the adaptive skills possessed by lecturers in maritime education, and to explore how these adaptive skills influence the training and preparedness of future maritime specialists. There is also an ultimate objective which encloses opening the multi-approach discourse in the scope of widely understood cooperation between maritime industry specialists.

The questions that the study seeks to answer are: What adaptive skills do maritime lecturers possess? And How do these skills impact student learning and preparedness for the maritime industry?

3. Literature review

3.1. Maritime Education and Training (MET)

Maritime education has a long history, dating back to the ancient civilizations that relied on sea navigation for trade and exploration. Over the centuries, maritime training has evolved form apprenticeship models to formalized education programs offered by specialized institutions. In modern times, Maritime Education and

Training (MET) encompasses a broad range of disciplines, including navigation, marine engineering, logistics, and environmental management.

Today, MET faces numerous challenges, including the need to incorporate new technologies such as automation and artificial intelligence, address environmental regulations, and ensure safety at sea. Additionally, there is a growing emphasis on soft skills, such as leadership, communication, and cultural competences, which are essential for effective teamwork and decision-making in a multicultural maritime environment.

3.2. Adaptive Skills in Education

Adaptive skills refer to the ability of educators to modify their teaching methods and strategies in response to changing conditions and diverse students' needs. Key components of adaptive skills include:

- Communication skills: Effectively conveying information and engaging with students.
- Technological proficiency: Utilizing digital tools and resources to enhance learning.
- Pedagogical flexibility: Adjusting teaching approaches to accommodate different learning styles.
- Cultural competence: Understanding and respecting cultural differences in a diverse student population.

Adaptive skills are critical for educators in any field, but they are particularly important in dynamic and highly technical disciplines like maritime education. These skills enable lecturers to stay current with industry developments, address varied student backgrounds, and foster an inclusive and supportive learning environment.

3.3. The Role of Lecturers in MET

Lecturers in MET are responsible for delivering both theoretical knowledge and practical skills training. They are expected to develop and update course content to reflect current industry standards, provide hands-on training using simulators and real-world scenarios, and mentor as well as support students in their academic and professional development.

The effectiveness of lecturers significantly impacts students' outcomes. Well-adapted lecturers can enhance students' engagement, improve learning retention, and better prepare students for the challenges of the maritime industry. Conversely, lecturers who are unable to adapt to changing conditions may struggle to meet educational needs of their students.

4. Methodology

The study is grounded in theories of adaptive learning, which emphasize the importance of personalized and flexible teaching approaches. Key theories include constructivist theory, which suggests that learners construct knowledge though active engagement and experience, as well as transformative learning theory, which focuses on how critical reflection can lead to significant changes in perspective and behavior. These theories provide a framework for understanding how adaptive teaching methods can enhance the learning experience in maritime education. By adopting a constructivist approach, lecturers can create interactive and experimental learning opportunities that are closely aligned with real-world maritime scenarios, which are absolutely essential as far as maritime training is taken into consideration.

This study employs a qualitative case study approach to explore the adaptive skills of lecturers in maritime education. This method allows for an in-depth examination of individual experiences and perspectives, providing insights into the phenomena under investigation. Yet, it is just an introduction and invitation to a widely understandable discourse on the topic. A qualitative case study is particularly well-suited for this research because it enables the exploration of complex, content specific issues. By focusing on a small number of lecturers (the authors) and their experiences, the study can uncover nuanced understandings of how adaptive skills are developed and applied in the context of maritime education.

5. Results

Effective communication is a cornerstone of adaptive teaching. Lecturers who excel in this area are able to clearly explain complex concepts, provide constructive feedback, and foster an open and inclusive classroom environment. Specific communication skills identified include simplifying technical jargon for better student understanding, encouraging student participation through open-ended questions and discussions, as well as providing timely and personalized feedback on assignments and assessments.

The ability to utilize digital tools and resources is increasingly important in maritime education. Lecturers who are proficient in technology can enhance their teaching by incorporating simulations, multimedia presentations, and online learning platforms. Key technological skills include using maritime simulation software to create realistic training scenarios, integrating multimedia resources to illustrate complex concepts, and employing online platforms for collaborative learning and assessments.

Pedagogical flexibility involves adapting teaching methods to accommodate different learning styles and preferences. Lecturers who demonstrate flexibility are able to modify their instructional approaches based on student feedback and performance. Example of pedagogical flexibility include varying instructional methods, such as lectures, group work, and hands-on activities, and adjusting the pace and complexity of the presented topics to the learning skills and abilities of the students.

Traditional approach to maritime education and training has always intended to acquisition and use of practical skills. However, the constantly changing reality enforces continuous adaptability and recognition of varied needs of individual students, their worth in the matter of efficient methods of training and education, and consistent development of lecturers' adaptive skills. All of the aforementioned are the subjects of further research.

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PREPARING MARITIME CADETS FOR APPLYING ARTIFICIAL INTELLIGENCE IN MARITIME EDUCATION

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Abstract: In recent years, technological advancements in artificial intelligence (AI) have been applied broadly in the maritime industry, such as autonomous ships, route optimization, and logistics chain management. The extensive AI applications in the shipping field not only increase efficiency of maritime companies, but also impose challenges on maritime institutions to enhance AI-powered education with maritime settings. In hope, cadets may obtain the proficient skills to navigate through the emerging AI-powered technology. However, so far there is a lack of integration of AI education into the curriculums, such as data analysis, forecasting and computer programming, of maritime colleges. In addition, there are insufficient well-equipped computer laboratories and other facilities to support resource-intensive AI-based fields in most maritime institutions. In this paper, we intend to present challenges of integrating AI-driven technology into maritime education and also propose possible solutions to the issue. We are well aware of the facts that the key elements to successfully build-up the integration of conventional maritime education with AI setup requires collaborative efforts of administrators, faculties, and cadets of maritime colleges. Administrators must demonstrate vision and commitment to make the change, and they also need to allocate sufficient funding from tight school budget to facilitate AI/ML learning. Faculties should acquire the required knowledge and skills to keep up with the latest trend. As AI is a relatively new field, and its complex nature demands a specialized set of skills that may not be readily available among professors of maritime colleges. At Massachusetts Maritime Academy, for instance, none of the approximately 100 faculty members hold a doctorate in computer sciences. And several professors, who have been offering AI classes, such as computer programming, data analysis, quantitative analysis, have solid backgrounds in science, math, and engineering. While they are greatly applauded for their efforts, it is still an undeniable fact that the lack of AI expertise among faculty members remains a considerable hurdle. Furthermore, cadets of maritime colleges must exhibit their determination to acquire new skill sets and be ready for the more testing workforce. The inclusion of more AI-based classes like Computer Programming and Quantitative Methods could increase the burden on already heavily loaded cadets, necessitating a significant redesign of the curriculum to ensure compatibility between traditional courses and AI courses. It is also important for maritime cadets to learn the computer programs like R, Java, Python, etc. so that they are not confined to using menu-driven software. Cadets should also gain hands-on experience by participating in research projects and course assignments related to AI and new technologies, and collaborate with industry partners through internships, research projects, and industry partnerships.

Keywords: artificial intelligence; maritime education; shipping industry

1. Introduction

In recent years, artificial intelligence (AI) and machine learning (ML) has growth exponentially in the shipping industry. According to the latest McKinsey Global Survey, transportation and logistics sectors have kept as a high growth rate as a nearly 25% year-over-year increase in the use of AI as in the other standard business processes, and early adopters with a proactive AI strategy in the shipping industry enjoyed profit margins higher than 5%. As a result, the AI-powered technology has reshaped maritime landscape, offering unprecedented opportunities for efficiency, safety, and environmental sustainability. Furthermore, through AI, the shipping industry is witnessing significant improvements in predictive maintenance, autonomous operations, route optimization, cargo handling, and environmental management. These advancements bolster operational efficiency and contribute to substantial cost savings and environmental conservation efforts. For instance, predictive maintenance can reduce equipment downtime by up to 35%. In comparison, AI-driven route optimization can cut fuel consumption by 5% to 10%, demonstrating the tangible benefits of AI technologies into the maritime facilitations.

It is exciting to observe that the strong AI development in shipping sector is quite in agreement with the nternational Maritime Organization (IMO)'s Strategic Plan (2018-2023). The plan states clearly that a key strategic direction is to "integrate new and advancing technologies in the regulatory framework." This involves balancing the benefits derived from new and advancing technologies against safety and security concerns, the impact on the environment and international trade facilitation, the potential costs to the industry, and finally, their impact on personnel, both onboard and ashore.

While stakeholders applaud the positive impact AI brings upon the maritime industry, they are also acutely aware of the high level of expertise required to effectively apply advanced algorithms and data analysis to achieve optimization objectives. As a result, it has been paramount that we support a call for maritime universities to enhance their AI Maritime Education and Training (MET), so that cadets may obtain proficient knowledge and specialized skills to navigate through this new era of artificially intelligent machines.

This paper intends to study how the AI-powered technology has been applied to the shipping industry and its tremendous advantages brought on the industry with the development. The paper also examines the important role maritime institutions play in the assimilation of AI-powered technologies to the established MET. Using Massachusetts Maritime Academy (MMA) as an illustrative example, this paper analyzes the challenges and barriers that have hindered the extensive integration of AI learning into the existing MET curricula of maritime institutions. The paper further explores strategies for maritime institutions to effectively leverage available resources in order to address the complexities posed by technological advancements and the application of AI in the maritime sector.

The paper is structured as follows: introduction describes the research purpose and contextual background information; Section 2 looks into how exactly AI and ML has been adopted into the shipping industry; Section 3 highlights insufficiencies in integrating computer science with existing maritime curriculums; Section 4 reviews the effective methodologies and results to incentivize maritime universities to implement trainings that promote computational informatics skills and technical literacy for their cadets; Section 5 offers discussion and concluding remarks on maritime preparation for the future of automation.

2. Advantages of AI and ML Adoption in shipping Industry

Nowadays it is a well-known fact that AI and ML has been adopted extensively in the maritime industry. From improving operations to enhancing safety measures, ML and AI are revolutionizing decision-making processes and unlocking new possibilities for the sector's future. In this section, we intend to explain how AI-powered algorithm technology are applied in the maritime settings, delving into their benefits and potential challenges.

Some of the outstanding applications of AI-powered technologies in the shipping industry include but are not limited to, improved analytics for decision-making, automation, safety, route optimization, and increased efficiencies. Advanced analytics are used extensively to make valuable business insights from many data sources, which also helps ensure the decisions to be cost efficient, rent seeking and environmental sensitive.

Safety and improved security are the areas AI-powered technology has been making greatest change. Through constant surveillance using various sensors, AI can detect and respond to potential security threats. By utilizing AI-driven solutions, maritime agencies can enhance their ability to monitor vast maritime territories and respond effectively to emergencies. These advanced initiatives enable real-time analysis of maritime data, empowering authorities to detect suspicious activities, identify potential security risks, and coordinate timely interventions. Consequentially, accidents can be avoided or reduced in a large number.

The power of data allows the shipping industry to forecast and optimize future performance. A good exemplary case is the route optimization. AI-powered algorithms have been applied constantly in route optimization, using methods such as analyzing historical data on shipping routes; weather patterns and sea currents to make predictions about future conditions; applying real-time information on weather, shipping traffic, port availability to plan the most cost-effective routes; and automatically adjusting ships' course to reduce risks of accidents. As route optimization is dependent on a multitude of factors, including fluctuating weather and sea conditions, and real-time data on fuel prices and consumption rates, it requires a high level of expertise and education to effectively apply advanced algorithms and data analysis to achieve optimization objectives with validated accuracy.

AI technology can help reduce carbon emissions, as AI -powered algorithm will choose the most fuel-saving travel speeds and shipping routes given various conditions. AI systems collect data from multiple sources, including weather forecasts, traffic conditions, and historical fuel consumption patterns. By analyzing this data, AI can identify patterns and predict the optimal speed for minimizing fuel consumption. And to reduce fuel consumption not only translates to significant cost savings for companies and consumers, it has significant importance to mitigating climate change and improving air quality, and therefore environmental protection and sustainability of maritime growth in the long run.

It is a great advantage to the shipping industry that AI can analyze data on cargo volume and delivery schedules to improve the supply chain management. By tracking and predicting cargo volumes, AI technologies help optimize load planning, reduce empty trips and offer timelines for goods being picked up, transported, and delivered. By identifying the most efficient times for pickups and deliveries, AI helps minimize wait times and avoids peak traffic periods, and thus AI helps guarantee a better planning and resource allocations.

Generally speaking, by leveraging AI for data analysis, supply chain managers can gain valuable insights into various aspects of their operations. This leads to more informed decision-making, improved efficiency, and enhanced reliability. The ability to analyze cargo volumes ensures optimal resource utilization, route analysis helps in cutting down transit times and costs, and schedule analysis ensures timely deliveries and better customer satisfaction. As a result, AI-driven data analysis transforms supply chain management into a more proactive, efficient, and responsive process.

Despite of tremendous advantages AI technology brings to maritime fields, there are still concerns, even barriers, to the widespread adoption of AI in the shipping industry, similar to what happened in other industries. The biggest concern will be the fear of job replacement and insufficiency of specific talents on the AI and ML trainings and skills. Among other ones, the concerns will include data integrity, information accuracy and lack of clear strategies for a long-term growth. There are also worries that computers and technology will have an impact on the type of jobs being created or replaced, and the kind of work likely shifting when AI is fully adopted. The challenges AI technologies might impose on labor force when workers need to spend time understanding and learning new technology in their workplace. And the industry as a whole will need to keep pace with the innovations of artificial intelligence, the Internet of things, sensor technology, etc.

3. Incorporation of AI Factors into Curriculum of Maritime Education

The technological advancements in AI and its various applications in the maritime industry offer a wealth of opportunities for optimized efficiency. However, an increasingly noticeable fact is the widening disconnect between the rapid distribution of AI innovations being implemented in professional practice, versus AI Computer Science (CS) courses being built into the MET curriculums at maritime institutions. In this section, we will discuss current MET methods and reasons for the ongoing discrepancy between MET reality.

3.1 The Insufficient AI Presence in Curriculums of Maritime Institutes

Despite the buzzing excitement regarding the untapped potential of the AI revolution, in maritime industry, we are unfortunately experiencing limited integration of AI, machine learning (ML), and fundamental CS courses offered in maritime institutions. Computationally capable cadets interested in developing AI tools should have access to courses such as: big dataset collection and statistical analysis; ML predictive forecasting using validated training datasets; and programming computational models with a maritime interface, to the same degree of availability as traditional MET courses for maritime institutions. Additionally, robust funding and expertise is required to maintain high powered local servers, well-equipped CS research laboratories, and the necessary hardware and software to properly support resource-intensive AI-based MET.

This paper uses MMA as our in vivo example. Looking at the current term (Fall 2023), only one in-depth AI course is offered by the academy: AI Programming for Engineering Applications. This course applies computer programming to solve common engineering problems, including: engineering modeling and simulation; motion animations; image processing; network communications. A limited number of ancillary courses do combine AI elements with established curriculums, such as the “Business Data Analysis” class. Additionally, several engineering classes now utilize software applications as an integral part of course requirements. Software examples include computer-aided design (CAD) and Geographic Information System (GIS). Expert command of industry specific software raises the ceiling for cadets who choose to hone these skills, expands their potential job horizons, and benefits maritime optimization.

3.2 Accounting for the Disconnect between industry demand and supply of maritime institutions

It is clear that gearing MET towards AI-oriented framework requires the collaboration of administrators, faculties, and cadets of maritime colleges. While the maritime industry benefits hugely from the applications and commercialization of new AI technologies, maritime institutions are not feeling a strong sense of urgency to transit from convectional MET to AI-oriented setups. This is partially due to the fact that graduating cadets are typically well-trained with necessary skills, and already in demand for employment from maritime companies. Using MMA as an example: senior cadets normally receive multiple job offers upon graduation, and procure such competitive entry level salaries amongst all college graduates across the USA, it becomes challenging to justify a dramatic change to basic educational frameworks and curriculums. Furthermore, the implementation of AI courses requires substantial funding from tight school budgets, adding financial complexity to the transition process.

Faculty members also play a significant role in successful progression and integration of AI into MET for maritime institutions. A general shortage of specialized AI knowledge and formal AI training amongst faculty members remains a critical issue. AI is a relatively new field, and its complex nature demands a particular set of skills that may not be readily available among the professors of maritime colleges. At MMA, for instance, zero of the approximately 100 faculty members hold a doctorate in Computer Science. Professors whom offer AI/ML classes, such as computer programming, data analysis, and quantitative analysis, have solid backgrounds in science, math, and engineering that facilitate transference to CS. It is certainly an undeniable fact that the lack of AI expertise among faculty members remains a considerable hurdle for maritime institutions to efficiently revise their METs and incorporate maritime CS and AI training to keep abreast of global demand.

Instating mandatory AI classes, like Computer Programming and Quantitative Methods, may increase the burden on cadets who are already heavily loaded. As a result, an AI overhaul would require significant changes to the curriculums to ensure compatibility between traditional courses and AI elements, which may be arduous for maritime institutes.

Inadequate financial support for AI education can pose an obstacle for maritime colleges as well. The resource-intensive nature of AI classes would require that colleges allocate special funds to guarantee access and ongoing support to maintain the necessary hardware, software, and infrastructure required for effective AI education and training.

4. How maritime institutions should prepare for AI education

As we meet the AI revolution, maritime colleges must confront the crucial challenges of how to offer students AI fundamentals, such as machine learning, data analysis, computer vision, language processing, and robotics. The seamless integration of AI into maritime education holds the potential to revolutionize industry logistics, offering companies the opportunity to harness the unparalleled power of computer optimization. By doing so, they can enhance their operational efficiency and competitiveness in an increasingly data-driven and automated world. This not only equips them with the cutting-edge skills demanded by the industry but also positions them as valuable contributors to the ongoing transformation of the maritime sector.

The primary objective of higher educational institutions is to empower graduates with the essential skills and qualifications required to ensure success in their future careers within the maritime industry. In the following section, we will delve into strategies and approaches that maritime institutions can adopt to best prepare cadets for acquiring AI knowledge within their MET programs.

4.1 Identifying the most relevant AI trends and integrate them in MET curricula

The realm of artificial intelligence is expansive and intricate, defined by the amalgamation of technologies that blur the boundaries between the physical, digital, and biological realms. Even within the maritime sector, AI applications are influenced by various distinct trends, such as clean energy, maritime robotics, maritime internet of things (IOT), big data & analysis, etc. Therefore, maritime institutions have to determine which trends bear significance for their industry and the feasibility to effectively infuse the trends into their MET.

Here, we will employ MMA as a case study to demonstrate how the academy places emphasis on a key AI trend - big data analysis- and diligently integrates it into its curriculum. MMA authorities, faculties and cadets acknowledge that big data analysis stands as the predominant AI trend pervading the maritime industry. Big data analysis supports various applications in diverse sectors such as supply chain optimization, port management, security and safety, weather routing, vessel routing monitoring, and numerous other critical facets of the shipping industry. Subsequently, in May 2022, department of Maritime Business proposed, for the first time, an AI-powered algorithms class called Data Science and Machine Learning Using R. at MMA.

Data Science and Machine Learning Using R. is a fully explored AI course, designed for business major seniors, using in-depth approach to big data analysis. "The class starts with an introduction to the popular statistical software and programming language, R, and then delves into machine learning algorithms such as classification, nonlinear regressions, generalized additive models, etc." (MMA Registrar Records, 2022). While this class is currently in the midst of formulating proposals and conducting evaluations, several other classes have efficiently incorporated AI components, including R programming and various machine learning techniques, into their curriculum requirements. Courses, such as Business Computation, Data Analysis, and Quantitative Analysis, have made R programming an integral part of their syllabi, with the intention of acquainting students with this statistical computing and graphics language. The MMA experience shows that the progressive integration of AI elements, however gradual, in addition to a fully explored AI course, are evidently proving successful at the MMA campus, altering the classroom environment and standard curriculums.

4.2 To mobilize all resources to maximize the outcome

The 2019 "Global Maritime Professional Body of Knowledge (GMP BoK)" report highlights the top three imperative skills for future mariners and maritime professionals: technical awareness, computing and informatics expertise, and technical competency. In order to empower maritime cadets with these essential proficiencies, maritime institutions must leverage their resources, mainly administrators, faculties and cadets, to seamlessly integrate AI into the established MET framework. Administrators must demonstrate vision and commitment to drive the change, faculties master the required knowledge to keep up with the trends, and cadets exhibit their determination to acquire new skill sets and be ready for the more testing workforce.

Understanding the significance of the AI revolution and its applications in the shipping industry is crucial for leaders of maritime institutions. This knowledge empowers them to make informed decisions regarding the integration of AI into both their operational processes and educational curricula. The leaders of maritime institutions should encourage their universities develop a practical curriculum that seamlessly blends existing coursework with AI education. Given the demanding academic workload typically found in most maritime programs, crafting a well-rounded curriculum that covers all essential aspects of maritime education, including AI learning, can be a formidable task. Furthermore, these leaders should allocate financial resources for the establishment of AI laboratories, procurement of necessary software, recruitment of new computer science faculty members, and the facilitation of curriculum adjustments to embrace this emerging trend.

Maritime faculties should play a critical role in the transition and change. However, many faculties, particularly those who were trained conventionally, struggle to keep up with the latest technological advancements. To overcome this, faculty members should keep themselves informed of the latest developments in AI and related technologies. Faculties should be engaged in continued scholarship, such as attending conferences, reading research papers, and keeping in touch with industry experts. To stay on the top of trend, faculties can gradually incorporate AI into their coursework by developing AI-related assignments and projects, and assigning relevant case studies and collecting real-life examples into their lectures.

There are several measures maritime cadets can take to prepare themselves for successful career developments at the new AI era. First of all, they must take AI-based courses, such as machine learning and data analysis. Cadets should be familiar with commonly used computer programs like R, Java, Python, etc. This will help them develop the skills to tackle the problems like route optimization, which requires sophisticated AI-powered algorithms to figure out the efficient shipping routes, using the data on weather patterns, sea currents, shipping traffic, and port availability. Secondly, they should gain hands-on experience by participating in research projects related to AI technologies. One good example is that one statistical course project gained big popularity among students when they were required to finish the assignment with three key requirements: a linear regression modal, a randomly generated dataset and the R programming language. Thirdly, cadets should collaborate with industry partners through internships to stay current with the latest developments. As we move into the AI age, maritime colleges are confronted with a critical challenge of offering students AI fundamentals, such as machine learning, data analysis, computer vision, natural language processing, and robotics. The ultimate goal is to equip graduates with essential skills and qualifications to make sure of their successes in the future careers. How much the objective can be achieved depends very much on the collective efforts of school leaders, faculty, and students of maritime institutions.

5. Conclusion and Discussion

The aim of this research is to understand that, while AI-powered algorithm technology can lead to significant industry-wide improvements in shipping efficiency and increasing profitability, they also impose huge tasks on maritime institutions to make compatible changes. Maritime colleges feel the urge to scrutinize the sustainability of ME. This would enable the future maritime workforce to possess the necessary skills, expertise, and requisite knowledge to embrace the challenges brought about by a new horizon of AI-powered technology. To achieve the goal, it is instrumental for administrators, faculties and cadets of maritime institutions to make the continued efforts to incorporate the new technology into established MET.

The AI-powered algorithms are unquestionably effective tools that provide substantial benefits to the shipping industry, and as a result, maritime institutions are eager to incorporate more AI and machine learning into their curriculums. Nevertheless, it is equally essential to instill ethical and social awareness among students regarding the consequences and obligations of employing AI in maritime settings and even in daily life. For instance, some educational institutions have expressed concerns about the potential for new technologies like ChatGPT to enable plagiarism. Given the recent introduction of this technology, it is helpful to have a comprehensive discourse regarding the advantages and disadvantages of adopting AI-powered algorithms and AI technology more generally.

It is certainly exciting to live at the age of this huge AI revolution, which bring about amazing changes constantly, such as higher productivity, and faster growth. At the same time, we do feel the responsibility of thinking through the possible issues associated with the implementation of AI-powered technology and impose proper rules to regulate their applications. We hope to elegantly optimize the advantages of machine learning developments, while foreseeing and proactively mitigating disadvantages.

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EMPOWERING EFL LEARNERS THROUGH DIGITAL STORYTELLING (BASED ON THE BSMA EXPERİMENTAL STUDY)

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Abstract: The objective of this paper is to investigate how the EFL Learners are empowered through digital storytelling, drawing on insights from the BSMA experimental study. Currently, Digital storytelling is one of the leading approaches in the English as a Foreign Language (EFL) education, since its integration in the language learning process enhances and empowers learners' motivation and engagement turning the learning environment into a meaningful and enjoyable process. Above and beyond, this method equips learners with the development of 21st century contemporary skills such as: 4 C's- critical thinking, communication, collaboration, and creativity. Moreover, these skills are related to higher-order thinking skills of Bloom's taxonomy and are essential ones to showcase deeper understanding, apply knowledge in the context, etc. To measure EFL learner's fluency practice an experimental study was conducted with two target groups one producing digital stories and another traditional. The study revealed that those target group students who were engaged in creating digital stories experienced improvements in their productive skills and the used platform was the facilitator for communication and self-expression. Based on the findings of the study, digital storytelling should be incorporated in EFL curricula considering its positive outcomes compared to traditional methods of developing students' fluency practice.

Keywords: digital Storytelling, EFL education, Bloom's taxonomy, productive skills, fluency practice

1. Introduction

Story-telling has always been applied in English as Foreign Language Classroom as an effective tool for developing students' productive skills, in particular speaking skills resulting in EFL empowering learners through improved oral practice. Traditionally story-telling has been an integral part of Foreign Language Curriculum since it comes in tandem with fostering speaking skills and requires from the learners to employ their creativity while developing stories based on covered topics. For effective story-telling in English the learners need to be able to think critically around the topic of the story presented by them through applying low and high-order skills of Bloom's Taxonomy (Remembering, Understanding, Applying, Analyzing and Evaluating). Besides, learners need to use creativity in order to design an original content of the story for better engaging the audience and meeting their expectations through effective communication of the message one intended to send through a particular story and ensure proper understanding by the recipients, i.e. decoding the message encoded in the story. Lastly, effective story-telling in English also involves collaboration with the audience through asking questions to elicit the received information and calling for immediate feedback to check their comprehension of the communicated message either direct or indirect through story-telling. Hence, Storytelling in parallel to developing EFL' learner's productive skills also contributes to developing 21st century skills, in particular critical thinking and creativity, together with communication and collaboration.

Since in the 21st Century EFL classroom the forms of story-telling has changed from traditional into digital storytelling, we have decided to explore the outcomes of integrating digital story-telling in EFL Classroom during the instruction of General English at Batumi State Maritime Academy. With this purpose, an experimental study was carried out with the participation of two target groups of EFL Learners from BSMA - one tasked to create a traditional story, whereas another - to produce a digital story. To measure EFL learner's fluency practice an experimental study was conducted with two target groups one producing digital stories and another traditional. The findings of the study can serve as a justified proof for diversifying existing General and ESP English Curriculum at BSMA with innovative and more effective strategies for developing EFL learners in the 21st century and empowering them with an opportunity or better expressing themselves and engaging audience via digital story-telling.

2. Literature Review

Digital storytelling v. traditional storytelling

A story spoken orally and transmitted orally from generation to generation is called storytelling. According to Dujmović (2006), storytelling is the skill of conveying a narrative orally rather than by reading. Because storytelling offers so many chances to engage listeners and turn them from passive hearers into active participants, it is quite different from reading stories aloud (Daniel, 2007). The use of speech, gestures, facial expressions, eye contact, and engagement to link a tale with listeners is also how Hsu (2010) defines storytelling. Therefore, storytelling is a two-way communication between the storyteller and the audience, during which the storyteller must elicit input from the audience by using the skill of storytelling. Regardless of the recollection, skill, or intention of the storytellers, storytelling is always changing (Anderson, 2002). The storyteller may alter the narrative according to his preference for location and specifics, as well as the audience's reaction to him (Dujmović, 2006). The tools that the storytellers employ are voice projection, facial expressions, and hand gestures; the building blocks are words, sounds, and linguistic patterns; and the final outcome is the production of shared human experiences (Choo, B. Y., Abdullah, T., Abdullah, M. N).

Because it stimulates students' imaginations and mental images of the narrative, oral storytelling is an effective teaching and learning method. Oral storytelling allows pupils to relate the narrative to their own experiences and get an understanding of human behavior, claims Dujmović (2006). Through the narrative, the children gain mastery of vocabulary and reading comprehension abilities, but they also gain an understanding of the fundamental truths about human relationships and how to interact with others. Digital storytelling is proposed as one option that uses today's technical affordances to make technology a relevant teaching and learning tool (Harriman, 2011).

One significant way that digital storytelling varies from traditional oral storytelling is the utilization of technology. Although they employ distinct methods, oral and digital storytellers both present their tales to audiences orally. Digital storytelling is defined by McLellan (2006) as "the art and craft of exploring different media and software applications to communicate stories in new and powerful ways using digital media", but Robin (2011) defines it as just the act of telling stories through computer-based tools. As a result, digital storytelling differs from oral storytelling in that it makes use of technology to improve the tale.

The audience's involvement is another distinction between digital and oral storytelling. When a narrative is told orally, the listener must mentally picture the tale in order to comprehend it. They may find this to be a very difficult cognitive task, which would make them passive listeners (Sundmark, quoted in Wallin, 2015). But with digital storytelling, the viewer may see the images and hear the soundtrack or music to have a more vivid understanding of the narrative. According to Rule (2010), digital storytelling is effective because it combines voice, narrative, music, and visuals to give people, circumstances, experiences, and fresh insights into life.

3. Method

This research project investigated the impact of digital storytelling on student engagement and outcomes. The objective aimed at evaluating benefits of digital story-telling in contrast to traditional forms of narration. It focused on exploring the potential of digital storytelling as an innovative teaching and learning approach and its potential to enhance student engagement and student outcomes.

For the purposes of an experimental study the Convenience Sampling was applied, which considered selection of volunteer student participants based on their availability and accessibility. For effective comparison and evaluation of the results of the experimental study, an online quantitative survey was used. The participants of the experimental study were kindly asked to fill in the evaluation form which assisted us analyze the results and draw a conclusion. Participants evaluation survey is accessible on the following link: https://forms.gle/mr1Gczy45fMJZPEbA

Application of this method is justified due to its usefulness for collecting primary data and secondary through obtaining student's insights via google-link form in a quick and efficient manner. Papers have to be written in good English using either UK or US spelling. The minimum length of the paper should be about 8 pages and maximum length should not exceed 10 pages including illustrations, tables and references. The file size should not exceed 10 MB.

3.1. Data collection and procedure

This research was based on the experimental study conducted at the base of foreign language students of Batumi State Maritime Academy. Two experimental groups were formed of volunteer students from the faculties of Navigation and Business and Management Faculties. The experiment which was carried out during Spring semester 2024 included 20 Intermediate level students. Two experimental controlled groups were provided detailed instructions based on the assigned story-telling method. The topic of the story was "XXI Century School".

Target Group 1 was divided into two sub-groups: a) Digital Story-tellers; b) Traditional Story-tellers. The students from subgroup a) were asked to make up a story in relation to the recently covered topic (Extraordinary School for Boys, Unit 7 English File Intermediate) and were encouraged to present the final product by using available mobile software applications. Students from subgroup b) were asked to make up a story using realia in relation to the recently covered topic Extraordinary School for Boys, Unit 7 English File Intermediate, after which they were encouraged to present the final product through performance in the class, which was recorded in the class. The same procedure was followed in the case of Target Group 2 with its sub-groups.

Recorded videos of the traditional and digital stories could be provided upon request with the agreement of participants.

3.2 Analysis of Results

Traditional storytelling (https://forms.gle/CDX4NVi5T528Q3RD8)

On the first statement - "On the scale 1-5 mark how involving you found the story-telling process? - 60 % of the surveyed students (traditional storytellers) marked point N 4; whereas 40 % marked level 3, which shows that the majority of the respondents found the storytelling process involving.

On the statement 2 - 'On the scale 1-5 mark how you enjoyed the process of making and telling the story?' 60 % of the respondents marked level 3, whereas 40 % marked level 4, which highlights their neutral satisfaction towards the task.

On the statement N 3 'On the scale 1-5 mark how well you understood the topic you were talking about?' 60% of the surveyed respondents marked level 4, whereas 20% marked level 3, and 10% marked level 5, which demonstrates that the majority of them quite well understand the topic similarly to digital storytellers.

On the statement N 4 'On the scale 1-5 mark how independent and empowered you felt while completing the task?' 60% of the respondents marked level 4, whereas 30% marked level 3 which shows their autonomy while completing the task.

On the statement N 5 'On the scale 1-5 mark which skills did you improve mostly in the story-telling process?' The respondents chose the following order: Communication and collaboration (70%), Conveying the message(50%), Critical thinking and Creativity (20%), structuring a story(30%). So, as we see from traditional storytelling, students mostly develop communication and collaboration since it was a group task and of course they also improve the method of conveying the message to the audience.

As for the **Digital Storytelling** analysis the data is following:

Digital Storytelling (a google doc link: https://forms.gle/Fpgm45ohNuBJV6ov7)

On the first statement - On the scale 1-5 please mark how involving you found the story-telling process? - 70 % of the surveyed students (DIGITAL storytellers) marked point N 5; 30 % marked level 4, which shows that digital storytellers showed a higher concentration at the highest level of involvement compared to traditional storytellers, who had a more evenly distributed response between points 3 and 4.

On the statement 2' - How you enjoyed the process of making and telling the story?' all the respondents marked level 5. In this case, digital storytellers were notably more enthusiastic and satisfied, where all the participants indicated the highest level of enjoyment, whereas traditional storytellers were mostly satisfied showing a bit more variability in their responses.

On the statement N 3 'How well you understood the topic you are talking about?' 100% of the surveyed respondents marked level 5, showcasing a higher consistency and depth of the knowledge, whereas traditional storytellers indicated good understanding.

On the statement N 4 ‘How independent and empowered you felt while completing the task?’90 % of the respondents marked level 5, and only 10% marked level 4. In this case, digital storytellers expressed a higher level of empowerment with the majority level indication the highest level, suggesting a more pronounced sense of autonomy and empowerment during the storytelling process, whereas traditional storytellers

On the statement N 5 ‘Which skills did you improve mostly in the story-telling process?’ Most of the respondents chose Communication and collaboration (80%), Critical thinking and Creativity (70%), Conveying the message (40%), Creating engaging scenarios (40%), Structuring a story (30%). These findings depict enhancing skills for effective communication and creative expression.

3.3. Discussion of Study Results

An experimental study on Empowering EFL Learners through digital Storytelling (based on the BSMA experimental study) resulted in the following significant outcomes: firstly, it showed us that digital storytelling can make second language acquisition more engaging than traditional method of storytelling. At the same time the students expressed their enjoyment with the process which can be a positive characteristic of the innovative method of digital storytelling.

Digital Story-telling can complement the learner's creativity, involvement and enjoyment allowing them to express their thoughts and ideas in a free and fluent manner in a more personalized and innovative way, which will result in deepening their language understanding through developing critical thinking skills.

On the whole, the study demonstrated the visible benefits of integrating innovative approaches to enhance language learning outcomes through practicing digital story-telling and empowering learners through fostering a more dynamic and inclusive learning environment.

4. Conclusion

Based on the findings of the Experimental Study we can conclude that our Institution showcased a significant potential for integrating Digital Storytelling as a powerful tool for empowering EFL learners through enhancing their language learning experience. The results of the experiment show that productive language practice through integrating Digital Storytelling can lead to increased language proficiency, student involvement in the language learning process and creativity.

The study highlighted students’ increased ability to enhance language skills through digital story-telling leading to more meaningful and interactive language learning processes focusing on development of so-called 21st century 4 skills, i.e. creativity, critical thinking, collaboration and communication.

The experiment at the same time one again made us aware of an increased potential offered through innovative pedagogical approaches that can add to EFL instruction and facilitate learners to become more confident and effective communicators in the target foreign language. Furthermore, based on the outcomes of the experimental study it will be advisable to continue further research and offer more professional development training to educators to facilitate more effective integration of the Digital Storytelling in their classroom practice and ensure that the latter can be more engaging and up-to-date learning practice.

On the whole, this very small scale local though valuable study due to its limitations brought to the surface transformative outcome of integrating digital storytelling in the EFL learning process at the example of the BSMA experimental group. It also highlighted the significance and an absolute necessity of integrating technology-assisted language teaching methods for creating a dynamic and inclusive learning environment and empowering learners to achieve more on their language learning journey.

Acknowledgements

The authors would like to extend gratitude towards the Faculties of Navigation and Business and Management of Batumi State Maritime, which supported the authors with undertaken publishing costs.

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IMPLEMENTATION OF A LIGHTBOARD STUDIO IN MET: A CASE STUDY AT JADE UNIVERSITY OF APPLIED SCIENCE

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Abstract: In this case study, we outline the process of setting up and launching a new Lightboard Studio (LBS) at the Jade University of Applied Sciences, the Department of Maritime and Logistic Studies in Elsfleth, Germany. The time span from the initial planning until completion the fully operational LBS expanded from September 2022 to December 2023. Using the Lightboard as an innovative presentation tool and central component of the LBS, the set-up process, including requirements assessment, structural and technical implementation decisions will be described to provide a good-practice example for guidance in similar endeavors in the Maritime Education and Training (MET) context. Furthermore, the challenges that emerged from the pilot use trials will be discussed, together with the solutions for optimising the effectiveness of the tool for potential users, as well as for the overall user experience and quality of results. Finally, the first results of a small pilot survey on end-user satisfaction with the LBS will be provided.

Keywords: Lightboard, LBS, Instructional video, MET, digital content, STEM subjects.

1. Introduction

Educational videos, especially during and after COVID pandemic are becoming increasingly important in most of the MET institutions, being considered as a popular learning means of communication. An instructional video for learning purposes is a modern visual tool designed to transfer knowledge, by teaching students specific concepts, skills or describing a process. For the purpose of educational content creation and digitization of the educational process, a lightboard was implemented and tested at Jade University of Applied Sciences (Jade UAS), Germany. The lightboard is a new tool that allows Users to write and draw during the recorded presentation while facing a camera, creating a dynamic and engaging experience for viewers. A "lightboard video" can be described as a short educational digital supplement to a course content, having a recording length of 3-6 minutes (Guo, P. et al., 2014). "What is the ideal length for a video?" is probably one of the most common questions asked by the staff (Dinmore S., 2019). From the authors' experience, the duration should be limited to a maximum of 10-12 minutes, mainly for three reasons: firstly, the limit imposed by the size of the writing board surface, secondly, due to the very short attention span of today's society and thirdly, because a short video will save valuable time in the post-production.

The initial idea to set up a LBS in the Faculty of Maritime and Logistic Studies, originated from the relatively modest performance of students in Science, Engineering, Technology and Mathematics (STEM). Although additional tutoring and pre-courses have been introduced, students' performance in mathematics, for example, has not improved notably and continues to be a challenge. As our actual students are part of digital native Gen Z being online & connected most of the time, a new idea has begun to crystallize: if some of them prefer to watch videos on various online video-sharing platforms instead of reading the bibliography or available scripts, then they would probably prefer to watch recorded videos as well. This could be justified by the fact that recorded lectures are free from time constraints and students have control over the lecture, such as pausing, revisiting etc. (Cardall, S. et al., 2008). So why not trying a different type of instructional videos the students can watch anytime, anywhere, more engaging and tailored to their needs, that differ from "classic" screenshots with static images or live recording lectures that lack of interactivity? This idea would bring more "visualisation", a fundamental concept in most of STEM subjects. Visualisation has always been considered as a powerful tool for understading and perception. A great quote, extension of an old familiar adage attributed to Fred R. Barnard in 1920 said: "If a picture is worth a thousand words, then a video is worth a million" (MacFarland, S., 2014). Based on this hypothesis, the authors aimed to test whether, with the new "lightboard videos", students would be more motivated and their performance would increase steadily and on a large scale. With this in mind, a LBS concept has been implemented and tested at Campus in Elsfleth.

The research questions the paper tries to answer were: “Does the use of lightboard videos improve student performance, by influencing students' learning & expectations in a positive manner”? and “Does this innovative technology offer an example of good practice to guide similar initiatives in the context of MET?”. The answer to the first question should support the research conclusions of Poquet O. (2018): “A stronger positive correlation between video use and student performance was empirically established empirically when videos were used as a supplement rather than a substitute for lesson participation”. Our findings will be provided at the end, in a small pilot survey, by investigating students' perceptions about the LBS and its effective use.

2. What is a Lightboard?

The Lightboard originated at Northwestern University USA, where its inventor, Prof. Michael Peshkin, created in 2013 a “Light Board” to stimulate and enhance the visual connection of engineering students watching his course videos. In 2014, Prof. Peshkin made the Lightboard technology available online as an open-source initiative (http://Lightboard.info). By promoting the Lightboard as Open Source, Peshkin’s website has fostered a collaborative and reciprocal environment of idea sharing and design documentation of Lightboard construction around the world (McCorkle &Whitener, 2020). Even though he is credited with the invention, another professor from San Diego State University, Dr. Matt Anderson, has simultaneously and independently arrived in 2014 at the same solution within a pilot project called “Learning Glass”. In 2015, Dr. Anderson founded his own company "Learning Glass" and has been producing lightboards ever since.

Basically, a “Lightboard” or “Learning Glass” is a transparent glass board, made of a special tempered Starphire low-iron glass, surrounded by small LED lighting strips attached to a metal sturdy frame that illuminate the working surface. The user can write on the lightboard the same way as in case of a classroom blackboard or whiteboard. However, when use special neon fluorescent markers and the room is completely dark, the handwriting ink on the board will glow and the colors become clearly visible thanks to the LED lighting. In a Lightboard Studio, the lightboard is located between the user and a camera, so that the Presenter always faces the camera, looking directly through the glass. While the handwriting is initially backwards to the audience, the text or image on the board is digitally mirror-flipped to the correct orientation by using computer software or by pointing a camera directly at a mirror while recording (McCorkle & Whitener, 2017).

3. Timeline of setting up the Lightboard Studio in Elsfleth

The roadmap of setting up the LBS started in September 2022. As in any other new project, a structured timeline was created to guide the whole process from the conception until the completion of the project. The duration was estimated initially to 12 months, but after revisiting & adjusting the time line in accordance with the results from the pilot use trials, it turned out that the duration should be 16 months to complete the project successfully and get an operational LBS. The structured time line can be broken down into four main phases, with their corresponding key activities, as indicated graphically in the infographic Figure 1 below:

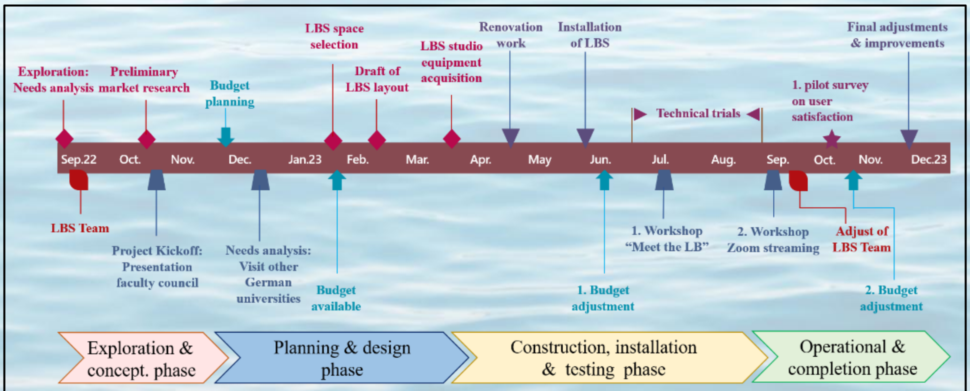

Figure 1. Timeline of implementation and setting-up the LBS in Elsfleth.

3.1 Exploration (3 months)

This conceptual stage of the project consisted of the following activities:

- *Identification of project team members.* Two full professors, together with one student assistant with extensive previous experience in digital media production have decided to form the LBS team (Sept. 2022).

- *Needs assessment: Market analysis & benchmarking of similar projects at German universities.* A preliminary online market research was conducted to analyse and compare the available lightboard types, their characteristics and their acquisition price (Oct.2022). The LBS team found that the implementation of an LBS is a relatively new practice in Germany and the closest university with a lightboard is HAW Hamburg, Faculty of Life Sciences. The HAW Campus Bergedorf was visited by the first two authors in December 2022, the feedback being excellent, with clear answers to questions on reliability, long-term running costs, customer service and technical problems encountered. At the same time, best practices of other LBS projects at German universities were analysed, such as Technical University of Munich (TUM) and Flensburg UAS, which claims being the first university in Germany to have installed such a system (Christiansen R, 2017).

- *Presentation in the Faculty Council.* In October 2022, the corresponding author presented in front of Faculty Council the results gathered in the exploration phase, together with an initial project implementation timeline. The aim was to promote the project at faculty level and to engage colleagues in discussions to provide feedback on the management plan and proposed timeline.

- *Budget planning.* Possible funding sources were identified to determine an estimated budget: on one hand, the Ministry support for a new professorship position (Jan. 2023) and on the other hand, an internal partially funded project about visualization in mathematics JADE-proBLEM (June 2023).

3.2 Planning & design (4 months)

This stage focused on needs assessment (process of lightboard procurement and decision about the technical & structural components needed to set up a LBS) and on space selection and drafting a layout of the studio. The key activities in this phase have been as follows:

- *Assign tasks & responsibilities.* Each team member received a list of tasks and responsibilities, with clear deadlines in accordance with the project management timeline.

- *Decision about dedicated LBS space.* Despite the fact that finding a free or under-utilized space in a university is usually a challenge, a former logistics lab of about 35 square meters in the faculty main building was identified, enough to house the lightboard and associated technical equipment.

- *Draft of the LBS layout.* For an effective space utilization, an initial space evaluation together with zone planning, furniture and equipment layout was made. The lighting conditions were analysed, a division of space into designated zones was suggested and position of camera and other equipment was clearly marked on the floor. A cable management was made on routes that will not interfere with movement of people inside the LBS.

- *Acquiring resources & tools.* Requests for price quotes have been sent out to various lightboard manufacturers which were then analysed and compared. A large-size lightboard panel was emphasized in the technical documentation, to cover the need for a large writing surface, requested especially in STEM subjects. At the same time, a list of the main technical components needed for the studio was compiled and the procurement process was carried out (March 2023).

3.3 Construction, installation & testing (5 months)

This execution stage was based on technical & structural implementation decisions made in previous phase. A small renovation work was executed on the selected space, consisting of painting two walls in matt black and sealing a connecting door to an adjoining classroom. Initially, the room was not acoustically treated. Focus was placed on the lighting, with two barndoor LED lights mounted on tripods to the left and right of the lightboard table. In addition, a robust IT support for editing and storage solutions was implemented, including network and data backup systems.

After the installation (June 2023), the whole system was technically tested in several pilot trials to troubleshoot any issue that may occur with audio, lighting or video quality. A hands-on “Meet the Lightboard” workshop has been conducted by LBS team in July 2023 with all teaching and administrative staff in the Faculty. The aims were, on the one side, to make sure all equipment is working as intended and on the other side, to familiarise the faculty members with the lightboard technology and provide them with best training on equipment usage and workflow in LBS. However, some challenges were identified during these tests, including the workshop, that had to be considered and dealt with by the end of the project. Among them, light sources that caused reflections in the glass board, poor room soundproofing or a too small size of the confidence monitor.

3.4 Operational & completion (4 months)

In this last phase, the LBS has been brought to an operational state, with necessary adjustments & improvements made and all previously observed deficiencies rectified:

- A second workshop was conducted in Sept. 2023, this time in a live Zoom streaming format, addressed to the whole Jade UAS. The goal was to promote the LBS at university level and to offer colleagues from the other 5 faculties the opportunity to gain insight into the new digital media production technology.
- To eliminate any source of light and ensure complete darkness during recording, a second row of window curtains was installed along with a backplate fitted behind the production desk.
- Two additional cameras were added, to enhance the production quality and versatility of the digital content.
- For sound insulation, the room was equipped with large, aluminum sturdy-framed sound-absorbing canvases (200cm x 200cm) on walls shared with other classrooms, along with a black sound-absorbing backdrop in the middle of the room and some loose-filled wool insulation in the cabling ducts.
- A rigging traverse system was installed, to create more space around the lightboard and to offer a 3-point lighting scheme together with a better sound;
- The LBS team has been expanded with a second assistant, whose main tasks now include operational management tasks (implementation of an online booking system), documentation tasks (preparation of a quick setup and troubleshooting guide) and feedback collecting task, all to ensure the smooth running of the LBS.

Implementing and setting-up the LBS was a complex, multi-step process that required careful planning, coordination, and resource management. The description above has been offered to guide readers in similar endeavors in a MET institution.

4. Layout and main components of the LBS

The LBS is installed in room W206 of main building of the Jade UAS, Faculty of Maritime and Logistic Studies in Elsfleth. The room operates both as a recording area for lightboard videos and for podcasts/interviews and promotional videos. A floor plan of the designated room is given below in Figure 2. After the full implementation stage, completed in Dec.2023, the LBS contains the following main equipment:

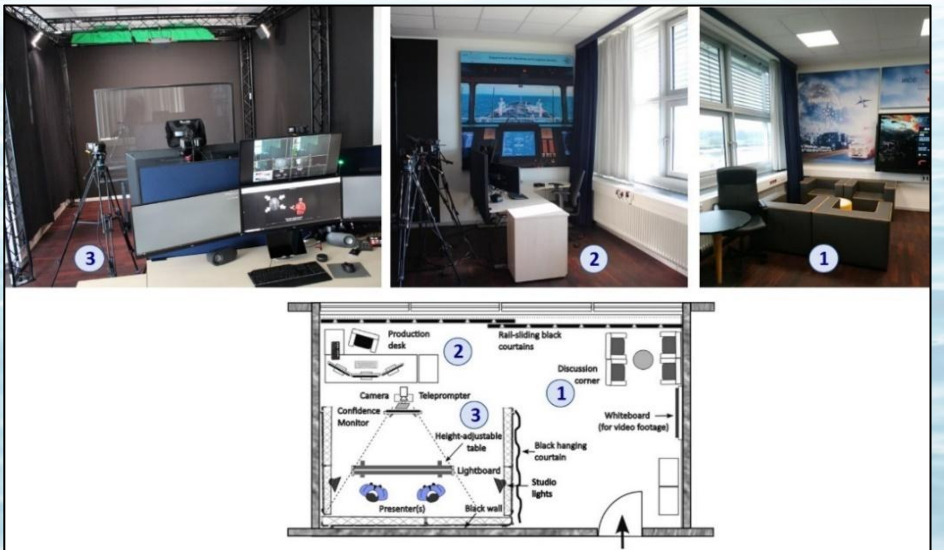

Figure 2. Floor plan of LBS in Room W206 in Weserstraße 52, 26931 Elsfleth

Recording space: The heart of the studio consists of a 88”-size lightboard with integrated LED-lights, having a working surface area of (194 cm x 109 cm), mounted on a mobile motorized height-adjustable table (Figure 2 / 3). The recording area’s back and side wall are painted in black, and the additional inner wall consists of a black curtain hanging down from the rig. To reduce the number of tripods inside the studio’s recording space, all relevant equipment is mounted on a rigging traverse system. The process is monitored and supervised from the production desk, located in front of the lightboard, about 4m away (Figure 2 / 2).

Lights: Besides the LED lights illuminating the lightboard, additional studio lights were installed to light the Presenter's face and minimize shadows. During the completion phase and installation of the rigging traverse system, the initial setup with two barndoor LED lights mounted on tripods was replaced by a 3-point lighting scheme. Using this technique, each source illuminates a separate dimension of the Presenter and creates a three-dimensional video with greater height, width, and depth, eliminating unsightly shadows.

Video: A Stream Deck is placed on the lightboard table to enable the User to control the presentation (Figure 3). For capturing the Presenter and the content written on the lightboard, three High-Definition 4K Sony Camcorders are available in the studio. To reduce reflections on the glass, each camera is fitted with a CPL polarising filter. For the multiple camera angles and inputs, three video splitters were installed to allow for switching between views. To assist Presenters with their script, one camera is equipped with a Teleprompter on Android-tablet base, which is controlled by a simple footstep controller. To monitor the User’s presentation and the images projected on the Lightboard, a 55” TV screen is placed underneath the main camera. This screen acts as a “Confidence monitor”, an essential tool for Presenters, offering real-time visual feedback and allowing for immediate adjustments to improve the quality of the presentation.

Audio: To be sure that the audience can clearly hear the Presenter and the sound quality is good, high-quality microphones have been purchased for the LBS. Either a directional condenser microphone, which was originally placed on a tripod next to the Lightboard, or two lavalier microphones, which are clipped directly to the User's shirt, can be used. After adjustments were made in the completion phase, the directional microphone was hung above the Lightboard and mounted on the rigging traverse system.

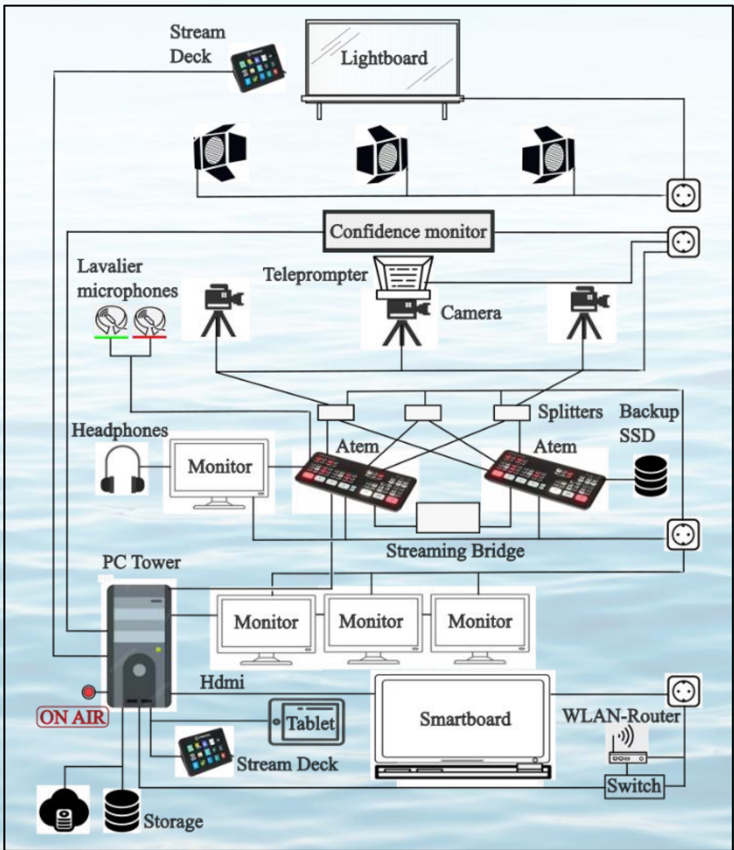

Figure 3. Block diagram of LBS architecture

Production desk: The main element is the computer tower, connected to the university network via a WLAN router. A large Smartboard, for the raw footage visualisation, is connected to computer via an ultra high speed HDMI cable. An ON AIR color-adjustable light can be found outside the room W206, together with a monitor light on the production desk. Here you can find speakers for sound monitoring as well. To share the camera and microphone output to the computer tower, two ATEM Mini Pros record the media input, one giving a direct output signal to the Editing Computer, while the other ATEM is recording to a SSD hard drive as a footage backup. All filming is handled with Open Broadcaster Software (OBS), a free open-source software designed for video recording and live streaming. OBS is used to visualize the final recording, including graphics or PowerPoint presentations that are not directly visible to the Presenter on Lightboard. The Editing Computer uses three monitors for controlling the recording with visualizations like PowerPoint, pictures, diagrams or other videos, Audio & Video mixing and afterwards editing the whole process. A fourth monitor is connected as ATEM control monitor directly to the ATEM to observe the camera inputs (Figure 3). A tablet is used on the production desk to supervise the Teleprompter.

5. Advantages and drawbacks of using a Lightboard in Maritime Education and Training

From the perspective of board development, the lightboard can be seen as a transition in the evolution of teaching aid's, from blackboards to chalkboards and then to whiteboards. In comparison with these educational boards, the lightboard offers several compelling advantages, particularly in the context of MET. The maritime industry involves intricate and detailed maritime science subjects, such as navigation, ship theory, meteorology, cargo handling, or maneuvering, which can benefit significantly from the visual and interactive nature of a lightboard. The versatility of the lightboard makes it suitable for a variety of other applications in MET, such as simulator's familiarisation, maritime expert's interviews or promotional videoclips where any maritime shipping-related event can be promoted on the university website. Some of the key success principles of using lightboard videos in MET are indicated in Figure 4 and include:

Direct interaction (Eye contact & gaze guidance)

Unlike any other educational board, you'll always have a better direct interaction with your learners. Presenters face towards the audience and maintain eye contact while writing or drawing in real-time on the lightboard, as opposed to turning their backs as they would with a traditional chalkboard or whiteboard. The students learn better from a videoclip when the Presenter shifts gaze between audience and the information written on board (van Wermeskerken & van Gog, 2017).

Non-verbal communication

Similar with lecturing using a classroom chalkboard, the lightboard takes advantage of the presenter's personal style (gestures and speech). But what's remarkable about lightboards is that the audience can see the Presenter's facial expressions, gestures and body language at all times. This is a clear pedagogical benefit and research evidence suggests that gestures and speech are deeply integrated with cognition-dynamic drawing and gaze guidance principles (Mayer, 2020). The videos are more effective and engaging when viewers can see the facial expressions and body language of the lecturer (Guo P. et al., 2014).

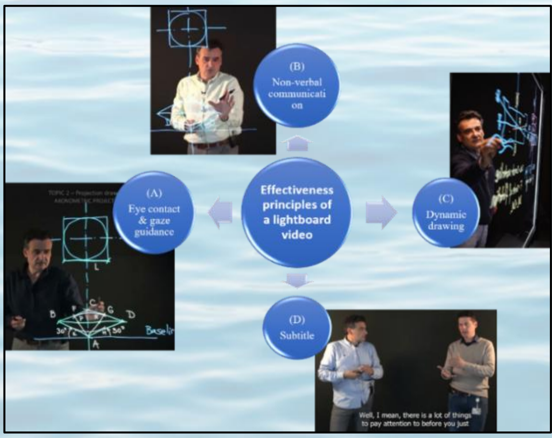

Figure 4. Some of the principles that ensure the success of a lightboard video.

Dynamic content delivery

A lightboard works best for subjects that demand dynamic visual representations, such as STEM subjects. In maritime education, besides maths or engineering, the dynamic drawing allows for real-time demonstrations of changing scenarios, such as weather routing or trim optimisation. It enables the Presenter to draw and annotate live, making complex concepts easier to explain and understand. However, this advantage is also beneficial for non-technical subjects, such as maritime law or intercultural communication due to lightboard's unique ability to illustrate abstract concepts or models in a visually appealing manner. A study made by Fiorella L. highlights that students learn and perform better from an instructional video when the onscreen Presenter draws "live" graphics on the board while lecturing, versus pointing to previously created, static images (Fiorella L & Mayer R.E., 2016).

Subtitle principle

Subtitles serve as an effective supplement to the visual and auditory content of a lightboard video. Subtitles are usually added to an educational video that contains speech in the Presenter's or student's second language (Mayer R.E., 2020). It is expected that students learn better from a video offered in a second language when printed subtitles are added or used to replace spoken words. Incorporating subtitles in lightboard videos not only makes the content more accessible and inclusive but also enhances the learning experience by providing text-based reinforcement of spoken words.

At the institutional level, the setting up of the LBS has brought for Jade UAS other competitive advantages such as a new teaching methodology, accessibility to a wider audience or an increased marketing potential. This way, the Maritime Faculty in Elsfleth demonstrates the trend towards innovation and creativity, providing an educational experience aligned with the needs and expectations of today's and tomorrow's global maritime professionals. Although lightboard videos offer many advantages for improving learning outcomes in MET, like any new technology, they also have some potential drawbacks that should be considered. Based on the authors' experience gained so far, here are some challenges associated with using a LBS in a MET institution:

- A LBS is a complex, elaborate and expensive system. The cost of setting up a LBS can be significant, including expenses for the glass board, lighting and high-quality video and audio equipment. Some small MET institutions may find the initial investment prohibitive;
- A LBS must be staffed with at least one, recommended two student assistants with technical expertise, required to help with the whole process (booking, training, recording and the footage post-production editing). This involves long-term funds, added to operational costs, which must be secured for their payment;
- An initial User's training and some trial runs are needed. In essence, any User needs initial familiarity with the lightboard technology and some time to reach a comfort level when teaching in front of a camera. This is probably the most difficult task, being completely different to the approach taken when preparing for a lecture or a tutorial (Dinmore S., 2019). However, from the authors' perspective, most LBS Users find the process of adapting to the new technology relatively simple and quick to master with some practice;
- Relatively large amount of time is required, at least initially, to design and plan the lesson, script the dialog and practice the presentation to ensure a smooth delivery of the digital content. In comparison with a traditional lecture, this activity can be considered time-consuming and as an added workload for the teaching staff;
- Keeping a video short to max.10-12 minutes is a challenging task. The attention drops off dramatically after this period and no one will watch to the end a longer video. If the topic is long and complex, break the topic up into a series of shorter, self-contained, but related clips (Dinmore S., 2019). This is in line with Mayer's "segmenting principle", which states that "people learn better from a multimedia lesson when it is presented in user-paced segments rather than as a continuous unit" (Mayer R.E., 2017);
- Cleaning the glass can be a task. The lightboard needs to be clean intensively after each use, otherwise you'll get reflections on the board at the next recording;
- A certain clothing is required while recording. McCorkle S. & Whitener P. (2020) have found that solid white and solid black shirts did not present well on the camera. Clearly, our findings support this research: black is to be avoided, as the room is dark and the Presenter looks like a "floating head", while white clothing appears very bright due to the studio lights and any text written on the board is not legible. Moreover, logos or text on a shirt will appear backward once the video is flipped (McCorkle S. & Whitener P., 2017).

- Resistance of teaching staff to adopting new technologies, especially if they are comfortable with traditional teaching methods. We can confirm that not all colleagues were interested in the LBS after attending the two workshops. However, it is authors' belief that soon, most of colleagues will be pushed to think more creatively and find ways in which they can illustrate and convey their messages to students more effectively.

All in all, while lightboard videos represent a significant opportunity to enhance MET, the LBS setting-up, implementation and ongoing use require careful consideration of potential drawbacks, especially in regard of financial and technical implications.

6. Planning an educational video: preparation, setup, recording and post editing & publishing

In the following, a set of production guidelines will be described to provide a good practice example for guidance in similar endeavours in the maritime higher education context. The information is based on practices observed by authors in planning assistance and production of videos for students and staff coming to the LBS.

6.1. Preparation

Familiarisation with the LBS. The first step is to book online a training session. This training is offered to support staff & students to create their digital content in a supervised mode. On one hand, the introductory session includes a presentation of LBS equipment's, the studio policies and what needs to be prepared by the Users in advance, before filming. The LBS team explains the Users the way the supporting materials are merged via a separate video feed to appear in the video, as well as a discussion of the Presenter's proper attire. On the other hand, the introductory session consists on User's training to learn how to communicate effectively to the camera. For a minimum comfort level, at least one trial run should be conducted.

Create the storyboard. With the training completed, the User could start preparing the topic to be recorded. This means to write a script with the detailed words and notes to be spoken during filming. As mentioned, the authors recommend as a rule of thumb: 1 Topic - 1 Board - 1 Video, i.e. to complete the video in a single take. The learning objectives and the visuals to be inserted in the video should also be decided beforehand.

6.2. *Setup*

The support team should check the technology and darken the room before the User arrives. This involves starting and checking all software programs relevant to the recording. The User's images or diagrams must be inserted into OBS and edited if necessary. The speaker's text has to be loaded onto the teleprompter. Once the Presenter shows up, the LBS studio should be ready and the "On Air" text is lighting outside the room, expressing the recording is on progress. To save time while recording, the Presenter can draw his charts or visuals on the board prior to recording. Meanwhile, the lightboard table can be adjusted in height to suit the User's height. Only the sound check is left before the recording starts. During this, the microphone settings are adjusted to the Speaker's voice volume and intonation. Once the sound is set, video recording can begin.

6.3. *Recording*

The room must be completely dark and the audio quality must be continuously monitored during the recording. Additionally, the LBS team are responsible for fading in and out the supporting materials. From authors' experience, the following can be recommended as best practices during a recording session:

- The Presenter should have in mind a clear layout of the presentation being filmed: He/she must carefully plan where to write or draw, where the images will be projected and where to stand while recording. The position (in the middle or to the side) depends on where you plan to project your images on the screen, on how much text you intend to write on the board and what is your dominant hand. Our tip: leave a space for yourself and do not write in front of your face! Write larger than usual and use different colours for emphasis;
- To encourage the direct interaction principle, look at the camera as much as possible when you are not writing and only talking or reading the Teleprompter;
- Do not afraid when making mistakes. Simply proceed with the presentation, just as you would in a normal classroom situation – the errors can be adjusted in post-production;
- Be yourself during filming. Behave naturally and use your normal gestures and teaching style. Be expressive and enthusiastic as your energy can significantly impact student engagement.

6.4. *Post editing & publishing*

Once the video is recorded, the standard MP4 file is edited in post-production by a standard video editor, such as Adobe Premiere Pro (APP) that offers a wide range of features including advanced editing tools, color correction, audio editing, and integration with other Adobe Creative Cloud applications. APP can also generate subtitles for barrier-free videos in publishing. The drafts and corporate design of Jade UAS consists of Adobe Templates as well. Every post-production involves removing long pauses, errors or trimming unnecessary parts. In the editing phase, subtitles can be added to ensure complete accessibility of the content. The subtitling process is done automatically, but the resulting text must be corrected for possible mistranslations. Once the recording is over, the Presenter is invited to watch the raw footage on a large Smartboard screen. This review is necessary to ensure that sound is clear, the visuals are visible and to enable the Presenter to reflect on the feedback and seek improvements, if necessary. The Users can take their raw footage with them on a USB flash drive, or the student assistants can add them to the learning media resource server, so they can be published in the learning management system. The file will be stored in the LBS for 1 more semester on a portable large-capacity SSD hard drive. Last but not least, the lightboard must be cleaned properly to remove the writing and marker residues and prepare for the next shooting session. A special cleaning kit can be used, consisting of cotton cloths, spray cleaning foam and squeegees.

7. Students' perspective and their satisfaction as end-users with LBS

A small-scale pilot survey was conducted with the defined aims of verifying the consistency of the questionnaire, testing the relevance of the questions being asked and identifying patterns in the responses. The sample size for the pilot study was N=21 respondents out of a group of 30 students, which represents a common semester size in an academic setting such as Jade UAS in the state of Lower Saxony. The group size can therefore be considered acceptable for gathering meaningful insights and feedback on the survey questions. The 70% response rate is relatively high, especially when compared to typical response rates in various survey contexts and ensure that the feedback collected is representative of the entire semester.

Practically, third semester students were suggested to record a short video in the LBS as part of their homework projects in "Marine Engineering" subject. The students were divided into small teams and the topic of each project was decided at draw. Their final presentations were also possible in classical Power Point format, and only 21 students voluntarily accepted the challenge to use LBS for the first time. The rationale for this activity was based on the research findings that student engagement in video production projects not only enhances subject knowledge and develops communication skills, but also that such projects stimulate positive emotions and enhance student satisfaction with their course (Pirhonen & Rasi, 2017). The aim was twofold: First, to provide students the opportunity for a more learner-centred and engaging role in their learning process. Second, students reinforce their prior learning and gain confidence in their own knowledge & teamwork, by using their skills to produce a video that will help their peers to understand the concepts presented. The quantitative analysis of the collected data was done in ChartExpo™ for Excel using a Likert scale chart. A 6-point scale was chosen in the questionnaire to avoid neutral answers and provide more nuanced feedback. For data analysis, a descriptive statistic with distribution of responses based on absolute frequencies and calculation of the weighted mean score was performed, with the results represented in form of a bar chart in Figure 5 below.

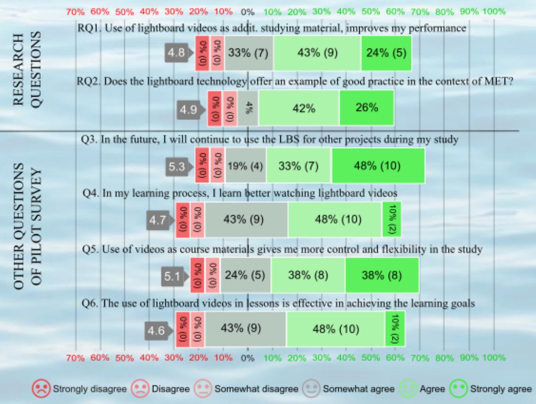

Figure 5. Likert scale bar chart for analysis of end-user's satisfaction

Insights

Analysis of responses distribution to identify patterns. The answer to first research question (RQ1) proves to be positive: most of the students (67%) felt that, if the lightboard videos are offered as a supplement to their lessons, this would be very beneficial to their performance during their study. This percentage suggests an agreement tendency. However, 33% of respondents had a neutral opinion, indicating that no pattern can be identified in the response. The answer to the second research question (RQ2) could be obtain by analysing the overall satisfaction level and the absolute frequency percentage of all questions in the pilot survey. A large proportion (68%) of respondents answered positively to all questions, with "strongly agree" and "agree". This percentage suggests as a pattern in the response an overall favorability that might indicate the effectiveness of LBS. Analysing other questions in the survey, we note that 81% respondents confirmed clearly their intention to use LBS for future projects and only 19% are somewhat in agreement (Q3). A possible explanation could be that some students have not reached a sufficient comfort level in working with a camera. Regarding the question (Q4), about half of students (58%) felt that lightboard videos helped them in the learning process, while the other half (43%) somewhat agree with this statement. Perhaps the question is biased, making it difficult for students to answer honestly. For a future large-scale survey, this question should be carefully rephrased to avoid misinterpretation. In terms of the flexibility and control gained when using videos (Q5), 76% of respondents confirmed the statement and only a quarter (24%) had a neutral opinion. In last survey question (Q6), 58% of the students believed that lightboard videos helped them achieve their learning goals, while the rest (43%) are more likely to somewhat agree. The explanation could be similar to Q4, meaning a bias question or maybe poorly asked and confusing for the respondents.

Calculation of weighted mean score to get an overall understanding of the responses. Based on the range and weighted average score (Figure 5), our interpretation is that the pilot survey indicates a general positive attitude of respondents. Question (Q3) has a weighted mean of 5,3/6 and is the only having the “strongly agree” as the most frequent response (10 times). All the other questions, including the two research questions have “agree” as the most frequent response. In first research question (RQ1), the weighted mean of 4,8 can be perceived as relevant, indicating students' level of satisfaction with their performance when using the lightboard videos. In case of second research question (RQ2), the weighted average of 4,9/6 shows the overall positive attitude of students to consider that the lightboard technology offers an example of good practice.

8. Summary and key recommendations. Conclusions

The paper addressed two research questions: Does the use of lightboard videos improve student performance during their study? and “Does this innovative technology offer an example of good practice for guiding similar initiatives in the context of MET? The feedback, based on a small pilot survey, is that the use of lightboard videos and LBS has been positively received by students. This attitude makes us confirm its recognition as "good practice" and consider it a "pro" argument for the continued use of this modern teaching tool in our MET institution. By analysing the distribution of responses, one can assess the central tendency: there is a pattern of agreement response for students’ performance improvement (RQ1). In our opinion, this high percentage (67%) could be seen as evidence of LBS and lightboard videos success and a good indication that lightboard videos are well-received by students. With reference to second question (RQ2), the high percentage (68%) must be treated similarly, without a validation from our side to endorse it as 'best practice'. In order to adopt such ratification, a comparison analysis with benchmarks or control groups is required. This detailed analysis will be part of a future study, being the only way to strengthen the arguments for it as best practice. A different limitation concerns the Likert scale used in the pilot survey, which is typically an ordinal scale. This means the interval is not intrinsically equal between successive points on the scale. However, this aspect is still a point of controversy among statisticians and researchers. As a future direction for research, exploration of reasons behind the neutral responses can unveil additional insights into student’s experience and satisfaction with using the LBS and help us to refine the questionnaire.

All in all, establishing a strong correlation between lightboard videos and student performance and validating that lightboard technology provides an example of best practice remains the focus of future work. However, in the meantime, the authors hope that this work will contribute to the existing literature and help other maritime universities to implement similar innovative technology.

Acknowledgements

The authors are grateful for the completion of the LBS project, which would not have been possible without the time invested and the financial support received by Prof. Dr. Georgios Athanassiou from the ministry. The project was supported by the Ministry of Science and Culture in Lower Saxony (MWK Niedersachsen) under the program "Support of digitization processes in teaching" and by internal research funds offered by the Executive Board of Jade University of Applied Sciences.

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THE WORDING OF IMO MODEL COURSES – SIMILARITIES AND DIFFERENCES

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Abstract: Maritime English represents a fascinating yet challenging domain within English for Specific Purposes (ESP), engaging both language researchers and seafarers. Adding to its complexity, Maritime English is subdivided into General Maritime English and Specialized Maritime Englishes, as outlined in the IMO Model Course 3.17 – Maritime English, which are designed for distinct ship crew departments. Given that vocabulary is a primary predictor of discourse comprehension, this study aims to compare the specialized vocabulary recommended by the IMO model courses for deck crew (IMO Model Courses 7.01 and 7.03), marine engineers (IMO Model Courses 7.02 and 7.04), and marine electrical engineers (IMO Model Course 7.08). To conduct this comparison, we employed the AntWordProfiler program (Version 2.1.0) developed by linguist Laurence Anthony for lexical analysis. This tool allows for the exclusion of the most frequent General English words, enabling a concentrated analysis of the technical vocabulary pertinent to the three Maritime English lexical domains. Our findings reveal both similarities and significant differences, underscoring the necessity of tailored approaches to language instruction and research for each domain. Consequently, we provide statistically substantiated frequency word lists of technical vocabulary critical for both pedagogical and research purposes. Furthermore, the methodology used in this study permits comparisons with findings from other ESP areas and can be extended through the application of additional software tools. These tools can analyze frequent collocations, n-grams, and other linguistic features, yielding further research and pedagogical insights.

Keywords: maritime English, word list, frequency, IMO model courses, vocabulary

1. Introduction

Given the international nature of the maritime economy and the role of English as the *lingua franca* of this global industry, the teaching, learning, and overall proficiency in Maritime English (ME) constitute a significant component of Maritime Education and Training (MET). English language instructors recognize Maritime English as a specialized branch of English for Specific Purposes (ESP) due to its close association with a specific international legal framework (Zhang and Cole 2018).

Effective English communication is essential for ensuring safety at sea, necessitating standardization. In accordance with the Standards of Training, Certification, and Watchkeeping (STCW) code and the International Maritime Organization (IMO) model courses for various MET domains, the IMO Model Course 3.17 for Maritime English has been established. This course, aligned with the segmentation of maritime domains and incorporating a genre-based approach, offers a two-stage syllabus within two core sections: General Maritime English (GME) and Specialized Maritime English (SME). GME emphasizes linguistic content, while SME focuses on professional content and the articulation of maritime workplace duties through language.

A defining characteristic of ESPs is their specialized lexical registers. Language competency requirements laid down by the Standards of Training, Certification and Watchkeeping for Seafarers (IMO STCW, 2017) state that all activities should be communicated in precise and clear language, primarily using vocabulary from the specific nautical or maritime domain (Đurović and Dževerdanović-Pejović 2023). Thus, we do not limit our discussion to the IMO Model Course 3.17 for Maritime English but extend our analysis to specific technical areas. To address these areas, we hypothesize that the various maritime onboard profiles — deck, engineering, and electrotechnical officers — are best encapsulated and reflected in their respective IMO Model Courses: 7.01 and 7.03 for deck officers, 7.02 and 7.04 for engineering officers, and 7.08 for electrotechnical officers. To examine the similarities and differences, as well as the challenges faced by language instructors in each area, we propose the following research questions:

Research question 1: How demanding are our professional maritime corpora in terms of vocabulary?

Research question 2: How similar and different are the onboard professional areas in terms of lexical considerations?

Research question 3: What are the potential applications and pedagogical implications of the applied methodology?

2. Methodology

With the advancement of Information Technologies (IT), the recommended communicative and data-driven approaches to teaching and learning are increasingly grounded in corpus linguistics. To provide a reliable response to the research question posed, we employed contemporary corpus linguistics methods and software for lexical analysis.

The initial method employed is Lexical Frequency Profiling (Laufer and Nation 1995), which is utilized to measure vocabulary types and levels within a corpus. For practical purposes, and to facilitate comparison with similar research while primarily focusing on constructing frequency word lists, we utilized AntWordProfiler (Version 2.1.0), a software tool developed by the linguist Laurence Anthony. This tool is based on the earlier RANGE program by Nation and Heatley (1994). Additionally, for text conversion and further analysis, we employed AntConcConverter (Version 2.1.0) and AntConc (Version 4.3.0). These software solutions are specifically designed to convert text into plain format (.txt), generate frequency vocabulary lists for ESPs, and examine words within specific contexts.

Our primary focus is on technical vocabulary, necessitating the exclusion of the most frequent General English (GE) words from our analysis. One of the significant advantages of AntWordProfiler is its capability to exclude predefined GE word lists. To achieve this, we utilized the software's default lists, such as the General Service List by West (1953) and the Academic Word List by Averil Coxhead (2000), in addition to Paul Nation's lists of the most frequent GE words extracted from the combined British National Corpus and Corpus of Contemporary American English (BNC/COCA) (Nation 2012).

2.1 Corpus Details

Based on the rationale presented in the Introduction, we compiled three specialized corpora for subsequent comparative analysis. For practical purposes, these corpora were designated as follows: Nautical Corpus (NC), derived from IMO Model Courses 7.01 and 7.03; Marine Engineering Corpus (MEC), derived from IMO Model Courses 7.02 and 7.04; and Electrotechnical Corpus (ETOC), derived from IMO Model Course 7.08. The specifics of these corpora are outlined in Table 1.

Table 1. Details of the target corpora.

Corpus	Tokens	Word types
NC (IMO Model Courses 7.01 and 7.03)	199,171	8,390
MEC (IMO Model Courses 7.02 and 7.04)	161,423	7,562
ETOC (IMO Model Courses 7.08)	42,793	4,304

As evident from the table above, and as anticipated, the NC and MEC corpora are nearly twice the size of the ETOC corpus, given the designated IMO Model Courses. This disparity must also be taken into account during the comparative analysis.

3. Lexical Demand of Our Target Corpora

First, we evaluated the lexical burden of the three corpora. This was achieved by measuring the coverage of General English (GE) words as defined by the General Service Lists (West 1953) and the Academic Word List (AWL) (Coxhead 2000), enabling a comparison of our results with other research findings (Table 2).

Table 2. Coverage of GE and academic words in the target corpora.

Word lists	NC	MEC	ETOC
GSL	147,571 (74%)	118,980 (74%)	30.407 (71%)
AWL	19,950 (10%)	19,013 (11%)	5.581 (13%)
Out of the lists	31,650 (16%)	23,430 (15%)	6.805 (16%)
Total (words and %)	199.171 (100%)	161,423 (100%)	42.793 (100%)

The analysis indicates that the most frequent GE words cover 71-74% of our target corpora. This is consistent with the 71.39% coverage observed in marine engineering instructional materials (Đurović et al 2021), and 71.38-73.83% in nautical and marine engineering textbooks (Đurović and Dževerdanović-Pejović 2023), but lower than the 78-92% coverage found in *various written texts* (Nation and Waring 1997), underscoring the technical nature of our target corpora. Notably, this coverage (NC and MEC) exceeds the percentage found in academic texts, which typically ranges between 70 -71.9% (Coxhead 2000). Moreover, the proportion of academic vocabulary in the ETOC (13%) exceeds the typical coverage found in other academic texts, which ranges from 10-12% (Coxhead 2000, Valipouri & Nassaji 2013). This surpasses the 8.07% observed in marine engineering instructional books (Đurović et al. 2021) and the coverage in nautical and marine engineering textbooks, which is 9.04% and 7.78%, respectively (Đurović and Dževerdanović-Pejović 2023).

As shown in Table 2, the remaining vocabulary not covered by the most frequent GE and academic words constitutes 15-16% of the corpora. Given that adequate reading comprehension requires knowledge of 95-98% of the vocabulary (Laufer 1989, Nation 2006) this implies that understanding these texts would not be achievable without knowledge of additional technical vocabulary specific to the professional maritime domains. This finding justifies the development of technical frequency word lists, which provide targeted lexical material for teaching specialized English.

4. Comparative Results of the Target Corpora Lexical Analysis

The primary component of our methodology involves identifying the most frequent technical vocabulary within the respective Model Courses. This step is crucial for enabling a comparative analysis and drawing conclusions pertinent to our second research question. Initially, the corpora were converted into *.txt* format to facilitate further analysis. To optimize this process, we removed extraneous information, including impressums, references, proper names, abbreviations, and similar elements.

Subsequently, we analyzed each corpus, beginning with the elimination of the most frequent General English words. This was achieved by excluding the first 2,000 most frequent GE words, as identified from the British National Corpus (BNC) and the Corpus of Contemporary American English (COCA) (Nation 2012). In addition, we eliminated common proper names, abbreviations, marginal words, and transparent compounds, which were similarly identified using BNC/COCA data and aligned with standard practices in vocabulary analysis (e.g. Nation 2016, Coxhead 2000, Đurović 2021).

Upon comparing the preliminary results from the three corpora, we elected to segment the results into two distinct parts: the first set consisting of the 20 most frequent technical words (Table 3), and a second set comprising an equal number of words ranked 21-40 (Table 4). It is important to clarify that the designation *technical* is conditional. Not all words beyond the most frequent GE and academic words are considered uniformly technical, or *cryptotechnical*, as were named by Fraser (2009). This classification is employed here for practical purposes and will be further elaborated upon in subsequent discussions.

Table 3. The first 20 most frequent technical words from the target corpora

Word rank	NC	MEC	ETOC
1	STCW	function	function
2	cargo	Code	technical
3	Code	competence	syllabus
4	international	marine	competence
5	annex	syllabus	electro
6	Convention	international	defines
7	cargoes	Convention	electronic
8	navigation	procedures	marine
9	competence	fuel	Code
10	bulk	diesel	STCW
11	defines	STCW	construction
12	vessel	construction	propulsion
13	maritime	principles	principles annex
14	voyage	ensure	voltage outcome
15	procedures	maritime	cargo

16	regulations	emergency	Convention
17	marine	defines	communication
18	navigational	components	temperature
19	content	cargo auxiliary	
20	ballast	assessment	

The rationale behind the cut-off point for the lists in Table 3 and Table 4 was not based on the frequency count (number of repetitions) due to the disproportions in corpus sizes, but rather on the frequency rank of the words in descending order. Furthermore, we are not providing the complete word lists (which can be a valuable outcome of the methodology) but rather the most frequent words deemed technical, to identify the similarities and differences between the three corpora related to general maritime terminology.

What insights can be gained from the most frequent technical words in the three marine professional corpora?

Firstly, it is evident that these corpora share a significant amount of vocabulary. Among the first 20 most frequent words, terms such as *STCW, Code, Convention, marine*, and *competence*, appear prominently within the first 20 most frequent technical words across all three corpora. This finding indicates a shared macrostructure of the IMO Model Course and suggests that their general design constitutes a distinct maritime genre.

Another consideration must be addressed here. The software outputs non-capitalized word forms, necessitating the application of extralinguistic knowledge as part of the methodology (e.g. *STCW, Code, Convention,* etc.).

As we progress further down the list, the words become increasingly domain-specific (Table 4).

Table 4. The next 20 most frequent technical words from the target corpora

Word rank	NC	MEC	ETOC
21	appropriate	methods	maritime
22	goods	manual	outline
23	ensure	appropriate	ballast
24	stowage	annex	methods
25	edition	objective	ensure
26	emergency	trim	assessment
27	trip	electronic	procedures
28	compass	outcome	data
29	carriage	survey	circuit
30	data	sketches	emergency
31	principles	turbine	objectives
32	manual	temperature	liquid
33	SOLAS	edition	auxiliary
34	Certificate	ballast	appendix
35	methods	voltage	structure
36	function	propulsion	principle
37	resolution	regulations	objective
38	crew	compliance	devices
39	angle	precautions	generators
40	hull	Certificate	distribution

When considering the words ranked 21-40 across all three corpora, the words become less common, although still shared (Table 4). The lexical specifics of each technical corpus are evident. For instance, terms such as *compass, trim, stowage, hull* (*draft, nautical*, etc. in the continuation) are identified in the NC corpus, while *turbine, survey, manual* (*valves, diesel, fuel,* etc. in the continuation) appear in the MEC corpus. In the ETOC corpus, terms like *electric, electronic, generator,* and *distribution* are prevalent. As anticipated, when considering all three corpora, MEC and ETOC share more technical vocabulary compared to NC (e.g. *function, propulsion, voltage, temperature*, etc.).

Additionally, common methodological terminology is noticeable throughout all three corpora, including *outcome(s), method(s), objective(s), data, ensure, edition, methods,* and similar, which highlight the pedagogical purpose of the genre. According to certain corpus classifications (e.g. Ivanović 2012: 17), our corpora can be considered both specialized and pedagogical.

The above trend persists further down the list, indicating individual specializations. Consequently, we can conclude that each maritime professional area possesses distinctive vocabulary, necessitating focused attention from maritime English instructors. This includes their extralinguistic knowledge, such as familiarity with the specific professional domain and close collaboration with maritime professionals.

This finding is corroborated by a study conducted by Đurović and Dževerdanović-Pejović (2023), albeit limited to nautical and marine engineering textbooks. In the following sections, we present further implications and potential applications of the methodology, with the aim of addressing research question 3.

5. Limitations and Further Implications of the Methodology

This study acknowledges several common limitations inherent in corpus linguistics methodologies. Firstly, the findings are restricted to the specific corpora used. Comparative analyses reveal notable differences when results are contrasted with those obtained from marine engineering instruction books or textbooks (cf. Đurović et al. 2021, Đurović and Dževerdanović-Pejović 2023). This highlights another limitation and potential avenue for further research: the absence of comprehensive word lists in specialized domains such as nautical and marine electrical engineering.

The employed methodology establishes a robust foundation for creating word lists and developing monolingual, bilingual, or multilingual glossaries and dictionaries. Đurović (2021) successfully applied this approach to marine engineering instruction books. The frequency criterion is widely recognized in general English dictionaries (e.g. Collins COBUILD English Language Dictionary, Macmillan Dictionary). However, detailed methodological discussions on compiling ESP lexical material are scarce (cf. Vuković-Stamatović and Živković 2023, Kruse and Heid 2021).

Furthermore, the extralinguistic knowledge required to apply this methodology necessitates consideration of the context-dependence of the extracted words. To address this, Laurence Anthony developed AntConc, a lexical analysis software tool that facilitates exploration beyond word frequency. It allows for the examination of frequent collocations, n-grams, keywords, and other lexical patterns, enhancing vocabulary materials and exercises. For illustrative purposes, we can compare the utilization of a common word across the three corpora within their respective contexts. As an example, we examined the word *Convention*, which appears frequently in all three target corpora (Figure 1, Figure 2, and Figure 3).

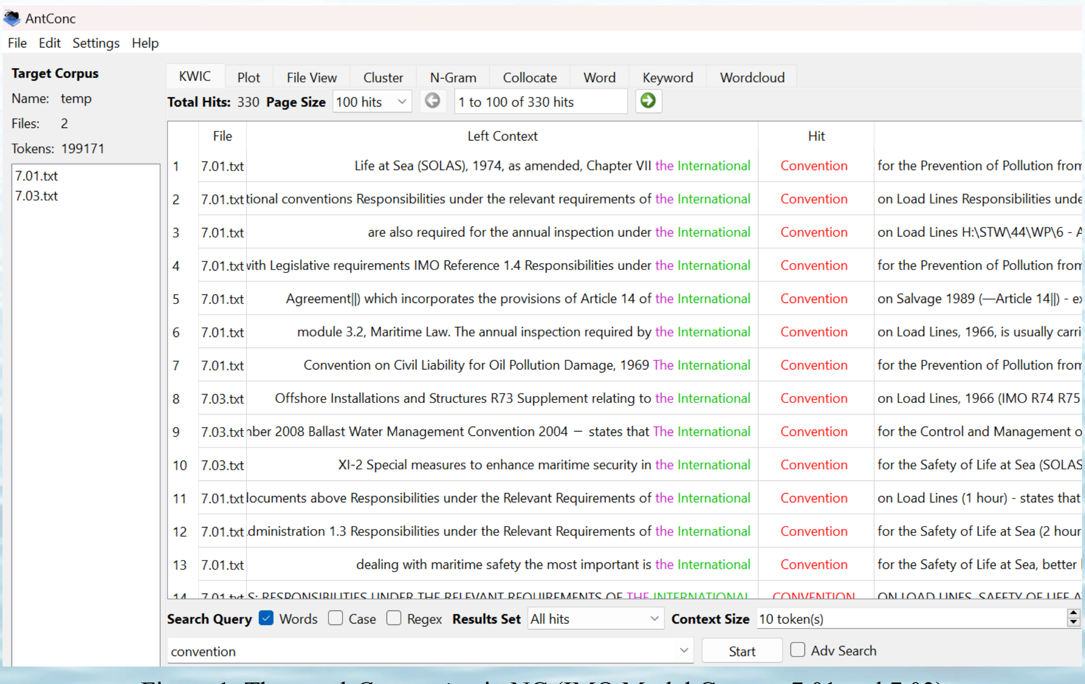

Figure 1. The word *Convention* in NC (IMO Model Courses 7.01 and 7.03)

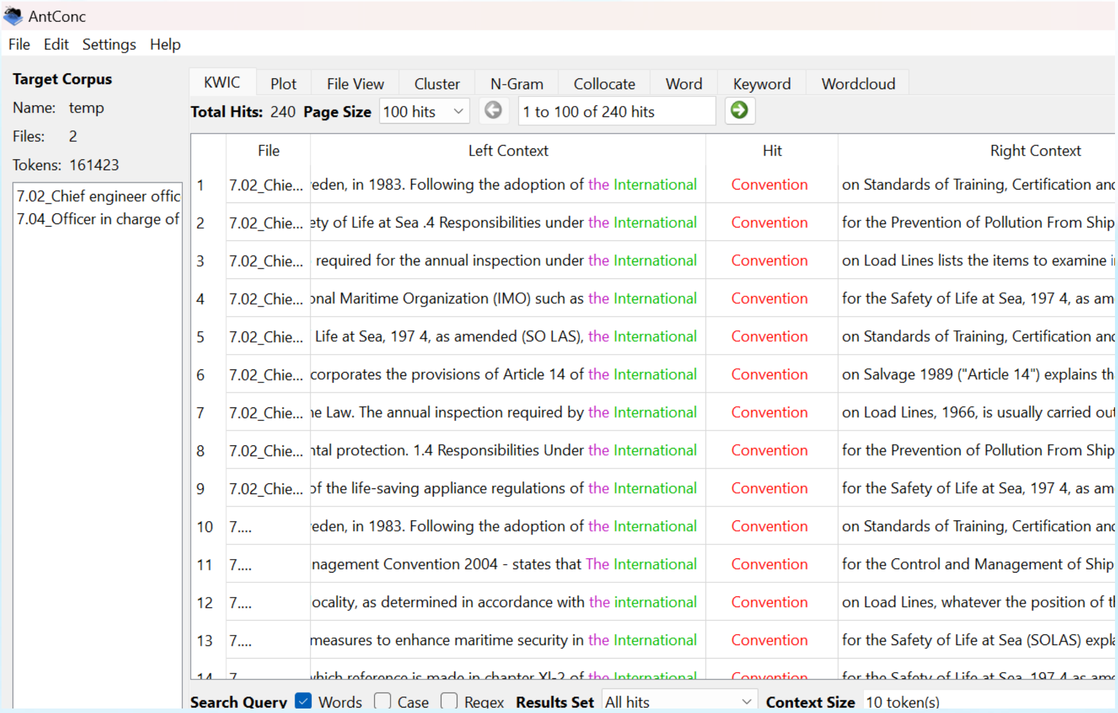

Figure 2. The word *Convention* in MEC (IMO Model Courses 7.02 and 7.04)

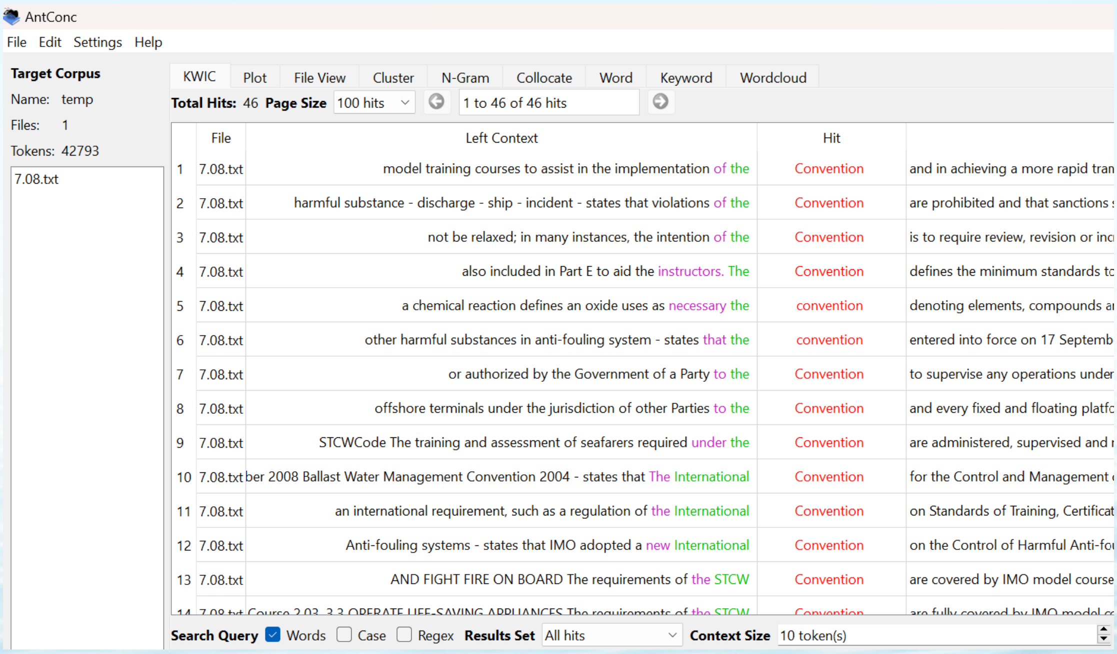

Figure 3. The word *Convention* in ETOC (IMO Model Course 7.08)

The necessity of further investigation beyond mere statistical frequency data is evident. For instance, utilizing AntConc (Version 4.3.0) yields multifaceted information. Primarily, although the word *Convention* is common across documents, it frequently pertains to distinct texts. In most instances, it is associated with general conventions such as STCW, MARPOL, and SOLAS, whose occurrence can be quantified within each corpus. Conversely, one can derive a comprehensive list of conventions pertinent to navigation, many of which are scarcely mentioned in the other corpora. Examples include the Convention on Load Lines, the Convention on the High Seas, the Convention on Salvage, the Convention for the Control and Management of Ships' Ballast Water, the Convention on the Territorial Sea and the Contiguous Zone, the Convention on the Continental Shelf, and many other.

Moreover, further contextual analysis reveals that even the same conventions are cited in different contexts and for varying purposes. This capability is beneficial not only for language instructors but also for professionals working with specialized corpora, enabling them to extract relevant information and data from specific documents or other professional texts.

6. Conclusion

When you are a maritime professional, you are specifically oriented towards the work environment, professional discourse, and corpora, all of which include specialized Maritime English. As a Maritime English instructor, your language learners rarely come from a single maritime domain. Instead, you often need to master various maritime genres and registers. Our aim here was to illustrate the challenges posed by the similarities and sophisticated terminological distinctions between three specialized Englishes, as outlined by the IMO Model Course 3.17. To achieve this, we compiled three technical corpora — Nautical Corpus, Marine Engineering Corpus, and Electrotechnical Corpus — and subjected them to lexical software analysis to address the three research questions posed.

Our analysis revealed that these corpora are more demanding in terms of vocabulary compared to many other types of texts. Thus, adequate comprehension of these professional corpora necessitates the mastery of technical vocabulary. In addressing research question 2, we obtained the frequency technical word lists of the three corpora and compared their results. We identified numerous similarities, indicating a shared Maritime English register, as well as overlapping macrostructures, confirming that IMO Model Courses constitute a distinct and unique genre.

To highlight the specificities of the three professional settings, we demonstrated how a shared word can belong to different contexts and semantics, resulting in significant differences for the end users of the designated model courses. Additionally, we presented the limitations and further possibilities of our methodology. Considering the lack of methodological evidence for building ESP glossaries and dictionaries, including those for maritime areas, the replicable methodology presented here has significant potential for further research and the development of vocabulary teaching materials that accommodate modern teaching methodologies, such as data-driven teaching and learning.

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CHARACTERISTICS OF FILIPINO CADETS' ENGLISH VOWELS: THE SOCIOLINGUISTIC VARIATION AMONG FILIPINO ENGLISH VARIETIES

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Abstract: In the Japanese maritime industry, Filipino seafarers comprise more than sixty percent of all crew members on outbound ships and Japanese mariners have relatively greater opportunities to work and communicate with Filipinos on board. In such situations, onboard communications are potentially affected by the linguistic backgrounds of seafarers, including their first languages such as Japanese, and varieties of Filipino languages. This study aims to conduct a closer investigation into Filipino English vowels from the viewpoints of inter-language and sociolectal variation by analyzing the recordings of Filipino English spoken by 22 cadets at MOL Magsaysay Maritime Academy (MMMA) both impressionistically and acoustically. While the distribution of front vowels is relatively homogeneous resembling the vowel space of the mesolectal variety regardless of their language background, the quality of back vowels varies among speakers and can be classified into three categories: 1. Acrolectal distribution, 2. Acro-mesolectal distribution, 3. Mesolectal distribution. The acrolectal distribution exhibits the distribution of back vowels that resembles that of an acrolect speaker. The Acro-mesolectal distribution features vowel distribution in between those of acrolect and mesolect. The mesolectal distribution forms five to six distinct vowel clusters resembling the vowel inventory of mesolect presented by Tayao (2008). The majority of speakers presented consistent front-vowel distribution throughout the recordings, but certain speakers exhibited varied back-vowel distributions according to the speech style—showing acrolectal distribution when reading short sentences or phrases, and acro-mesolectal or mesolectal distribution when reading lists of words. The present study observed continuum vowel inventories between mesolect and acrolect in Filipino cadets' English. It is suggested that Japanese seafarers communicating with Filipinos onboard and listening to their English should become accustomed to the mesolectal pronunciations of the Filipino English vowels. It is worth investigating the effect of lectal and stylistic variations on the intelligibility of Japanese-Filipino communication in future research.

Keywords: Acoustic analysis; English vowels; Filipino English

1. Introduction

Filipino seafarers account for 69.8% of approximately 60,000 crew members on Japanese ocean-going merchant ships, while Japanese constitute only 1.5% (Japan Maritime Center, 2023). This indicates that Japanese workers in the shipping industry are likely to have opportunities to communicate with Filipino seafarers onboard or via radio at some point in their careers. Although Filipino English was derived from American English in the early 20th century, it has phonetic and phonological characteristics that deviate from those observed in American accents, such as General American English. Although Japanese English education models General American English, English users in Japan need to be familiar with such Filipino English characteristics; otherwise, these differences may hinder communication between Japanese and Filipino seafarers. Therefore, it is beneficial for English lecturers in the Japanese maritime industry to understand the features of Filipino English that could obstruct smooth communication with Filipino seafarers.

Today, the English language is spoken worldwide and has become a lingua franca in many industries. However, as is evident, each speaker of English is influenced by their linguistic backgrounds: their first languages, age cohort, gender, and other sociolinguistic factors. These backgrounds give rise to distinct English varieties such as Indian English, Hong Kong English, and Filipino English.

The linguistic background in the Philippines is especially complex with a wealth of indigenous languages that "are so different one from the other that the (monolingual) speaker of one language does not understand communication in one of the other languages (McFarland, 2008)." There is still no agreement among scholars on the number of indigenous languages in the Philippines since there is still room to discuss whether each "language" should be counted as a distinct language or just a variation of a larger language continuum. Most studies quote numbers far above a hundred; for reference, *Ethnologue* lists 175 living indigenous Filipino languages on its website as of July 2024 (Eberhard et al., 2024).

Since English in the Philippines is greatly affected by the aforementioned complex linguistic backgrounds, it is difficult to clearly define what Filipino English is. In this paper, the term Filipino English is used as a cover term referring to English varieties that emerged under the influence of one of the indigenous languages spoken in the archipelago and, as will be mentioned below, those affected by Filipino sociolinguistic backgrounds.

In the following subsections, the present author briefly provides an overview of the characteristics of Filipino English accents described in previous research and clarifies the aim of the present study.

1.1 Emergence of Filipino English and its Characteristics

Bautista (2000) noted that the earliest study on Filipino English dates back to Llamzon (1969). Llamzon (1969) was a pioneering work that first stated the existence of Filipino English and claimed that Filipino English had already been standardized at the time of its publication. One of the controversial points stated in this early literature was that "there is a standard variety of English which has arisen in the Philippines [that] stands or falls on the premise that there is a sizable number of native and near-native speakers of English in the country" (p.84). This raised questions of whether an English variety called Filipino English truly exists and whether its native speakers were sizable enough (Gonzalez, 1972; Hidalgo, 1970).

The skepticism about the existence of Filipino English has been resolved by Kachru (1997) by considering two types of nativeness: genetic and functional nativeness. In the Philippines, speakers of English are, in most cases, native speakers of one of the indigenous Malayo-Polynesian languages, but the English language is used in a wide range of domains with a great depth of permeation into Philippine society (Bautista, 2000). Thus, the native speakers of Filipino English are more functional than genetics.

After Llamzon (1969), there have been attempts to examine the common features of Filipino English among educated speakers. Bautista started descriptive studies of varieties spoken by yayas, nursemaids who may not have finished elementary education and typically work in the homes of the upper and middle class (Bautista, 1982). This revealed another facet of Filipino English: the lectal continuum with the acrolect (most prestigious) and the basilect (least prestigious) on its ends. In between those two extremes is the mesolect, which holds intermediate features between the basilect and the acrolect.

1.2 The Aim of this Study

Among the few studies on Filipino maritime English, Takagi and Uchida (2011) successfully confirmed that common phonetic/phonological features of Filipino English are also used by the Filipino mariners and cadets. Focusing on both segmental and suprasegmental features in Filipino maritime cadets and instructors, their study auditorily determined features such as [p] for /f/, trilled [r] for /ɹ/, omission or glottalization of voiceless stops in word-final position or word-final consonant clusters, [t] for /θ/, [d] for /ð/, [s] for /z/, [b] or [w] for /v/, spelling pronunciation etc. All of these features reported by Takagi and Uchida (2011) were also impressionistically observed in the present dataset, except for the substitution of [ts, ks] and [dz] for /tʃ/ and /dʒ/, which were attested only in the speech of older speakers in their study.

While this study focused only on the common features of Filipino English, there is still room to examine the inter-language variations of Filipino English in more detail. Furthermore, sociolinguistic variations should also be taken into account, considering speakers' backgrounds. This study is a preliminary attempt to investigate the pronunciation of Filipino maritime English from these different perspectives, focusing on the features of vowel tokens.

2. Vowel Inventories of dialects of Filipino English

This section overviews the vowel inventories provided in the previous studies. The vowel inventories in Figure 1 are based on the description provided by Tayao (2008) and reproduced by the present author. Each of the four vowel spaces denotes the vowel space of the basilect (upper-left), the mesolect (upper-right), and the acrolect (lower-left). The lower-right figure represents the vowel space of General American English. As can be seen from this figure, the vowel space of Filipino English approximates General American in the order of basilect, mesolect, and acrolect.

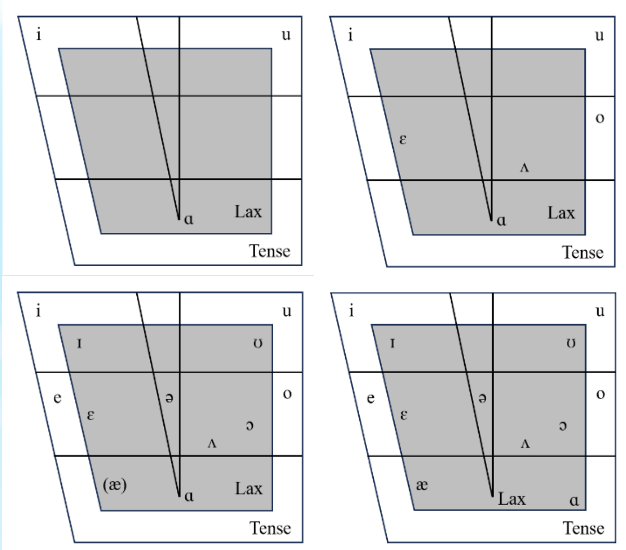

Figure 1. Vowel inventories of sociolects of Filipino English (upper-left: basilect, upper-right: mesolect, lower-left: acrolect, lower-right: General American (reference) (Tayao, 2008)

3. Methodology

This section briefly explains the methodologies used for data collection and the subsequent acoustic analysis.

3.1. Data Collection

The data were recorded by the present author at MOL Magsaysay Maritime Academy (MMMA) in Cavite, the Philippines. Each recording consists of three sections: 1. An English fable, *the North Wind and the Sun*, 2. Selected SMCP phrases (based on the list presented in Takagi and Uchida (2011)), and 3. Lists of words including international phonetic alphabets (Alpha, Brabo, ..., Zulu), cardinal numbers (1-25, 30, 40, 50, ..., 90), and other 107 common English words including vowel minimal pairs (e.g., cap-cup, fit-feet, full-fool). The contents of each section are presented in Appendices A-C.

The participants were 22 cadets who were born and raised in the Philippines. One of the notable characteristics of MMMA cadets is the diversity of their language backgrounds: While 17 out of 22 cadets were native speakers of Tagalog, the most widely spoken indigenous language with 39.9% of households (Mapa, 2023), there were also three speakers of Cebuano Bisayan, one speaker of Hiligaynon Bisayan, and one speaker of Tuwali, a language widely spoken in the Province of Ifugao in northern Luzon.

Participants' pronunciations were recorded using an IC recorder (SONY ICD-UX560F/B) with a sampling frequency and quantization bit of 44.1 kHz/16 bit, which is sufficient quality to avoid the effect of aliasing of language sounds.

In addition to the recordings, participants were asked to complete an online questionnaire regarding their sociolinguistic backgrounds (i.e., gender, age, birthplace/hometown, first language, and questions regarding the language use in everyday life, such as "What language do you mainly use when you communicate with your family/relatives?"). Since all the cadets were in almost the same age cohort (18-23 years old), only the parameters that could make a difference in the results of the analysis were extracted and summarized in Table 1. Note that the first language of those who answered that their native language is Filipino is regarded as Tagalog.

Table 1. Sociolinguistic backgrounds of participants of the recordings.

First language	Male	Female	Total
Tagalog (Filipino)	10	7	17
Cebuano Bisayan	1	2	3
Hiligaynon Bisayan	1	0	1
Tuwali Ifugao	1	0	1
Total	13	9	22

3.2. Acoustic Analysis

Acoustic analysis was conducted referring to vowels' first and second formant frequencies (F1 and F2) using the acoustic analysis software Praat (Boersma and Weenink, 2020). The analysis employed the algorithm introduced in Kimura (2023), which automatically optimizes "formant ceilings," an acoustic parameter used to search formant values in the Praat algorithm, and identifies the nucleus of vowels, the stable part of the vowel formant trajectory, before the actual measurements of formant frequencies. Note that the acoustic parameters F1 and F2 are respectively associated with the height and backness of the tongue in the articulatory phonetics: a lower F1 indicates a higher vowel and a lower F2 indicates a backer vowel. In the present study, only tokens with primary or secondary stress were involved in the acoustic measurement.

The formant frequencies were first measured in Hertz and converted into the auditory Bark scale following the conversion formula (1) introduced in Traunmüller (1983), where Z is the resulting Bark-converted dimensionless parameter, and f denotes the formant frequency in [Hz]. Traunmüller (1990) reported that this formula deviates less than 0.05 (Bark) from the empirically derived table presented in Zwicker (1961) in the frequency range of 0.2 [kHz] < f < 6.7 [kHz], which is a sufficient range for the acoustic speech analysis of vowels.

$$Z\,(Bark) = \frac{26.81\,f}{1960\,[Hz] + f} \tag{1}$$

After the Bark conversion, both F1 and F2 (Bark) were normalized using Gerstman's range-transformation method (Gerstman, 1968) to enable inter-speaker comparisons of the acoustic vowel spaces. Gerstman's method normalizes F1 and F2 within each speaker's vowel space using formula (2) without averaging formants or using any inter-speaker parameters. Note that, in formula (2), the suffix n denotes the formant number (e.g., when $n = 1$, f_1 denotes the first formant), F_n^{max} and F_n^{min} refer to the maximum and minimum values of measured n^{th} formants, and f_n^{norm} is the resulting normalized value of the n^{th} formant ranging from 0 to 1. Among the formant normalization methods devised so far, this method is suitable for the present study since averaged formants do not necessarily display the varying nature of English accents. Figure 2 is an example of the resulting vowel space of one of the speakers.

$$f_n^{norm} = \frac{f_n - F_n^{min}}{F_n^{max} - F_n^{min}} \quad (n = 1, 2) \tag{2}$$

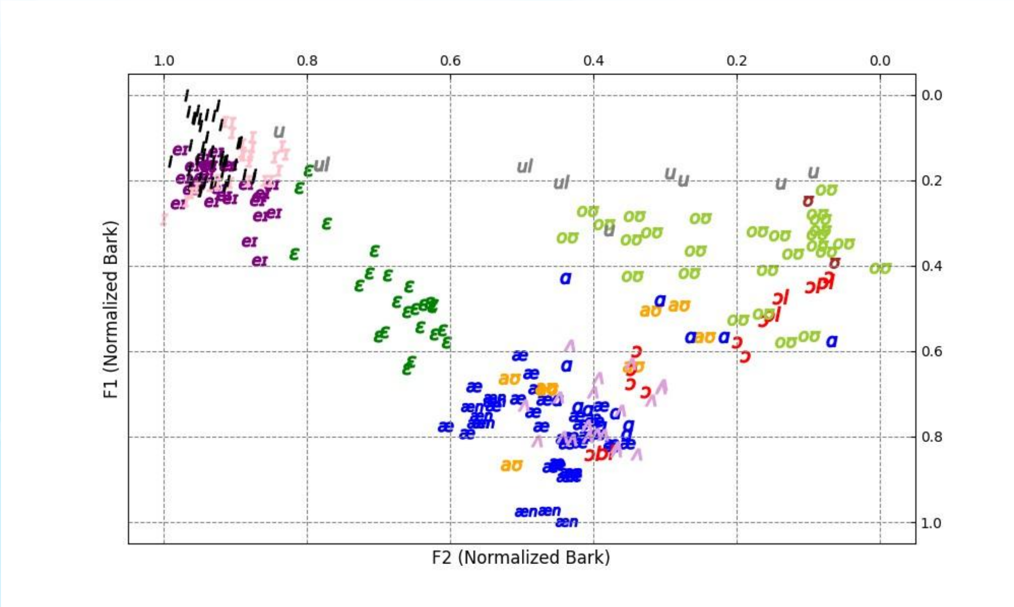

Figure 2. An example of the resulting vowel space.

4. Results and Discussions

The resulting vowel spaces showed different tendencies between front and back vowels: 1. Complete acrolectal distribution, 2. Acro-mesolectal distribution, 3. Mesolectal distribution. The complete acrolectal distribution resembles the vowel inventory presented by Tayao (2008) (Figure 1, lower-left) with clear distinctions of each vowel phoneme (Figure 3). For reference, the vowel distribution of General American English is presented in Figure 6 (Reanalysis of the General American English data used in Kimura (2023) and Kimura (2024)).

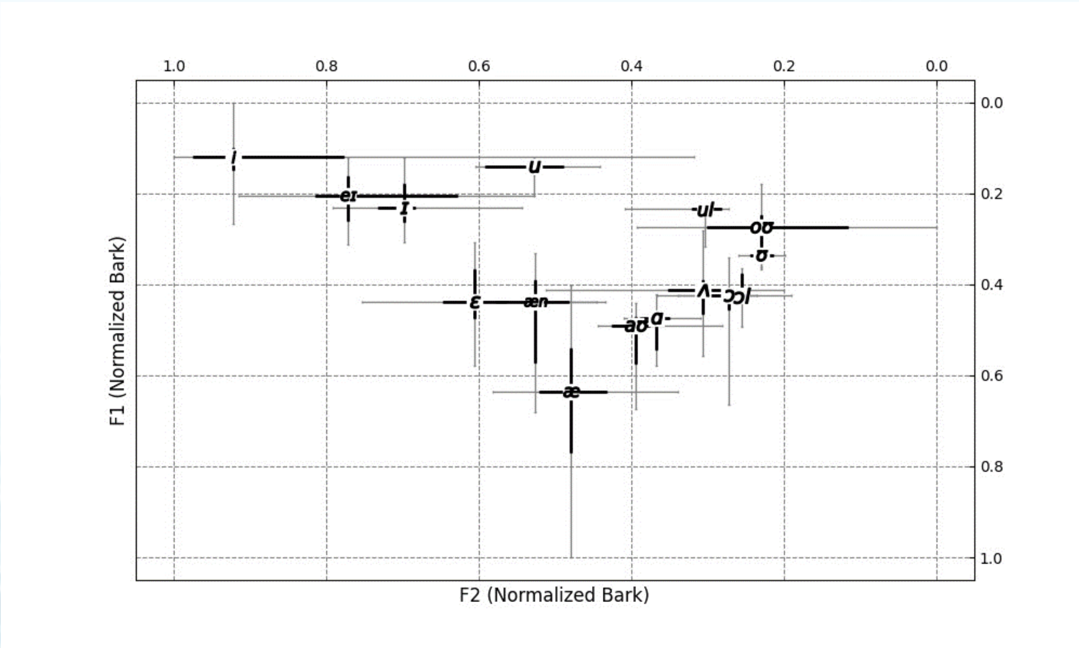

Figure 3. An example of the complete acrolectal distribution.

Figure 4 is an example of the vowel space of the acro-mesolectal distribution, the distribution intermediate between the acrolect and the mesolect. While this speaker presented acrolectal distribution regarding front vowels, back vowels form three clusters in lower-mid, lower-back, and upper-back areas of the vowel space resembling the vowel distribution of the mesolect.

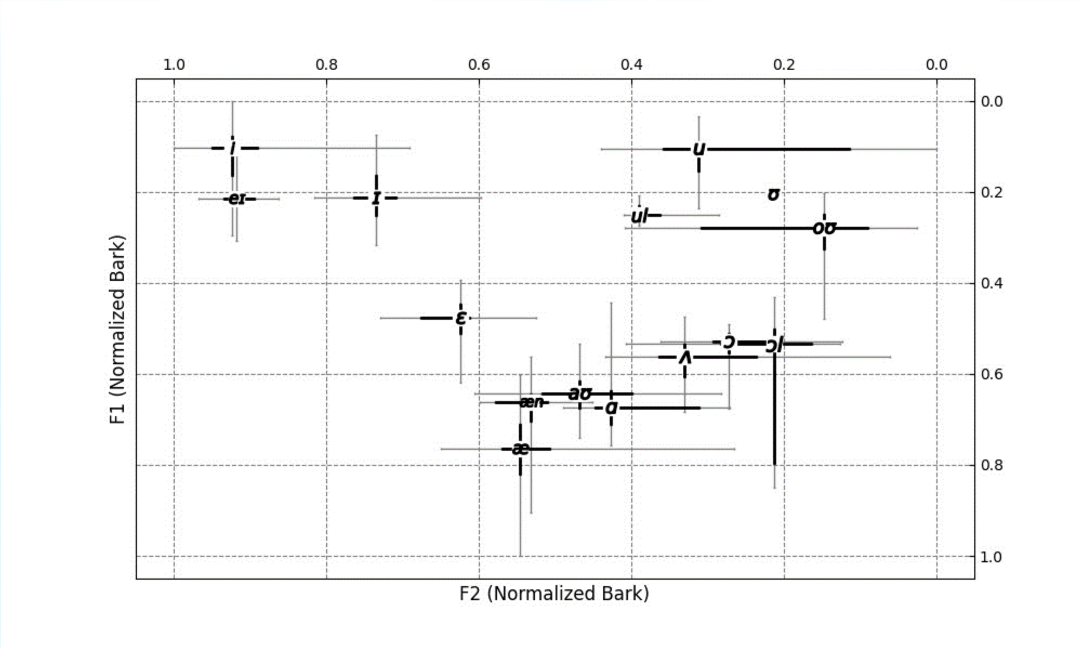

Figure 4. An example of the acro-mesolectal distribution.

An example vowel space of the mesolectal distribution is shown in Figure 5. This speaker's back vowels form three clusters that are similar to those shown in Figure 4. As for the front vowels, the distinctions among phonemes /i/ (of FLEECE), /ɪ/ (of KIT), and /eɪ/ (of FACE) are smaller than the acrolectal distribution. These constitute the mesolectal vowel inventory presented by Tayao (2008) (Figure 1, upper-right).

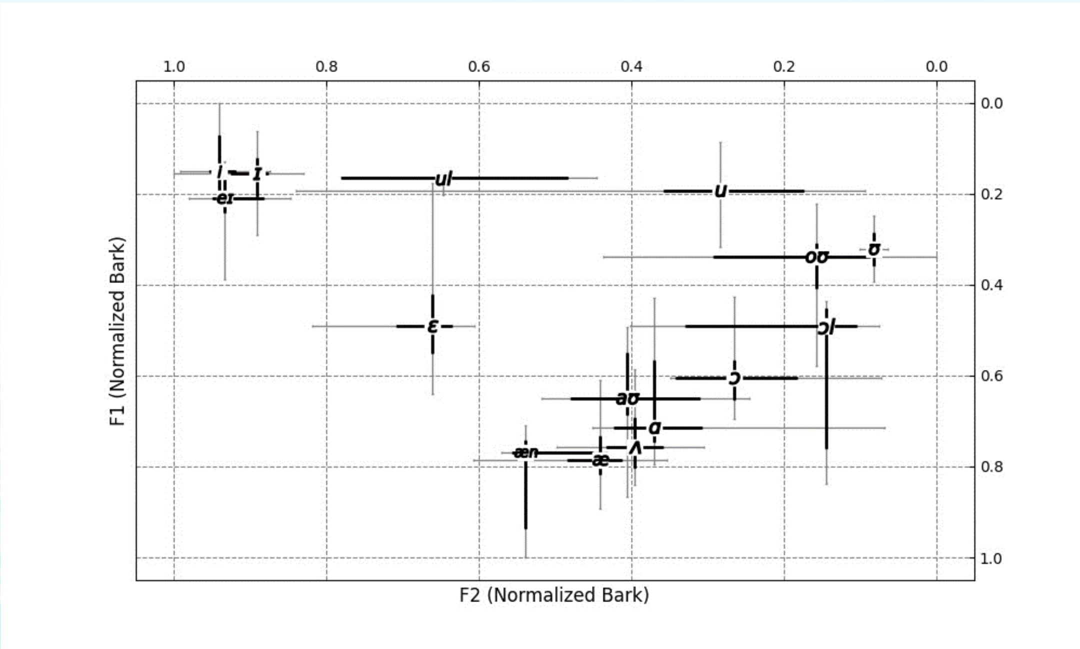

Figure 5. An example of the mesolectal distribution.

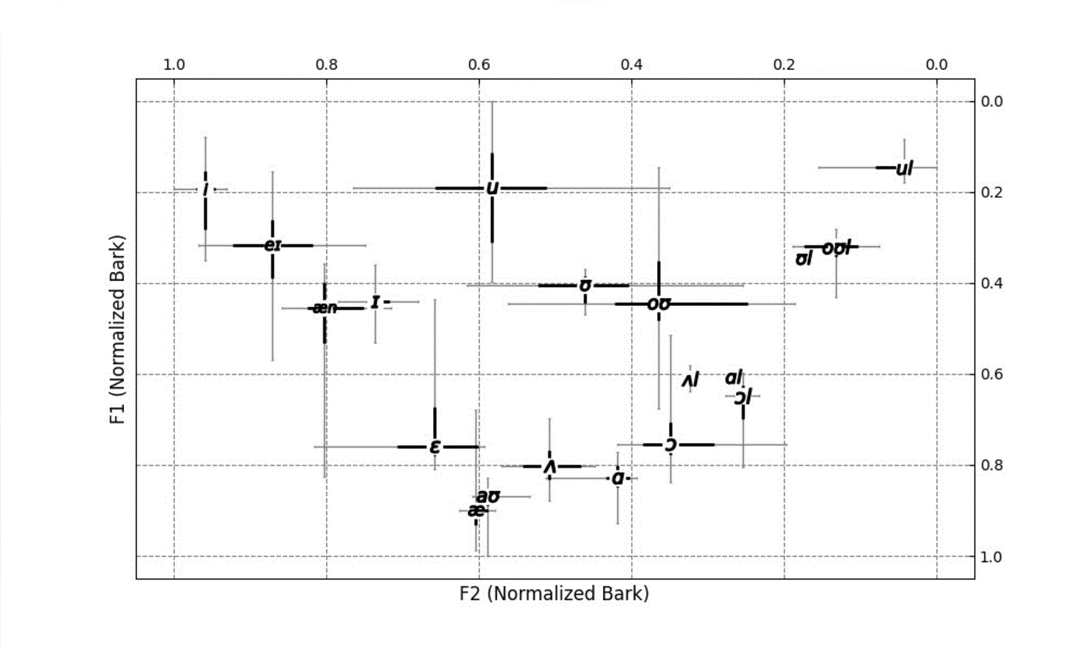

Figure 6. An example of the vowel distribution of General American.

The majority of speakers presented consistent front-vowel distribution throughout the recordings, but certain speakers presented varied back-vowel distributions according to the speech style. For example, one participant presented acrolectal back-vowel distribution when reading short sentences or phrases, while they exhibited mesolectal distributions when reading lists of words.

5. Conclusion and Future Prospects

The present study acoustically observed three patterns of back-vowel distribution in addition to the previously reported characteristics of Filipino English. It was indicated that the three distributions showed stylistic variation in certain participants' speech. No inter-language variation was attested in the present research.

Since the participants exhibited continuum vowel inventories between mesolect and acrolect, it is suggested that Japanese seafarers communicating with Filipinos onboard and listening to their English should become accustomed to the mesolectal pronunciations of the Filipino English vowels.

Although this study is more oriented toward linguistic interests and is still a preliminary stage of maritime English research, it is indicated that the aforementioned vowel distribution may appear in onboard communication with Filipino seafarers. It is worth investigating the effect of stylistic variation on the intelligibility of Japanese-Filipino communications through auditory experiments in future research. Appendix A The North Wind and the Sun

The North Wind and the Sun were disputing which was the stronger, when a traveler came along wrapped in a warm cloak. They agreed that the one who first succeeded in making the traveler take his cloak off should be considered stronger than the other. Then the North Wind blew as hard as he could, but the more he blew the more closely did the traveler fold his cloak around him, and at last the North Wind gave up the attempt. Then the Sun shined out warmly, and immediately the traveler took off his cloak. And so the North Wind was obliged to confess that the Sun was the stronger of the two.

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Appendix B The Selected SMCPs based on Takagi and Uchida (2011)

(1) This is Motor Vessel Sea Hawk, Sea Hawk, call sign JPAT, JPAT, Come in please.

(2) I read you loud and clear. How do you read me? Over.

(3) I suggest port to port passing. Do you agree?

(4) Port to port passing. I agree. I will alter course to starboard for port to port, red to red passing.

(5) Changing to Channel one four. Channel one four.

(6) Going back to Channel one six. Over and out.

(7) What are your intentions.

(8) My flag state is the Philippines. My last port of call was Mindoro. My cargo is crude oil.

(9) Aft station, aft station, this is bridge. Make fast the tug on the starboard quarter.

(10) The pilot boat is approaching. Rig the pilot ladder 1 meter above water.

(11) My present course is 135 (one three five) degrees. My speed is 15 (one five) knots.

(12) The CPA of the vessel 20 (two zero) degrees on our port bow is 3 nautical miles, the TCPA is 13 (one three) minutes.

(13) We will use the starboard anchor and put 7 shackles in the water.

(14) Mayday, Mayday, Mayday. This is motor vessel X (substitute X with your family name). Our present position is 090 (zero nine zero) degrees from the Bravo Buoy, distance 8 cables. I am on fire after explosion. I am sinking.

Appendix C The Word List

Table 2. List of words recorded at MMMA.

cap	foot	tin	fast	bat	pool	Don	feet
available	sip	cup	Paul	tug	possess	pose	fool
three	simple	den	full	fan	live (verb)	pole	force
fit	then	pan	tap	forth	zip	coat	saw
pull	bus	dough	gone	day	caught	aft	pat
laugh	pace	very	vat	leaf	buzz	fat	dawn
code	tape	apt	face	con	leap	gap	faith
bathe	through	cot	ban	sample	possible	van	focus
cod	fort	row	pig	love	surface	tuck	warp
process	batch	tree	purpose	thin	worth	station	
badge	decision	cough	fate	raw	comfortable	lot	
phase	wharf	they	worthy	dove	pick	food	
dub	something	tab	true	berry	lip	past	
though	sue	caution	ship	leave	cub	zoo	

PHILIPPINE MARITIME EDUCATION AND TRAINING STANDARDS ON EXAMINATION AND ASSESSMENT

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Abstract: One of the regular issues raised by inspectors from countries that recognize Philippines Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) certificates under Regulation I/10 is the low quality of assessment instruments used by Maritime Higher Educational Institutions (MHEIs).This paper addresses the issue through the Table of Outcome Assessments (TOA) system that will standardize the various examination and assessment systems used by MHEIs and focus on assessing the course outcome statements to include the STCW competence, knowledge, understanding, and proficiency addressed by the course.
The TOA did away with the higher order thinking skill (HOTS) and lower order thinking skill (LOTS) taxonomy in summative assessment but stays with the STCW taxonomy. The main difference between the old and the new system is that with the TOA, the assessment instrument must align with STCW Table A column 3 "methods for demonstrating competence" and column 4 "criteria for evaluating competence." The final instruments are also referred to as authentic assessment as it requires the candidates to perform tasks that are similar, if not the same, as actual duties aboard ships. By standardizing the MHEIs examination and assessment systems, aligning all instruments to column 3 and column 4 of the STCW Code, it is believed that the issue raised by international inspectors will be resolved. The TOA was adopted by the Philippine administration and issued as Policies, Standards, and Guidelines (PSG) of maritime higher education under Joint Commission on Higher Education and Maritime Industry Authority (CHED-MARINA) Memorandum Circular 01 series of 2023 requiring all MHEIs to develop their examination and assessment to align to the system. The above conclusion was validated when the Independent Evaluators on their second visit sampled the TOA instruments and accepted the same as compliant to the STCW Code.

Keywords: MET, Examination and Assessment, CPS, SPAR

Introduction

The 1978 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), as amended, provides for recognition of certificates issued by one party by another party to the convention as per Regulation I/10. The provisions provide a mechanism for the Administration making the recognition to "*[confirm], through an evaluation of that Party, which may include inspection of the facilities and procedures that the requirements of the Convention regarding standards of competence, training and certification and quality standards are fully complied with*."

Armed with this provision, the European Maritime Safety Agency (EMSA) carried out inspection on the implementation of the STCW Convention in the Philippines seven times:

Table 1. EMSA Inspection Visit to Philippines (excerpts from EMSA European Union (EU) report, 2021)

Maritime Administration	Date of Inspection	Draft report sent to the Maritime Administration	Final report sent to the EU Commission and Maritime Administration
Philippines	06-28 Mar 2006	09-08-2006	31-01-2007
Philippines	12-23 Apr 2010	22-06-2010	20-09-2010
Philippines	08-14 Mar 2012	02-04-2012	10-05-2012
Philippines	16-19 Apr 2013	03-06-2013	10-07-2013
Philippines	29 Sept – 3 Oct 2014	21-11-2014	19-12-2014
Philippines	13-23 Mar 2017	20-06-2017	11-07-2017
Philippines	24 Feb – 13 Mar 2020	30-10-2020	15-01-2021

The results of all these seven (7) EMSA inspections are the same: the requirements of the Convention regarding standards of competence, training and certification, and quality standards were not fully complied with.

Below is the actual inspection report under the 2020 inspection:

The Philippines is included in the '*List of third countries recognized as regards the systems for training and certification of seafarers for the purposes of Directive 2008/106/EC*'2. The re-assessment of the Philippines was initiated in 2006 with the first inspection conducted by EMSA. This inspection was followed by a series of other inspections conducted in 2010, 2012, 2013 (when two inspections were conducted), 2014 and 2017. Following assessment by the European Commission, the system of the Philippines was considered not to be giving full and complete effect to the provisions of the STCW Convention and Code.

Stronger words were used in the latest "*Notification following the reassessment inspection regarding the maritime certification, training and certification system of the Republic of the Philippines,*" sent to the Maritime Industry Administration (MARINA), dated 20 December 2021, signed by Mr. Henrik Hololei, Director-General of the European Commission's department for Mobility and Transport. The terms "shortcomings" and "deficiencies" were no longer enough and findings such as the "*inconsistent teaching and examination methods, facilities and equipment,*" referring to the Maritime Higher Educational Institutions (MHEIs), were now classified as "grievances." The letter ended with a warning that if the services of the European Commission will not receive within the deadline, no later than 10 March 2022, *"sufficient information demonstrating that the deficiencies have been rectified, the European Commission could, in accordance with article 20(6) of Directive 2008/106/EC, withdraw the EU-wide recognition of the Republic of the Philippines' certificates*."

In case the European Union withdraws recognition of Philippine issued STCW certificates, it will lead to a massive dislocation of Filipino seafarers. In 2017, thirty thousand six hundred fifteen (30,615) officers holding Filipino Certificates of Competence (CoCs) held valid endorsements of recognition issued by EU Member States (*Seafarers' Statistics in the EU - Statistical review 2017 STCW-IS data*), this number does not even include the Filipino ratings which are greater in number.

The Philippines, after failing all the previous EMSA inspections since 2006, cannot afford to fail again for the nth time. Lives of the Filipino seafarers, considered as the country's modern-day heroes, and their families are at stake. The MARINA and the Commission on Higher Education (CHED) jointly created a technical working group to address all the shortcomings found by the EMSA inspectors. The primary author, being a member of the Technical Committee Marine Engineering (TCMARE) of the CHED**,** was also part of this working group.

As representative of the CHED, the primary author accompanied the EMSA inspectors when they visited MHEIs offering STCW academic programs and was fortunate to have viewed the same objective evidence found by the inspectors leading to the grievances.

Below are excerpts from the inspection report on the assessment and examination shortcomings:

1. Exam questions were not designed to evaluate the achievement of the learning outcomes and the related competences.

2. Examination questions and tasks were not related to the cognitive domain specified in the outcome-based syllabi, which did not ensure a coherent level of difficulty and relevance.

3. The tables of specifications (TOS) for the exams did not follow a common approach and the exams did not always adhere to the relevant regulations and criteria and did not cover the competences addressed by the corresponding course.

4. The designed simulator scenarios did not cover all the 'assessment outcomes' defined in the scenario specifications.

5. Several scenarios reproduced unusual situations that were not relevant to the assessment outcomes and did not take into account normal operating shipboard procedures.

6. The tasks described in the specifications were not consistent with the actual tasks carried out by the candidates and some of the tasks were not carried out.

7. Some assessment outcomes required to be assessed by practice were not evaluated through a practical method or not assessed using all the required facilities and equipment.

8. Some assessment tasks and outcomes defined in the simulator exercise documents did not specify the performance and assessment criteria.

9. The examination systems implemented by the MHEIs were not sufficient to evaluate the students' achievement of the learning outcomes. This did not contribute to the implementation of the outcome-based education required by the national regulations. Consequently, the examinations conducted by the MHEIs were not structured, including the methods, media of delivery and procedures as necessary in order to assess the students' achievement of the prescribed standard of competence, as required by Section A-I/6.1.1 of the STCW Code (Shortcoming: Regulation I/6 of the STCW Convention).

Root causes of assessment and examination shortcomings

The CHED shifted to Outcome Based Education (OBE) when they issued CHED Memorandum Order 46 Series of 2012 - *Policy Standard to Enhance Quality Assurance (QA) in Philippine Higher Education through an Outcomes Based and Typology Based QA*. In this issuance, higher academic institutions are required to declare/state what the learners can do and demonstrate at the end of the course or program delivery. Unfortunately, MHEIs did not adopt OBE in terms of assessment and examination and retained the archaic model as described below. One common denominator in all MHEIs is that assessors are all seafarers who studied to qualify to work aboard ship, not to teach. They, therefore, continued the antiquated assessment practice they experienced when they were students.

In Philippine Maritime Education and Training (MET) curriculum, the term "course outcome" is used to refer to the clear statement of what the learner is expected to know, understand, and do as a result of learning experiences after the course. While the meaning of this statement seems to be straightforward and uncomplicated, it is beyond comprehension why MET assessors focus on assessing the topics instead of the outcomes:

a. Topics as per syllabus were assessed, not the course outcomes.

b. The topic delivery time dictated the number of questioners.

c. The topic instruments were distributed in the "Table of Specifications" (TOS) via Bloom's Taxonomy starting with remembering followed by understanding, applying, analyzing, evaluating and creating (Anderson & Krathwohl, 2001), regardless of the outcome taxonomy.

d. Higher Order Thinking Skills (HOTS) was the norm, replacing STCW taxonomy.

e. Level of difficulty is defined as number of correct responses divided by number of all responses, thus, when all learners get the correct response, instead of jubilation for attainment of the learning outcomes, questions were raised as to instrument validity.

f. STCW competence, Knowledge, Understanding, and Proficiency (KUP), method for demonstrating competence, and criteria for demonstrating competence were all ignored.

Practical assessments were a hodgepodge of what equipment was available, with no semblance of structure and no defined standards as to acceptable performance by the learners. As with cognitive examination, STCW competence, KUP's, methods of demonstrating competence, and criteria for evaluating competence were mostly ignored.

Authentic assessment was not adopted resulting to "scenarios that reproduced unusual situations that were not relevant to the assessment outcomes and did not take into account normal operating shipboard procedures" (EMSA inspection report, 2021).

The CHED Policies, Standards, and Guidelines (PSG) regulation requires that maritime assessors have completed training on Assessment, Examination & Certification of Seafarers (IMO Model Course 3.12) and Simulator Instructors and Assessors (IMO Model Course 6.10). In fact, the topic-based assessment, distribution of progressively higher order thinking skills taxonomy, and the level of difficulty formula were part and parcel of these model courses that in hindsight lead the Philippine MET assessors astray from the path expected by EMSA inspectors.

In summary, Philippine MET examination and assessment regularly failed the EMSA inspections due to the continued use of the obsolete topic-based assessment, lack of regulatory assessment standards and inadequate faculty development.

The Table of Outcomes Assessment (TOA)

To ensure that the Philippine MHEIs examination and assessment system is fit for purpose and acceptable to external inspectors, instead of doing the same thing while hoping that this time it will be acceptable, it is a must not to repeat past mistakes. A new system of examination structure and assessment system needs to be adopted to replace the antiquated topic-based TOS system, coupled with regulatory guide and standards, followed by workshops on the system to ensure faculty adoption and development.

In the preparation of summative assessment instrument, TOA must replace the TOS for both theoretical and practical assessment and is now structured around the STCW table of competences with the following elements:

1. Assess all Course Outcomes (CO), the addressed competence and related competences, and the knowledge, understanding and proficiency, as defined in the course specifications in the PSG.

2. The method of assessment is defined by STCW Table A-II/1 or III/1 Column 3 (C3), methods for demonstrating competence.

3. The standard to pass the assessment is defined by STCW Table A-II/1 or III/1 Column 4 (C4), criteria for evaluating competence.

4. Assessment instrument taxonomy must retain the taxonomy as per Course Outcome (CO); in case the CO is not aligned with STCW C4, the verb required by C4 is used.

5. Level of difficulty is defined as number of thinking processes required to solve the problem.

6. Instrument shall be authentic, i.e. the question and or the task and scenario shall be similar or the same as what the seafarers encountered aboard ship.

7. The assessment instrument shall contain three (3) elements

a. Theoretical = Taxonomy + Object of the verb + Standards

b. Practical = Condition + Performance + Standards (CPS)

8. Correct response by the candidate

a. Theoretical: Must satisfy the elements of the instrument, i.e. Verb + Object of the verb + Standard and STCW C4 Criteria for evaluating competence

b. Practical: minimum performance=Safety + Procedure + Results (SPAR) and must satisfy STCW C4 Criteria for evaluating competence

Level of difficulty

Since the quotient of the correct response divided by all responses is no longer the basis of the assessment level of difficulty, or using higher taxonomy, but the context by which the taxonomy is used, to convince cynics, the system should be demonstrated to convince MET stakeholders to adopt the system.

By way of example, we use the Marine Transportation and Marine Engineering common course Maritime Law with the following elements, as defined in the course specification in PSG Joint CHED MARINA Memorandum Circular (JCMMC) 1 s2023:

a. STCW Competence: *Monitor compliance with legislative requirements*

b. KUP addressed: *Basic working knowledge of the relevant IMO conventions concerning safety of life at sea, security and protection of the marine environment*

c. Course outcome: *Identify evidence of compliance with legislative requirements relating to safety of life at sea, security and protection of the marine environment.*

d. C3-Method for demonstrating competence: *Examination*

e. C4-Criteria for evaluating competence: *Legislative requirements relating to safety of life at sea, security and protection of the marine environment are correctly identified*

The CO taxonomy identifies and mirrors the taxonomy in the criteria for evaluating competence to correctly identify legislative requirements. Thus, in the crafting of assessment instruments, the verb identify (Blooms remembering) must be always used with varying levels of difficulty. Below are assessment instrument examples in the context of Philippine legislation domesticating international conventions:

Assessment instrument with different levels of difficulty:

a. Easy: Identify the legislative act relating to the STCW convention?

Correct response: Republic Act (RA) 8544 and/or RA 10635

b. Medium: Identify the legislative act that harmonizes all legal and administrative measures relating to the STCW convention?

Correct response: RA 10635

c. Difficult: Identify evidence of Philippine (seafarer's) compliance with legislative requirements relating to Regulations III/2 of the STCW convention?

Correct response: An E4 license issued by the Philippine administration is evidence of compliance to the legislative requirements of RA 8544 relating to Regulation III/2 of the STCW convention.

In the above examples, without changing the verb "identify," we created assessment instruments with progressing difficulty. The easy question has two (2) possible correct answers with surface knowledge of the law; the medium question requires the learner to at least read the provisions of the legislation; and lastly, the difficult questions require in-depth knowledge of the law and of the convention. This is HOTS while remaining aligned to the criteria for evaluating competence.

Dissecting the assessment instrument and the correct response

Instrument: Identify evidence of Philippine (seafarer's) compliance with legislative requirements relating to Regulations III/2 of the STCW convention.

a. Taxonomy: Identify evidence

b. Object of the verb: Philippine (seafarer's) compliance with legislative requirements

c. Standards: relating to Regulations III/2 of the STCW convention

Correct response: An E4 license issued by the Philippine administration is evidence of compliance to the legislative requirements of RA 8544 relating to Regulation III/2 of the STCW convention.

a. Taxonomy (identity evidence) E4 license

b. Object of the verb (compliance to legislation) RA 8544

c. Standards (relating to) STCW convention

To aid and simplify the adoption of the TOA by MET assessors, a template will be issued to all MHEIs

Table 2: Table of Outcome Assessment template

Elements	Assessors Guide
1. Course	Encode here the Course Descriptive Title
2. Course Outcome addressed	Encode here the CO to be assessed
3. STCW competence addressed	Encode here the specific competence covered by the course and addressed by the instrument
4. KUP addressed	Encode here the specific KUP under the competence addressed by the course
5. Methods for demonstrating competence Go to STCW code Column 3	Identify if assessment is theoretical/practical or both BSMT- Table A: II/1 C3 BSMARE – Table A: III/1 C3 Column 3 Method for demonstrating competence Examination= Theoretical required Assessment + workshop/lab/simulator= Practical required
Theoretical or cognitive	Answer this with required or not required
Practical or Psychomotor	Answer this with required or not required
Laboratory equipment	Answer this with required/alternate/Not applicable
Simulator	Answer this with required/alternate/Not applicable
6. Criteria for evaluating competence Go to STCW code Column 4	Copy and paste Criteria for evaluating competence aligned to the competence to be assessed. This will point to the standard that must be met.

	Identify the elements of the competence that must be assessed, and all KUP covered by the competence.
7. Write the assessment instrument using the three elements	
Theoretical or Cognitive	Taxonomy + Object of the verb + Standard
Taxonomy	Retain the taxonomy of the course outcome statement, if the outcome taxonomy is not aligned to STCW C4, the assessor to follow the verb required by STCW C4.
Correct Response	Must satisfy Verb + Object of the verb + Standard Must satisfy STCW C4 Criteria for evaluating competence
Coverage	All elements of the competence
Level of difficulty	Number of thought processes required to solve the problem using the same taxonomy. Distribution of level of difficulty, institutional decision
Theoretical	**Correct Response**
7.1 Instrument 1	
7.2 Instrument 2	
Practical or Psychomotor	Written as task with the following elements: Condition + Performance + Standards (CPS) Note: see Practical Assessment Guide
Task	As per outcome statement, or as stated in the competence, KUP, or from criteria for evaluating competence. Authentic assessment.
Minimum performance	Safety + Procedure + Results (SPAR) Must satisfy STCW C4 Criteria for evaluating competence
Coverage	All KUP under the competence requiring practical assessment
Practical	**Minimum Performance**
7.a See exercise document Task #1	
7.b See exercise document Task #2	
Prepared by: Reviewed by: Approved by:	

Table 3. Example of TOA Theoretical Assessment Documentation

Elements	**Example**
1. Course	Maritime law
2. Course Outcome addressed	CO1. Identify evidence of compliance with legislative requirements relating to safety of life at sea, security and protection of the marine environment.
3. STCW competence addressed	Monitor compliance with legislative requirements
4. KUP addressed	Basic working knowledge of the relevant IMO conventions concerning safety of life at sea, security and protection of the marine environment
5. STCW code Column 3 Methods for demonstrating competence	Assessment of evidence obtained from examination or approved training
Examination or cognitive	Required
Psychomotor	Not required
Laboratory equipment	Not applicable
Simulator	Not applicable
6. STCW code Column 4 Criteria for evaluating competence	Legislative requirements relating to safety of life at sea, security and protection of the marine environment are correctly identified*
Safety & Security	a. SOLAS convention and family i.e. ISM
	b. STCW
	c. Maritime Labor Convention
	d. PSC Memorandum of Understanding
Protection of the marine environment	e. MARPOL Convention
	f. Ballast Water Convention
	g. Anti Fouling Convention
	*This means that all legislative requirements from a. to g. must be assessed and correctly identified.

7. Write the assessment instrument using the three elements	
Cognitive	Taxonomy + Object of the verb + Standards
Psychomotor	Condition + Performance + Standards
Cognitive	**Correct Response**
7.1 **Essay:** Identify evidence of Philippine (seafarer's) compliance with legislative requirements relating to Regulations III/2 of the STCW convention?	An **E4** license issued by the Philippine administration is evidence of compliance to the legislative requirements of RA 8544 relating to Regulation III/2 of the STCW convention.
7.2	
Prepared by: Reviewed by: Approved by:	

Table 4. TOA Template for Practical Assessment Documentation

Elements	Description
Course	Encode here the Course Descriptive Title
Practical Exercise Title	Refers to the descriptive name of the scenario which is related to the learning outcome.
STCW Competence Addressed	Encode here the specific competence covered by the course and addressed by the practical exercise
KUP Addressed	Encode here the specific KUP under the competence addressed by the activity
Course Outcome Addressed	Encode here the CO under the course addressed by the activity
Task	Encode here the specific activity required of the student through an outcome statement composed of a) Condition, b) Performance. C) Standards.
Pre-requisite	Encode here any requirements needed prior to the practical activity.
Duration	Refers to the estimated time in the execution of the exercise for each phase to complete the entire scenario. (Familiarization, Briefing, activity, debriefing)
Venue/Equipment	Encode here, the location where the activity will be held and the equipment that will be used.
Training Equipment Particulars	Refers to the specifications of the specific equipment within a system that will be used in the practical exercises.
Scenario	Refers to the script or outline of the activities
Initial Condition	Refers to the starting state of the equipment/environment, at which the student will use as starting point in performing the given task.
Failure state	Refer to the conditions by which the exercise will be prematurely terminated
Student's Actions	Refers to the activities the student is expected to undertake while undergoing the practical exercise.
Performance Criteria:	Refers to the description of the quality of student's performance in accordance with the learning outcome. As per STCW Code Column 4 (Minimum SPAR or Safety, Procedural and Results)
Performance Standard: SPAR	Safety: deviation from standard
	Procedural: deviation from standard
	Results: deviation from standard
Prepared by: Reviewed by: Approved by:	

An example of TOA Practical Assessment Documentation was already presented by the principal author at IMLA 24 Conference 10-14, November 2016 in Texas A&M University, Galveston, Texas, US. At that time, the TOA for both theoretical and practical were not yet part of the administration's PSG.

The TOA system was accepted by the technical working group and subsequently approved by the Technical Panel for Maritime Education (TPME) and by the CHED Commissioners. It was initially adopted in the PSG JCMMC 1 series of 2022 and again embedded under the latest PSG JCMMC 1 series of 2023. However, due to some resistance, the topic-based Table of Specifications (TOS) was retained for formative assessment.

There are six sections and one annex from PSG JCMMC 1 series of 2023 on examination and assessment that are driven by the EMSA-EU grievances and on the adoption of the TOA system. The most important provisions are quoted verbatim below:

Section 2.2. *Assessment of Competence: Refers to the process of evaluating evidence of competence through one or more of the methods of demonstrating competence under Columns 3 and 4 of the competency tables of the STCW Code.*

Section 16. *The MHEI shall design and develop, review and verify, validate and approve their theoretical and practical assessment tools for all Course Outcomes defined in the course specifications.*

Section 18. *MHEI shall establish a structured examination and assessment system.*

Annex E: *Procedures manual for assessment and evaluation*

Section 2.2 requires MET examination and assessment aligned with STCW C3-method for demonstrating competence and C4-criteria for evaluating competence. Section 16, on the other hand, mandates assessment for all course outcomes and related competences and informs the MHEIs that for purposes of Administration monitoring, only the summative examination will be the basis for making a finding while the formative assessment will be left to the institution's discretion. Section 18 specifically addresses the whole process of examination and assessment system to be structured. By structured, it refers to standardized design, development, review, verification, validation and approval of theoretical and practical assessment tools, the documentation of which can be found in the institution's quality standard system manual. Annex E of the PSG contained the procedure manual for both summative and formative assessment.

On the second or return visit in 2022 of the Independent Evaluators, as provided for under STCW Regulation 1/8, they reviewed the CHED examination and assessment system including examples of instrument and have given their seal of approval.

To ensure full adoption of the structured examination and assessment system as provided for under the PSG, CHED scheduled seminar workshop on assessment of seafarers' competence alignment to the requirements JCMMC 1 series of 2023 this 3rd quarter of 2024 for MET assessors.

Full disclosure

The primary author, C/E Rodolfo Paiso is the chairman of the Technical Committee Marine Engineering (TCMARE) of the Commission on Higher Education (CHED), the primary agency that regulates and supervises higher education in the Philippines. TCMARE is the working arm of the Commission that develops Policies, Standards and Guidelines (PSG) addressing STCW maritime education and training (MET) programs. The summative theoretical and practical assessment now embedded in the PSG Joint CHED MARINA Memorandum Circular (JCMMC) 1 series 2023 was contributed by the author in his capacity as member of the TCMARE.

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DELIBERATE PRAGMATIC OMISSIONS IN MARITIME VHF COMMUNICATIONS

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Abstract: Maritime VHF communications follow specific rules of procedure and guidelines to achieve clarity, efficiency and speed in message transfer. However, owing to reasons of language economy it is not infrequent to find that certain parts of the syntactic structure are omitted in routine communication. Although there are guidelines and recommendations to ensure safe, clear and effective communication, officers on board vessels, as well as shore service operators frequently resort to pragmatic omissions for the sake of language economy. The omission of redundancies is quite common in natural dialogue, especially in common activities, so-called scripts, where the utterances are stereotyped. In the case of maritime communications, particularly routine communication, there are informationally redundant utterances (overinformative) that can trigger pragmatic omissions as pieces of information can be inferred from prior context and from the knowledge of the world shared by the participants in maritime VHF exchanges. The goal of this paper is to analyze 30 routine exchanges from the Adriatic area to investigate which elements of VHF message and which items of syntactic structure are most often omitted. The sample communication exchanges have been collected in the area of the Adriatic and constitute a part of a large corpus of exchanges from the area. The sample exchanges will be analyzed qualitatively and quantitatively. The communication exchanges will be analyzed quantitatively according to a set of pre-defined variables to determine which parts of speech and syntactic structures are most commonly omitted through a gap analysis. Afterwards, a qualitative analysis will be undertaken to gain a deeper insight into the issues raised by the quantitative analysis.

Keywords: VHF communications; spoken corpus; omissions

1. Introduction

Effective communication in maritime traffic is one of the prerequisites for ensuring safety at sea. This paper focuses specifically on VHF communications which follow specific rules of procedure and guidelines to achieve clarity, efficiency and speed in message transfer.

VHF communications are covered in various documents, regulating its structure and phraseology with the goal of achieving understanding of the intended message between the sender and the receiver, reducing the risks of misunderstandings despite differences in language (IALA 2017). English as the official language of maritime communications is defined in the Regulation V/14.4 of the International Convention for the Safety of Life at Sea (IMO 2020). The IMO Resolution A.1158(32) Guidelines for vessel traffic services states that communication should be “timely, clear and unambiguous”, while the IMO Resolution A.918(22) IMO Standard Marine Communication Phrases emphasize the need for standardization of the language used to ensure “precise, simple and unambiguous” communication. The IALA Recommendation R1012 VTS Communications also advocates for the standardization of phraseology, procedures and technology of VTS communications as a means of reducing risks of misunderstandings. The IALA Guideline G1132 VTS Voice Communications and Phraseology also states that “Ambiguous or non-standard phrases are frequent causal or contributory factors in marine casualty, incident and near miss situations”. As a great majority of the participants in VHF communication are non-native speakers of English, the issue of effective and clear communication is rather important. Hence, the Standard Maritime Communication Phrases (SMCP) (IMO 2002) were designed to promote standardized communication in predictable contexts of situation. Unfortunately, as Jurkovič et al (2019) has shown, the recommendations and rules for the standards in maritime communication are inconsistent and dispersed among the various documents that proscribe them, which gives room for inconsistent application of the standard in real-life situations.

It has been highlighted in some research studies (cf. Johnson 1994, Pritchard and Kalogjera 2000, Kataria 2011, Dževerdanović-Pejović 2013; Jurkovič et al. 2019) that maritime VHF communication resembles spoken everyday dialogue. Most theories of pragmatics state that redundancy is avoided in spoken discourse (Kravtchenko

& Demberg 2022) and this has also been noted in maritime communications. The omission of redundancies is quite common in natural dialogue, particularly in common activities, or scripts, where the utterances are stereotyped. Although there are guidelines and recommendations to ensure safe, clear and effective communication, officers on board vessels, as well as shore service operators frequently resort to pragmatic omissions for the sake of language economy. In the case of maritime communications, particularly routine communication, there are informationally redundant utterances that can trigger pragmatic omissions as pieces of information can be inferred from prior context and particularly from the knowledge of the world shared by the participants in maritime VHF exchanges. The goal of this paper is to analyze 30 routine exchanges from the Adriatic area to investigate which elements of VHF message and which items of syntactic structure are most often omitted.

2. Background

Besides the regulatory framework regarding VHF communications, various research studies have been conducted which deal with VHF communications from the aspect of their divergence from the standard protocol on the macro- and micro-levels (e.g. Jurkovič 2022, Ahmmed 2020, Boström 2020, Jurkovič et al 2019, Brodje et al 2012), the discourse features (e.g. John et al 2019, John et al 2017, Dževerdanović-Pejović 2013, Pritchard & Kalogjera 2000), the macro-level structure (cf. Bocanegra-Valle, 2011), most frequent topics and scenarios (e.g. Pritchard & Kalogjera 2000; Perea-Barberá & Parada Galindo 2020) or general features of VHF communications (e.g. Franceschi 2014, Bocanegra-Valle 2011). When it comes to discrepancies with the standard protocol of communication, the studies mostly report on various omissions, either omissions of parts of the standard protocol or omissions of parts of sentences. On the macro-level, the segment that is most often omitted is the first move, "establishing contact" (cf. Pritchard & Kalogjera 2000, Jurkovič 2022), while on the micro-level the parts that are most often omitted are the turn-yielding signals "over" and "out" and message markers (cf. Jurkovič 2022), while on the syntactic level Ahmmed (2020) reported on the ellipsis of subjects or predicates in 9.3 % of the analyzed conversations.

As noted previously, maritime VHF communications approximate to everyday spoken interaction in some features. One of these features are deliberate omissions, or ellipsis, of parts of messages or parts of sentences. White (2013) considers these omissions as markers of interaction in spoken discourse. Brazil (1995) refers to omissions as "zero realization" of elements within an utterance which the speakers might expect owing to the logic of sequencing rules within the utterance. In this way, the speaker avoids making a second reference to a unit in the same sequence. This is an effective strategy of economic efficiency in spoken discourse that can frequently be found in informal types of spoken discourse such as chatlogs, text messages and textchats (cf. Scott 2013, White 2011). However, these omissions are one of the reasons that spoken discourse is considered ambiguous, which is something to be avoided in VHF communications. The ambiguity stems from the fact that the hearer needs to infer the elements that have been left out by relying on the context, extra-linguistic information as well as their knowledge of the world. Several studies tried to investigate the different functions of omissions in spoken discourse. One of the most commonly mentioned reasons why omissions occur is the so-called "law of least effort" (Zipf 1949), which states that the people try to minimize their efforts when performing an activity. Omissions also help the participants to develop and maintain a shared understanding in the discourse, i.e. the so-called intersubjective alignment (cf. White 2013, Oh 2005). They also indicate that the interlocutor is following along and that the interaction is progressing smoothly (ibid.). Omissions can also be used for self-correction, rephrasing, maintaining coherence or even boosting the meaning of some parts of the message (cf. Oh 2005, Hendriks & Spenader 2005). Omissions in spoken discourse were also classified into syntactic, i.e. when the meaning is inferred from the syntactic context, semantic, i.e. when the pragmatic context helps in understanding, and situational omissions discussed by Oh (2005) when referring to the omissions of personal pronouns.

One of the recommendations for maritime VHF communications is the use of full sentences. However, as the examples from our corpus show, owing to various reasons, the speakers often do not comply with it. Therefore, it is not uncommon to find examples like (1), where the noun has been omitted, (2) where the verb has been omitted, or (3) where the preposition has been omitted.

(1) Stand by zero nine.

(2) Good watch.

(3) We sent it sixteen forty-one.

This work aims to analyze the omissions found in a corpus of specialized spoken discourse of maritime VHF communications between shore services and ships in the Adriatic area. The analysis specifically focused on a sample of 30 communication exchanges selected randomly from the corpus to see what linguistic units and message parts are omitted in speech and detect any differences between the shore services and the ship regarding these omissions.

3. Methods

The research was conducted on a sample of communication exchanges extracted from a larger corpus of communication exchanges collected in the area of the Adriatic. The corpus consists of about 15 hours of communication exchanges between the shore service operators and ships. The recordings were granted by the Maritime Safety Directorate of the Croatian Ministry of the Sea, Transport and Infrastructure provided that the recordings are treated in accordance with the EU General Data Protection Regulation. This meant the anonymization of the data during the transcription stage and complete confidentiality of the audio materials. Anonymization included the removal of any personal information, e.g. ship names, place names, station names, from the transcribed corpus so that messages cannot be associated with specific ships or places.

The sample exchanges were selected randomly from the corpus and were then analyzed quantitatively and qualitatively. Even though the selection was random, care was taken to have various scenarios in the final selection to avoid any bias because of topicality. The communication exchanges were first analyzed statistically according to a set of pre-defined variables to determine which parts of speech, syntactic structures and message parts are most commonly omitted through a gap analysis. The observed variables were selected based on a qualitative analysis of the samples whereby the omitted elements were identified. The selected variables consisted of three groups:

1) Message parts (address, This is, identify, over, out)

2) Parts of speech (POS) (personal pronouns, nouns, auxiliary verbs, main verbs, prepositions, question words, articles).

3) Syntactic elements (subject, predicate, object).

The standard parts of the message, recommended according to above-mentioned guidelines and documents, were selected to check the level of adherence on a macro-level of structure. Specific parts of speech were selected to observe the omissions made at the level of turn, in individual sentences and the omissions of syntactic elements were analyzed to see where the omissions occur in sentences. After identifying the variables, the transcribed exchanges were separated into columns, one for the ship and the other for the shore service, and then into individual turns. Each turn was assigned with the value “1” or “0” depending on whether a variable was expected in a specific turn and whether it was observed in a particular turn. This annotation served as basis for quantitative analysis.

4. Results and discussion

The analysis of 30 selected sample exchanges included 170 turns by ships and 158 turns by shore stations. The results of the gap analysis, shown in Figure 1, indicate that shore stations more frequently addressed the vessels and used the turn-indicating signal “Over” and “Out” more than ships, while ships more frequently identified themselves and used the phrase “This is” more than shore stations. These results are expected in light of the role of the shore stations and the fact that ships need to identify themselves to the shore stations. As for the use of POS, the results of the analysis show that ships more frequently omitted personal pronouns, nouns and auxiliary verbs, while shore stations omitted more full verbs and question words. Qualitative analysis of exchanges showed that shore stations frequently used nouns to indicate a full question, particularly in exchanges involving maritime reporting, like in the example (4):

(4) Shore station: ETA?

Ship: ETA zero six zero zero local time.

Shore station: Total person on board?

Ship: Twelve crew members. One two crew members. And no passengers.

Shore station: Cargo?

Ship: I am in ballast condition. Not gas. Free.

Shore station: Bunker?

(…)

Maritime reports are one of the more frequent scenarios or scripts and the speakers are familiar with the procedure. In this particular example, the turns constitute only of the bare information, which is most often conveyed by nouns. Therefore, even though the sentences are stripped down to a bare minimum, the omissions do not pose an obstacle for understanding. In such instances, the speakers also resort to the cooperative principle in interaction (Grice 1975), which is one of the basic principles of spoken discourse. According to the principle, the speakers cooperate in an interaction by being truthful, informative, relevant, and clear to make the communication successful. The increased use of nouns also contributes to information density (Biber 1989), while less omissions of main verbs by ships may indicate that they are more oriented towards situations and actions. It should also be noted that prepositions are not frequently omitted, which is probably due to the fact that they perform a specific role in connecting words, conveying specific information about location, time or direction and expressing relations between words. Articles, on the other hand, are frequently omitted, which might be due to the fact that this occurs in SMCP as well or to the fact that their omission is not crucial to understanding the message.

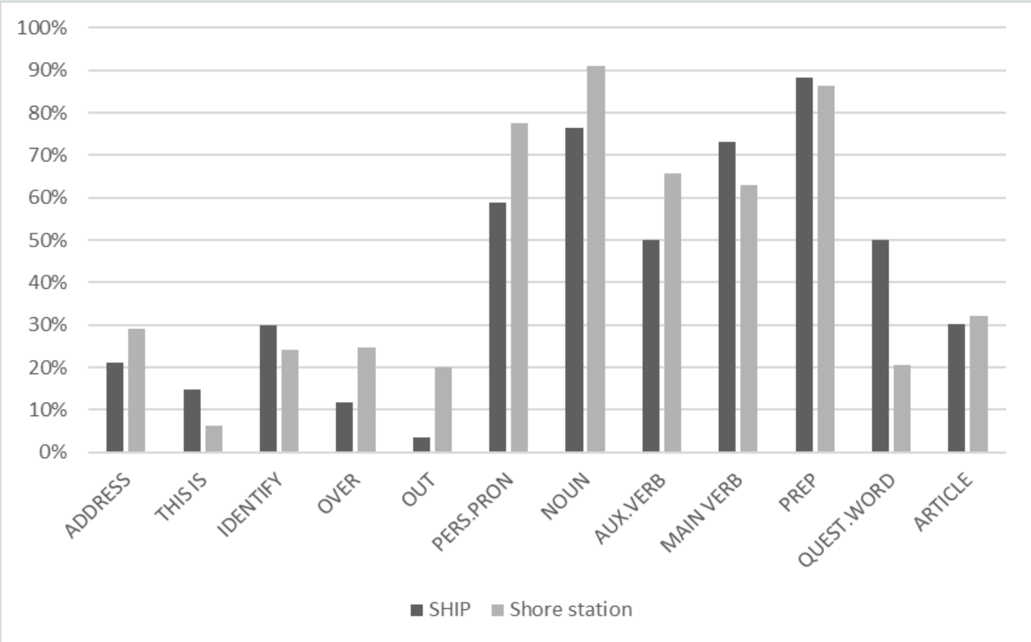

Figure 1. Observed values for variables in ship discourse and shore station discourse

Figure 2 shows the expected and observed values for the variables concerning the standard message parts. As mentioned previously, these are the elements of the standard form that are frequently omitted as they require a lot of repetition, which goes against the principle of economy, or least effort in conversation. Qualitative analysis showed that the "address and identify" parts are used in the initial call, or establishing contact stage, but not in the rest of the exchange unless there has been an interruption. These omissions also do not constitute a barrier to understanding, however, it should be noted that the participants in maritime communications share a common knowledge of the world and are therefore never confused with the omissions. In these cases it would perhaps be more suitable to refer to these omissions as "zero realizations" as these units are in fact realized in the participants' common understanding of the context and of communication procedures. The example (5) shows an initial establishment of contact between the ship and the shore station without the use of "This is" and "Over". A person not familiar with the standard would not be able to fill the gaps in the conversation, which would probably influence greatly on their understanding, while the participants in these exchanges have no trouble understanding and communicating.

(5) Vessel. ProperName Traffic. Good morning.

ProperName Traffic. ProperName Traffic. Vessel.

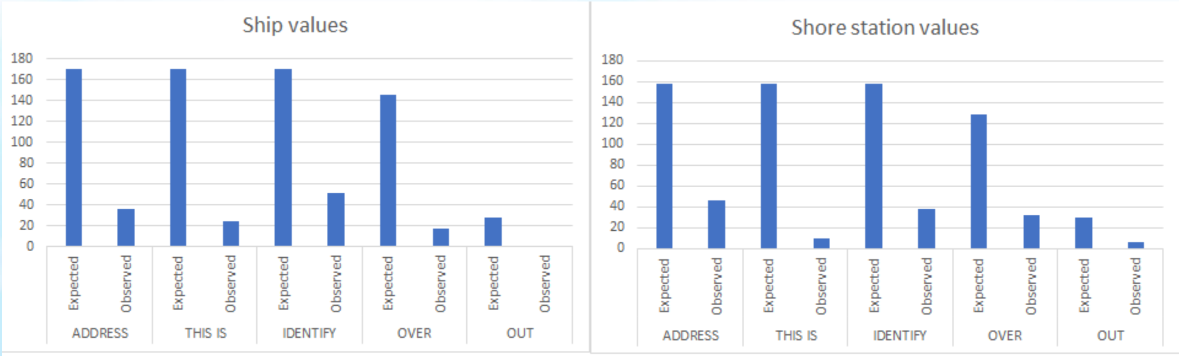

Figure 2. Expected and observed values for variables referring to message parts

The following Figure 3 shows the results for the expected and observed values regarding the parts of speech used in communication exchanges. The values for question words in ship communication have been excluded as there have been very few examples and are therefore not relevant. The results show that omissions occur in all parts of speech. Verbs are more frequently omitted than other parts of speech. Prepositions are the least omitted words in both ship discourse and shore station discourse.

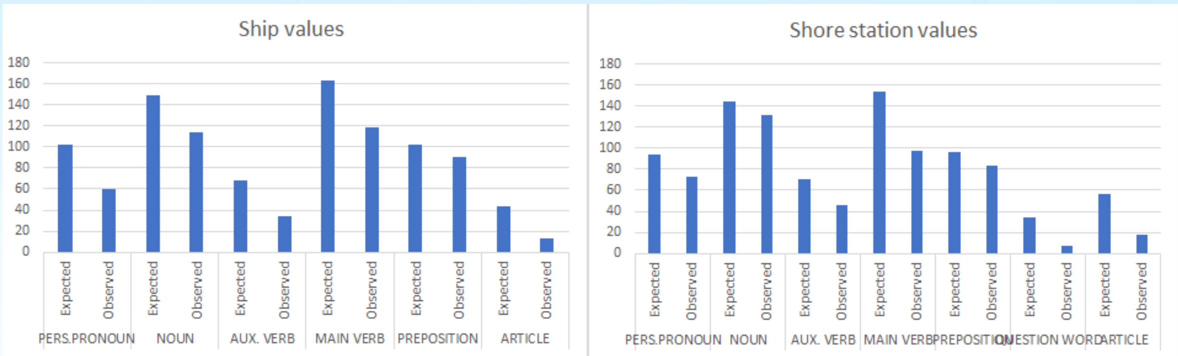

Figure 3. Expected and observed values for POS

The results of expected and observed values for syntactic elements are shown in Figure 4. They mostly reflect the results of the analysis of the POS in that the shore stations omitted predicates more frequently than subjects while the ships omitted subjects more frequently than predicates. However, the interesting result is the one for the objects which are rarely omitted. This might stem from their function in the sentence as they give information about the results or outcomes of an action. As the doer of the action and the action itself might be familiar from the context, the object might be the new information communicated between the speakers.

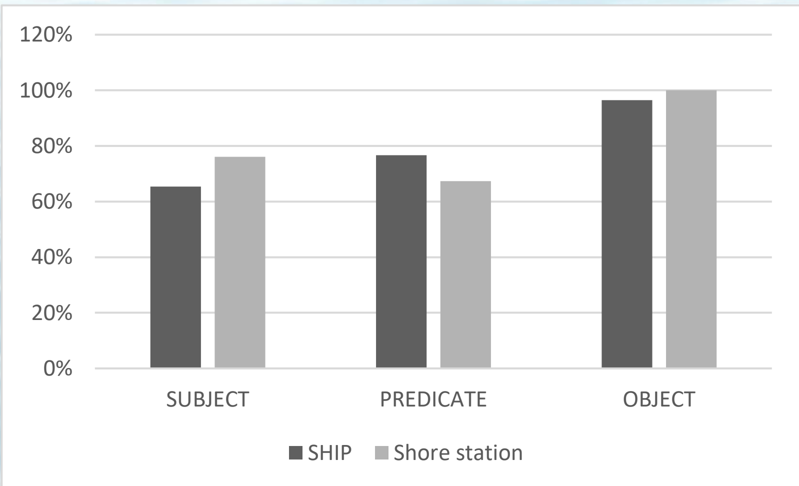

Figure 4. Observed values for syntactic elements in exchanges

3. Conclusion

Even though the sample observed in the study is rather small and restricted in terms of geographical location, the results can be considered relevant as there is a restricted number of scenarios in maritime VHF communications that can be found anywhere in the world. The results of the study have demonstrated that omissions are quite common in everyday routine communication exchanges. Having in mind that VHF communications are realized by voice and listening only, without extralinguistic information, such as facial expressions or gestures to aid comprehension, additional omissions of parts of a message might lead to miscommunication and lack of understanding, which might lead to adverse events. However, these omissions do not hinder communication or understanding of the situation and the utterances are actually more informative and understandable to participants owing to the context of the situation. The participants make pragmatic inferences based on their previous experience and knowledge of the context and thus fill the gaps. The common knowledge of the world enables participants to strip down the utterances and still achieve a high level of understanding and a clear information flow. This cooperative communicative behavior of participants and the predictability of scripts in this kind of communicative act represent the basis for safe and effective communication.

Acknowledgements

This work has been fully supported by the University of Rijeka project code uniri-mladi-human-23-24.

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IMMERSING CULTURALLY AND EMBRACING DIVERSITY FOR A BETTER ME: THE INTERCULTURAL EXPERIENCES OF SELECTED MARITIME CADETS

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Abstract: Interculturalism is becoming inherent in the shipping industry, with different nationalities coming and working together to transport goods and people, and service the economy. It is for this scenario that maritime education and training has integrated in its curriculum the development of intercultural competence among its students, to equip them with the knowledge and skills necessary to survive and thrive in the intercultural and multicultural maritime arena. The Maritime Academy of Asia and the Pacific (MAAP) continually forge partnerships with different organizations to provide as many avenues as possible for the development of the requisite skills of its cadets. Two partner agencies, the International Mariners Management Association of Japan (IMMAJ) and Singapore Polytechnic designed and implemented intercultural immersion programs that MAAP cadets participated in. This study primarily documented the experiences of Filipino students on board the training ship (Group A) and the cruise ship (Group B). In particular, this research delved into the intercultural communications between Filipinos, Japanese, Malaysians, and Singaporeans as seen from the lens of the Filipino students. Specifically, it addressed the following objectives: to describe the communicative atmosphere from the first and the last day of the immersion; to determine the communicative connections that emerged between the two groups during the immersion; to describe the communicative strategies used by both groups during the immersion; and to describe the insights they gained from the experience. The focused group interviews revealed that Group A cadets were initially anxious to communicate with the other students. They were intimidated by the uniform of the Japanese students and were hesitant to initiate conversations because of the absence of a common starting ground. On the other hand, Group B instantly connected with the Singaporean students who welcomed them at the airport and served as their tour guides. Eventually, Group A connected with the Japanese through their showering activity and foods. Meanwhile, Group B strengthened their connections with the other nationalities through recreational activities and shipboard training stories. During their interactions, Group A students made use primarily of non-verbal means to convey their messages. Along the way, they also learned to adjust to each other's verbal communicative uniqueness like pronunciation, accent etc. Group B used simple English words and sometimes broken English to communicate with other students. Both groups realized the value of using English all the time in building their confidence. They also stressed the power of openness, honesty, flexibility, respect, and acceptance in bridging communication gaps, improving social skills and strengthening a team. Both programs have been culturally enriching and educational to both groups of cadets, and its continuation would be contributory to equipping maritime students with competencies required on board and beyond.

Keywords: Intercultural competence, immersion, social and communicative skills

1. Introduction

The shipping industry is a community of differences- races, genders, cultures, preferences, among others. Aboard one ship alone, one may find crew members of different genders, nationalities, religious affiliations, educational backgrounds etc. These crew members compose a team and must work harmoniously to ensure safe operations on board and the efficient delivery of goods across the world. Since communication is imperative in all the ship's operations, intercultural communicative competence among the crew members is necessary. For maritime higher education institutions, one way of developing intercultural communicative competence among the students is intercultural immersion programs. As part of the learning process, cultural immersion "provides students with the opportunity to experience diversity and develop cultural safety" (Bucanan et al. 2021). In addition, such activities or programs affect the view of participants about themselves and about others (Onosu 2021). These goals of immersion programs also address the requirement of a global maritime professional who

"…exhibits a high level of …and multicultural/ diversity awareness and sensitivity… (International Association of Maritime Universities 2019, p.4). Aside from these, immersion programs also "… enhance the students' global mindedness and awareness of social issues" (Maakrun & Kearney 2020). All of the benefits of immersion programs should be capitalized by maritime higher education institutions since their students are going to work in multicultural and multilingual settings.

Recognizing the importance and the benefits of immersion programs, the Maritime Academy of Asia and the Pacific (MAAP) forged partnerships with different maritime entities to maximize the opportunities for the development and advancement of both its maritime faculty and students. Two programs were the focus of this study, the immersion activity for the third year maritime students aboard their training ship in Japan (Group A) and the immersion of the fourth year students aboard a cruise ship (Group B) that sailed from Singapore to Thailand then back to Singapore. In particular, this study documents the cultural and communicative experiences of the Filipino cadets as they lived and interacted with other students of different nationalities on board the ships.

This study addressed the following objectives:

1. to describe the communicative atmosphere from the first and the last day of the immersion;
2. to determine the communicative connections that emerged between the two groups during the immersion;
3. to describe the communicative strategies used by both groups during the immersion; and
4. to describe the insights gained by the students from the experience.

With its unique nature of housing crew members of different nationalities and cultures over a period of time, a ship presents a great opportunity to witness diversity at work. This kind of working environment may be both challenging and rewarding. For instance, Galešić and Coslovich (2019) described the experience of Croatian seafarers working with different nationalities as generally favorable despite the challenges of language and human relationships. Focusing on communication barriers among multinational and multicultural crews, Kumar (2018) described different communication problems and recommended solutions to be undertaken by different stakeholders in the maritime industry. Relatedly, Indonesian seafarers disclosed that they experienced communication challenges while working with multinational workers aboard international ships, but they tried to overcome these challenges using non-verbal means (Riyanto et al. 2023).

With safety in mind, Nævestad et al. (2022) surveyed seafarers working on Greek and Norwegian cargo and passenger vessels, and revealed that more safety concerns arise because of misunderstandings between crew members of different nationalities. To address safety issues brought about by multiculturalism, Montallana et al. (2023) pointed out in their research the importance of awareness of cultural differences and cultural sensitivity. Canimoğlu and Yildirim (2023) also recognized the potential of communication problems to negatively affect the safety of the ship and its operation, and came up with the profile of a seafarer who can effectively work on board multicultural ships. They found that having respect for cultural differences, having respect other religions/beliefs, and being fair were the top three desirable characteristics. In connection to this, Sampson et al. (2020) showed in their study the preference of some seafarers to keep their religion private as they work aboard multicultural ships in order to avoid conflicts with the other crew members.

The previous studies mentioned all point to the crucial role of cultural sensitivity and communication skills in the workplace. Shipping has been recognized as globalized (Sampson et al. 2020; Gekara & Sampson 2021) and as such, seafarers work in a place where they encounter people with different cultural backgrounds and communication abilities.

2. Methodology

This qualitative research used focused group interviews to address the objectives of the study. Two groups of students were interviewed: Group A was composed of third year students who went to Japan and socialized with Japanese students. The group was further divided into two groups (engine and deck groups) for the interview; Group B consisted of four (4) fourth year students who went to Singapore for a maritime experiential learning cruise with Japanese, Singaporean and Malaysian students. Prior to the conduct of the interview, the researcher secured the consent of the students and assured them of the confidentiality of the information they would share. The interview was audio recorded, with the consent of the participants. The responses in the interviews were transcribed, read a number of times, and coded to arrive at categories and themes. During this process, the researcher went back to the objectives of the study every now and then to make sure that the data being analyzed did not deviate.

3. Results and Discussion

After going over the content of the interviews, coding the responses and arriving at themes, the following paragraphs present the answers to the obsjectives of the study.

3.1. Communicative Atmosphere from the First and Last Day of the Immersion

Group A shared during the interview that they were initially shy and hesitant when they met the Japanese students. The atmosphere on the first day may be described to be awkward as both the Filipino students and the Japanese students did not know how to approach each other. The deck Filipino group were a bit intimidated when they saw the Japanese students in their uniforms and with their tall heights. One Filipino marine engineering student wondered how the fair-skinned and skinny Japanese students could perform the tasks in the Engine room. Group B, on the other hand, had a friendlier and more comfortable initial interaction with the Singaporean, Malaysian and Japanese students. Their shipboard experience, which gave them a chance to interact with people of different nationalities, helped them a lot in interacting with the other students from other countries. The group also revealed during the interview that most of the said students who met them at the airport and in the cruise ship were very friendly and accommodating so they had no difficulty connecting with each other. The students of the second group, both from the Philippines and other Asian countries, were generally unhesitant to mingle and make friends with each other.

According to the Filipino cadets who went to Japan, the last day and cultural night of the immersion was both a happy and a sad moment. When they had the farewell program, one of the good English speakers from the Japanese group shared, *"I feel like my hair grew longer during these past days,"* alluding to the developmental ascension to ranks of the cadets in the Academy. This indicated that the interaction between the Japanese students and the Filipino students made the former understand the life in the Academy, starting from being bald to having hair. The games facilitated that night also became a chance for the Filipino students to introduce and explain to their Japanese teammates some local games played here in the Philippines. Through their communications to win the game, the Filipino students also shared their culture to their newfound friends. Before the program ended, most of the students from the two groups exchanged their Instagram accounts so they could continue communicating even if they parted ways.

The second group under study appeared to be more used to parting ways. While they also did not want the cruise to end and continue being with their new friends, they were also excited to go home and be with their friends in the Philippines. They took the experience to widen their network, expand their horizon and extend their learning. This may still be due to their experience of leaving their loved ones, meeting and working with 'strangers' who turned to colleagues, and parting when it was time to disembark during their shipboard training.

3.2. Communicative Connections during the Immersion

After the initial awkward moment between the Japanese and Filipino cadets under Group A, the atmosphere became very familiar toward the end of the day. Surprisingly, the practice of Filipino cadets showering together in their barracks was also very similar to the culture of the Japanese. This moment broke all the barriers between the two groups. They showered together and shared jokes with each other despite some difficulties in relaying their messages. As the days progressed, they strengthened their bond when they shared and talked about their foods. In their shared cabins, the Japanese students explained with pride to their partners the meanings of their names. Furthermore, these Japanese students shared how their "nato" (fermented soy bean) was prepared, while the Filipino students shared "kalamay" (glutinous rice) and cooked "pancit canton" (noodles) with the Japanese students. The Filipinos also introduced using hands when eating and although this was new to the Japanese students, some of the latter tried and eventually enjoyed their meal, together with their Filipino buddies. The initial reaction of the Japanese students may be described as part of culture shock where the person/s involved are challenged to adapt (Furnham 2019). Additionally, Jones and Bond (2019) mentioned that culture shock "…occurs in the domain of social encounters, social situations, social episodes, or social transactions between sojourners and hosts and requires the development of specific, teachable skills in order for the individual to adapt" (p. 20). The social situation in this study was the mealtime in the messhall of the vessel. In order to adapt to the situation, the Japanese students took time to learn to eat with their hands and became one with the Filipino students.

Humor during awkward or uncomfortable situations is very helpful. It eases the tension and fosters connections between and among individuals (Kargupta et al. 2023). In the case of the Filipino and Japanese students, humor turned the difficult situation into something friendly and comfortable.

For Group B, the Filipino students became closer to the other students in the cruise when they shared about their experiences as students in general, and as maritime students in particular. Since the members of this group had their shipboard training already, they had more to share with the other maritime students from the other countries. They exchanged their Facebook accounts so even while in the ship, they started following and getting to know each other more. They also became closer as they swam, sang in videoke and strolled together.

3.3. Communicative Strategies Used to Address Communication Breakdowns

Communication breakdowns are inevitable in a communicative setting where the people involved come from different linguistic backgrounds. Korkut et al. (2018) define communication breakdowns as syntactic, semantic or pragmatic problems in communication. Syntactic problems refer to grammar mistakes committed by interlocutors. Semantic problems deal with the differences in meanings ascribed by the sender and the receiver. Pragmatic problems arise when the context is disregarded by either of or both the interlocutors. These problems result in a misunderstanding between the speakers. Recognizing these problems and addressing them by employing different strategies would result in the continuity and success of the communication process. As mentioned by Acejo in Gekara and Sampson (2021), using communication strategies deters misunderstanding and makes sure that assigned works are accomplished without delay.

The communication between the Japanese students and the Filipino maritime students, albeit the challenges, gradually became negotiable and manageable. As shared by the Filipino students, their group and the Japanese group employed strategies to make sure that their messages were conveyed and understood by the other party. Both groups of students made use of non-verbal cues to make themselves understood. Their utterances were accompanied by many gestures and drawings. Both groups made use of online dictionaries with translator to make themselves understandable. On some occasions, the Filipinos adapted the Japanese accent and even using simple Japanese terms to make their communication easier. Often, each communicator had to speak slowly, repeatedly and using broken English, with animated expressions. Thumbs up, nodding, and words like “ah,” or “ok, ok” became very common in their dialogues or conversations. One shared that in the cabin, the Japanese students would talk among themselves first before they answer their Filipino buddies. Accordingly, the former group discussed the utterance to make sure they understood then they talk about how to answer it appropriately before finally giving a reply.

Drobot (2021) noted the importance of knowing more than one language in multicultural communication. While English has been established as the global language, the same author highlighted that knowing other languages is equally necessary. Applied to the experience of the group who participated in this study, their knowledge of basic Japanese terms somehow served as the bridge that connected their linguistic abilities and that of the Japanese’s.

The group that joined a cruise was not very different in the strategies employed during communication breakdowns. The interlocutors made use of the google translator when they had communication difficulties. Aside from this, they also made use of sign language, simple English words, broken English and slower speaking speed during the troublesome exchanges.

The strategies used by all the students from the different groups in this study support the claim of Argyle (1982) and Bochner (1982) as cited by Jones and Bond (2019) on the necessity of verbal and nonverbal communication skills in cross-cultural encounters.

Dealing successfully with people from another culture requires intercultural communication skills, which entail knowledge of different communication styles in different cultural contexts and knowledge of the manner to communicate in the said contexts. Examples of intercultural communication skills are “…listening, speaking clearly and projecting positive body language” (Taylan & Weber 2022). Speaking clearly was employed by all the groups of students as described by interviewees. One interviewee was even particular when he shared that he appreciated the one communication practice of the Japanese students, and that was they always put away their gadget whenever they were talking with other people. This gesture not only indicated their desire to fully understand the message but it also displayed their politeness as they gave their full attention to the person talking. This observation was seconded by the other interviewees.

3.4. Insights Gained by the Students from the Experience

The experiences as shared and described by the two groups of Filipino students left them some impressions and inferences. The students who went to Japan affirmed that communication is a shared responsibility. It cannot become successful if the other party acts passively. Moreover, one interviewee said that cultural awareness and relativism are very important. Knowledge on these two concepts should lead an aspiring seafarer to adjust to the situation. The same student also voiced out that not all seafarers understand English so each one has a responsibility to make the communication and the task work. This solves the issue on linguistic and cultural differences mentioned by Jensen and Oldenburg (2020). The said authors posited that misunderstandings result from the differences between the crew members on board.

Culturally, the Filipino students observed that the lack of proficiency in the use of the English language was compensated by the Japanese through mastering their work and doing it diligently and excellently. Another student shared that sometimes it takes too long for communication loop to be successfully accomplished. Speaking on behalf of the Filipinos, one deck cadet inferred that Filipinos are very patient and helpful, especially during those times when their group and the Japanese student could hardly process each other's messages. From here, the same cadet realized that Filipinos do not always have the advantage in communication just because they knew English better.

The group of Filipino students who went on the cruise with other Asian students realized that the former students were not difficult to deal with as they had initially thought. Recognizing the role played by their previous shipboard training experience, they had no trouble feeling comfortable with the other groups of Asian students because they were almost culturally similar. They also felt during the voyage that it was more comfortable speaking with foreigners than with their countrymen because their co-Filipinos tend to be judgmental. Relatedly, they also realized the importance of always speaking and socializing with others so they could hone their communication skills and feel more comfortable and confident in using a language other than their native language. In terms of social skills, the Filipino students learned to adjust to some differences with the other students so that they could get along well. Based on their observations also, the same group appreciated the other Asian students because of how they valued time, money and how they openly interacted with their teachers.

4. Conclusion and Recommendations

This study documented the experiences of the two groups of Filipino students who participated in two separate immersion programs aboard a training and a cruise ship, respectively. Both groups shared their discoveries and insights from the programs despite the communicative and cultural challenges they faced. Both groups agreed that the experience was very fruitful and paved a way for them to experience new and relevant situations that they will experience when they become seafarers. Being immersed in the actual future workplace, together with other students of different nationalities, the Filipino students had a very positive impression of the programs. Being young and curious, both groups of students took every opportunity to learn something new and connect with other students other than their classmates. Their curiosity also led them to discover things about themselves and bout others. These discoveries made them more aware of their differences and similarities with other people and pushed them to ponder ways to strengthen the similarities while they celebrate and resolve their differences.

Their insights also yielded to some recommendations that the Academy or any other maritime higher education institution such as: continuation of the programs and participation of other students to similar engagements; offering of theoretical and/or skills trainings related to cruise ships as the Academy is focused more on preparing students for cargo ships; trainings and/or seminars on cultural awareness and relativism. Maritime students in the Academy are sponsored by international shipping companies so they would be sailing with seafarers of different nationalities and cultures. If all students have immersion experience similar to what the present study has covered, the benefits of the takeaways may be expanded and extended. This way, all students may be prepared for the kind of crew that they may encounter during their shipboard training and in the course of their future career. Similarly, it would be worth considering to offer courses or trainings that cater specifically to cruise ships. At the moment, maritime students in the Academy are being prepared for cargo ships. While this targets what the industry needs, education and training for cruise ships may also widen the future career options of the graduates. Finally, intentional training or seminars/workshops on cultural awareness and relativism may be facilitated to further equip the maritime students with the needed social and communicative skills.

Acknowledgements

The researcher would lie to acknowledge the support of the management of the Maritime Academy of Asia and the Pacific thru the Academics Research Unit for its continued support to the research projects of all its faculty and students.

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SHIP ELECTRONICS TRAINING AND DESIGN OF AUTOMATIC SHIP CONTROL SYSTEMS WITH PYTHON: CHANGING TRENDS AND FUTURE PERSPECTIVES

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Abstract: The aim of the article is to highlight the need to change the content of maritime training courses in connection with the increasing digitalization of the maritime industry and the increasing complexity of electronic systems on ships and to emphasize the importance of the use of programming languages. It is also aimed to state that the successful design and implementation of automatic ship control systems using Python coding is an important strategy to increase efficiency, reduce operating costs and reduce the workload of personnel. The article also aims to demonstrate the use of Python's data analysis libraries in collecting and analyzing sensor data with coding examples. Thus, it is aimed to contribute to the development of automatic ships. Today, it has been observed that the use of programming languages such as Python, which stands out with its easy-to-understand structure and comprehensive library support, has become inevitable in marine electronics courses that provide comprehensive information on digital maritime, design and operation. Successful design and implementation of automatic ship control systems is an important strategy in the ship industry to increase efficiency, reduce operating costs and reduce the workload of ship personnel. It has been demonstrated that Python's data analysis libraries Pandas and NumPy enable engineers and researchers in the maritime industry to effectively develop and implement automated ship control systems through the collection and analysis of sensor data. In one code example in this study, random sensor data was converted into a Pandas DataFrame and various plots were plotted using Matplotlib to visualize it. Next, basic statistics were calculated and some features of the dataset were plotted. Examples from such work demonstrate how effective Python's data analysis libraries are for processing real-world data such as sensor data. This narrow provides important information to assess the ship's environmental conditions, determine its route and optimize ship performance. As a result, developments have been identified in the maritime industry's transition to digitalization, and it has been revealed that integrating Python coding, which has a user-friendly structure and comprehensive library support, with ship electronic information is an important strategy to increase efficiency in both the ship and port sectors, reduce operational expenses and ease the burden of ship personnel. Leveraging Python's data analysis libraries such as Pandas and NumPy, these automated control systems tasked with autonomously managing a ship's parameters are proving effective in processing data collected from a variety of sensors and creating effective control systems to assess environmental conditions and perform maneuvers. Python can be proven Its versatility; ease of implementation and strong support underline its potential to revolutionize the maritime industry and play an increasingly important role. Therefore, its adoption is expected to become widespread, heralding a new era of innovation and efficiency in automated ship control systems.

Keywords: Marine Electronics , Maritime Digitalization Python , Ship Electronics

Introduction

According to the evaluated researches [1-20] in this study, there are four main clusters of artificial intelligence (AI) in maritime research. As seen in Figure 1, these include: digital transformation, application of big data from Automatic Identification System (AIS), energy efficiency and predictive analytics. Digital transformation, which is of high importance for electronic systems, and the application of big data from AIS and energy efficiency are interconnected. Therefore, it is inevitable that the subject will find a place in modern education in the form of autonomous ships, big data, artificial intelligence, cyber security, Internet of Things (IoT) and virtual reality [12].

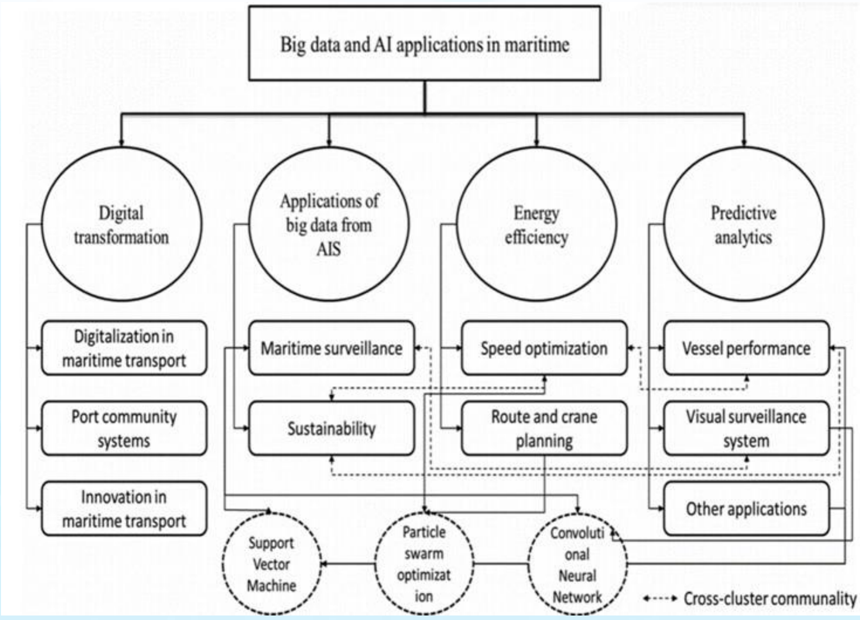

Figure 1. Main clusters in Big data and AI Applications in Maritime [12]

On the other hand, the maritime industry has been undergoing a significant transformation driven by digitalization and the increasing complexity of electronic systems on ships. This paper, aims to highlight the necessity for updating maritime training course content to align with these advancements. The emphasis on incorporating programming languages, particularly Python, is crucial for the successful design and implementation of automatic ship control systems. This approach aims to enhance efficiency, reduce operating costs, and decrease the workload of personnel. Additionally, this paper demonstrates how Python's data analysis libraries can be utilized to collect and analyze sensor data through coding examples, thereby contributing to the development of automatic ships.

The primary objective of this article is to underscore the need to revamp maritime training courses in response to the growing digitalization of the maritime industry and the escalating complexity of electronic systems on ships. The integration of programming languages, especially Python, is pivotal. By leveraging Python coding, the design and implementation of automatic ship control systems can significantly boost operational efficiency, cut down costs, and lighten the workload on ship personnel. Furthermore, the article aims to exhibit Python's data analysis libraries in action, illustrating how they can be employed to gather and analyze sensor data. This demonstration includes coding examples that provide insights into developing automatic ships.

Methodology

This study employed a mixed-methods research approach to investigate the current state and future prospects of using coding and artificial intelligence (AI) in marine electronics education. The research consisted of three phases that involved both qualitative and quantitative data collection techniques. To explore the perspectives on coding and AI usage in marine electronics education, a survey was conducted among students at the Istanbul Technical University Maritime Faculty. The questions aimed to gather opinions on the necessity, general contributions, and impact of coding and AI on classroom management and educational processes. Additionally, environmental factors affecting the use of coding and AI in educational settings were discussed with academic groups.

1. Literature Review: In the first phase, a comprehensive review of academic articles, books, and reports related to the use of coding and AI in marine electronics education was conducted. This review aimed to establish the current state of the research topic and inform the research questions.

2. Survey Studies: Two separate survey studies were conducted in the second phase, targeting marine electronics students and academics. The student survey aimed to determine their attitudes towards coding and AI, their experiences with using these technologies, and their opinions on the use of coding and AI in marine electronics education. The academic survey aimed to identify how academics were using coding and AI in their

marine electronics courses, the perceived advantages and disadvantages of using these technologies, and the factors influencing the use of coding and AI in marine electronics education. In this study, the opinions of ITU Maritime Faculty students regarding the purposes of coding and AI use within the "Ship Electronics" course were taken with the questions given in the Table 1.

Table1. Survey Evaluation for Ship Electronics" course in ITU, Maritime Faculty

Survey Questions
“What do you think about the use of Coding-AI in Ship Electronics training?”
“Do you think it is necessary to use Coding-AI in Ship Electronics training?”
“How do you evaluate the general contribution of Kodlama-AI to Ship Electronics education and training processes?”
“How and in what direction does the use of Coding-AI in Marine Electronics education affect classroom management?”
“In which activities do you use Coding-AI in education processes as a student?”, “For what purposes do you use Coding-AI in education processes?”
“How often do you use Coding-AI in education and training processes?”
“For what purpose, how often and how do you think academics use Coding-AI in their learning processes (preparation/reinforcement/research/measurement-evaluation, etc.)?”
“What are the environmental factors (school infrastructure, economic accessibility level, etc.) that affect the use of coding-AI in ship electronics education environments?”
“How do environmental factors affecting the use of coding-AI in ship electronics training environments affect the use of technology?”
“What do you think are the environmental factors (school, family, socioeconomic level, etc.) that affect students' technology use?”
“How do environmental factors affecting the use of coding-AI in ship electronics education environments affect students' access and use of technology in educational processes?”

3. Case Study: In the third phase, an in-depth interview was conducted with an academic at ITU Maritime Faculty who actively uses coding and AI in marine electronics education. This interview explored the academic's experiences and insights on using coding and AI in their courses, student responses to these technologies, and overall perspectives on the use of coding and AI in marine electronics education.

The collected data was analyzed using both qualitative and quantitative data analysis techniques. Qualitative data analysis involved coding, categorizing, and interpreting data from the surveys and interview. Quantitative data analysis involved statistical analysis of data obtained from the surveys.

Results and Discussions

Contemporary observations indicate that the inclusion of programming languages like Python, noted for its comprehensible structure and extensive library support, has become indispensable in marine electronics courses. These courses deliver comprehensive insights into digital maritime operations, design, and functioning. The effective design and implementation of automatic ship control systems using Python are strategic for enhancing efficiency, reducing operational costs, and alleviating the workload on ship personnel. Python's data analysis libraries, such as Pandas and NumPy, enable engineers and researchers in the maritime sector to effectively develop and implement automated ship control systems. This is achieved through the collection and analysis of sensor data. For instance, some case example in my courses have demonstrated how random sensor data can be converted into a Pandas DataFrame, and various plots can be created using Matplotlib for visualization. Basic statistics have been calculated, and some dataset features are plotted. Such examples illustrate the efficacy of Python's data analysis libraries in processing real-world data, such as sensor data, to assess ship's environmental conditions, determine optimal routes, and enhance ship performance.

Therefore, this study focused on the new requirements of maritime education in a digitalizing world and the importance of using the programming language (such as Python) in ship electronics education. The study aimed to analyze in detail the benefits of integration and use of artificial intelligence (AI) in maritime education and the presence of these divisions and academics. The findings revealed that it is important to run programming languages such as Python and data library analysis to increase the efficiency of maritime expenditures, reducing operating costs, and minimizing the workload of personnel.

The survey results, presented in tabular and graphical formats, indicate that educators recognize the positive impact of coding and AI on student engagement and classroom management. Coding promotes 21st-century skills, such as problem-solving and analytical thinking, and enhances the teaching process by making lessons more interactive. However, challenges such as technical issues, infrastructure limitations, and economic constraints were also highlighted. The need for financial support to access necessary technological tools was emphasized.

Digitalization of Maritime Education: The digitalizing world has brought significant changes to the maritime sector. Traditional methods alone are no longer sufficient in maritime education; students need to be knowledgeable about digital tools and programming languages. User-friendly programming languages like Python facilitate students' understanding and control of complex systems.

Data Analysis and Use of Sensor Data: In ship electronics education, the use of Python’s data analysis libraries (such as Pandas and NumPy) to collect and analyze sensor data plays a significant role. Proper processing of this data is critical for evaluating the ship's environmental conditions, determining its route, and optimizing its performance. Equipping students with these skills will contribute to their future professional success.

The Role of Coding and AI in Education: Coding and AI applications offer an interactive and dynamic learning environment in maritime education. These technologies enhance students' analytical thinking, problem-solving, and creative thinking skills, preparing them for the demands of the 21st century. The use of AI in education allows for tracking individual performance, personalizing lesson content, and determining the teaching model.

Impact of Technology on Educational Environments: The active use of technology in education helps make lessons more interactive and engaging. However, excessive and uncontrolled use of technology can lead to issues like distraction and concentration problems among students. Therefore, technology must be used in a balanced and effective manner. Additionally, the cost and accessibility of technological devices pose significant challenges for both students and academics. Factors affecting the use of coding-AI in ship electronics education were discussed with academic groups with various questions in this **study**. The findings obtained in this context are presented graphically in Figure 2.

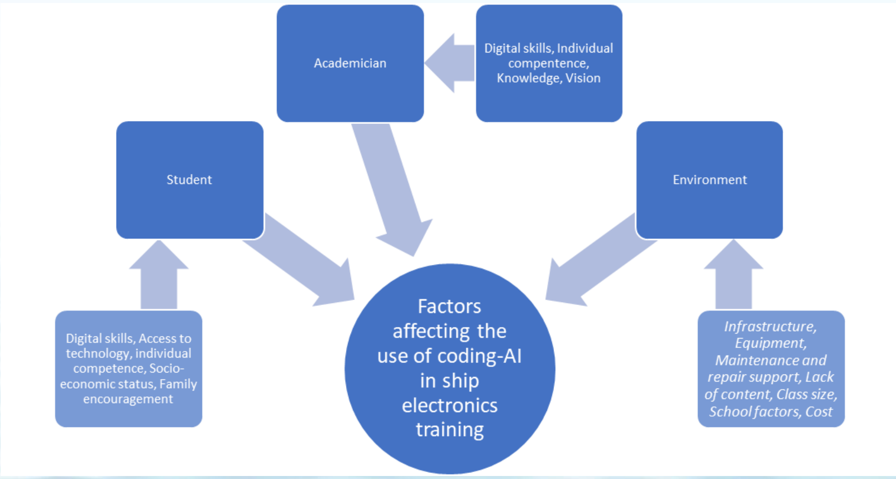

Figure 2. Factors affecting the use of coding-AI in ship electronics education

Views of Academics and Students: The opinions of academics and students on technology and coding directly affect the quality of education. Academics' digital literacy and proficiency in this field enable students to use technology effectively in their educational processes. At the same time, students' socioeconomic status and family support are determining factors in their access to and use of technological tools.

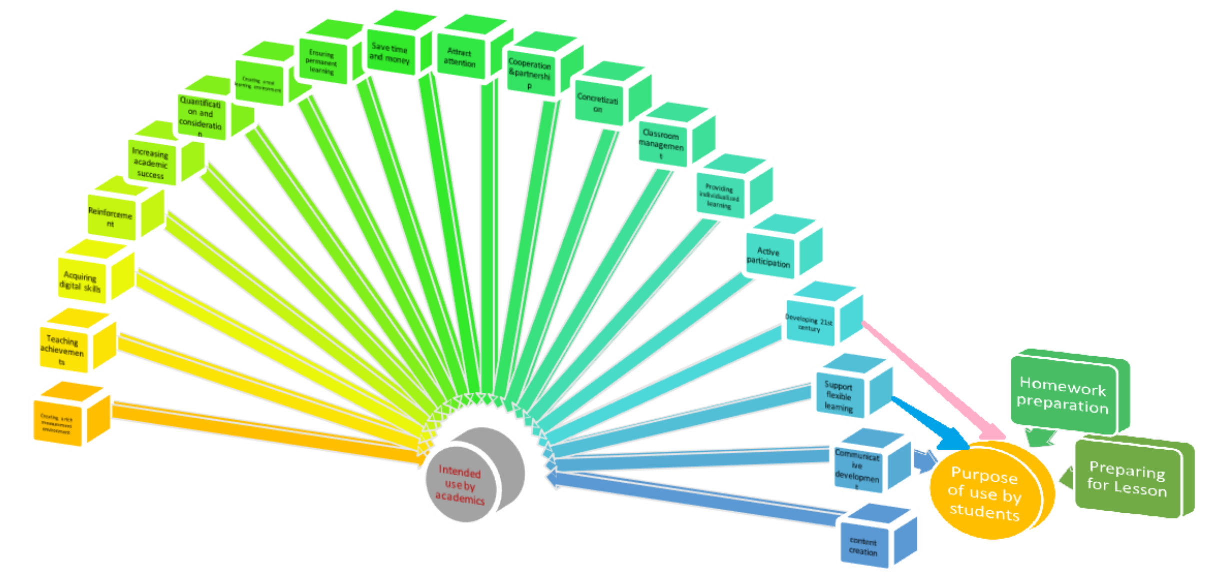

Figure3. Factors related to the use of coding-AI in Ship Electronics Training

As seen in Figure 3, they discussed the contribution of current technology to education and training processes from different perspectives. The issues mentioned in the opinions of academics cover a wide spectrum. The notifications received from experienced academics are presented in table table 2.

Table 2. Academicians' opinions

"As it increases the student's attention, it also facilitates the academician's dominance in the classroom." "Coding serves the purpose of providing 21st century skills. It encourages problem solving, creative and analytical thinking."	"As it increases the student's attention, it also facilitates the academician's dominance in the classroom." "Coding serves the purpose of providing 21st century skills. It encourages problem solving, creative and analytical thinking."
"Technological tools can negatively affect course management due to technical disruptions experienced during the course process." "Coding-AI makes it easier for students to discover ways to learn how to learn by knowing themselves better."	"Technological tools can negatively affect course management due to technical disruptions experienced during the course process." "Coding-AI makes it easier for students to discover ways to learn how to learn by knowing themselves better."
"Technology has very positive contributions in terms of keeping professional development alive and broadening the horizons of academics. "One of the common conditions for having 21st century skills is to have coding-AI competence." "Although there are some unusual situations that may have a negative impact on the use of coding-AI in the education of the Marine Electronics course, it generally has a positive impact on classroom management. "Especially in student groups with no prior knowledge of the course, digital contents and coding applications keep the students' attention and help the academician manage the classroom more easily."	"Technology has very positive contributions in terms of keeping professional development alive and broadening the horizons of academics. "One of the common conditions for having 21st century skills is to have coding-AI competence." "Although there are some unusual situations that may have a negative impact on the use of coding-AI in the education of the Marine Electronics course, it generally has a positive impact on classroom management. "Especially in student groups with no prior knowledge of the course, digital contents and coding applications keep the students' attention and help the academician manage the classroom more easily."
"In language education, creative thinking, computational thinking, etc. are promoted in educational environments by digitally publishing the content created by students (magazine, blog, etc.). "The use of coding-AI in ship electronics course training is supportive in developing skills." "Since it is mandatory to ensure classroom management during software-hardware problems when using technology in Marine Electronics course training, it is necessary	"In language education, creative thinking, computational thinking, etc. are promoted in educational environments by digitally publishing the content created by students (magazine, blog, etc.). "The use of coding-AI in ship electronics course training is supportive in developing skills." "Since it is mandatory to ensure classroom management during software-hardware problems when using technology in Marine Electronics course training, it is necessary

to have a 'B' plan and therefore more importance should be given to planning."	to have a 'B' plan and therefore more importance should be given to planning."
"Some technological tools that would be useful in education and training processes cannot be accessed due to economic difficulties." "Financial support is needed to increase the use of licensed software in schools."	"Some technological tools that would be useful in education and training processes cannot be accessed due to economic difficulties." "Financial support is needed to increase the use of licensed software in schools."

The transition towards digitalization in the maritime industry has necessitated significant changes in the educational paradigms for maritime training. The integration of Python coding, characterized by its user-friendly structure and extensive library support, emerges as a crucial strategy for improving efficiency in both the ship and port sectors, reducing operational expenses, and easing the burden on ship personnel. Python's data analysis libraries, such as Pandas and NumPy, prove effective in processing data from various sensors and developing automated control systems to evaluate environmental conditions and execute maneuvers. This versatility and ease of implementation underline Python's potential to revolutionize the maritime industry, indicating its growing importance in the sector.

The advancements in maritime training highlight the shift in educational goals from merely obtaining a degree to solving real-world problems. Modern education, influenced by artificial intelligence applications and the utilization of big data, has enabled personalized educational programs, individual performance tracking, curriculum development, and determination of teaching models, significantly enhancing the quality of education. Technology plays a central role in steering learning processes, enriching educational environments, and providing interactive learning experiences. Technology-supported education prepares students for future challenges, encouraging global perspectives and critical thinking.

Despite the benefits, the integration of technology in maritime education faces several challenges. These include the need for infrastructure, financial accessibility, and maintenance support. Educators also need to continuously update their technological knowledge and skills. The economic aspects, such as the cost of technological devices and licensed software, present significant barriers. Financial support is essential to overcome these challenges and enable broader access to technological tools in education.

Artificial intelligence (AI) tools have an important role to support Marine Electronics teaching and enable students to better understand scientific concepts. By sharing the AI tools in the table 3 with the students while conducting the Marine Electronics courses coded DUI232 and MNS 222 within the ITU Maritime Faculty, I observed that the interest of the students who are open to development increased.

Table 3. Examples for AI tools in Ship Electronics Course at ITU Maritime Faculty

AI tools	***Description***
The Robot Factory by Tinybop	It is an application that aims to teach basic programming and robotics concepts. Students can design and program their own robots.
Cognimates	Cognimates, a platform that teaches coding and artificial intelligence topics, focuses on teaching students basic artificial intelligence concepts. For example, training image recognition models to identify an image.
MIT App Inventor	This platform, developed by MIT, provides students with basic information about mobile application development and also touches upon issues related to artificial intelligence. For example, creating a simple chat bot.
Simulink	It is a graphical programming environment that is part of MATLAB. It is used for modeling and simulation of ship electronic systems. This software allows students to mathematically model and simulate real-world systems.
MATLAB/Simulink with AI Toolbox	MATLAB and Simulink, when used with the AI Toolbox, offer students the opportunity to use artificial intelligence techniques for modeling and control of physical systems. This combination teaches students how AI-based systems can be used in real-world applications.

Code.org	Offering a wide range of programming training from beginner to advanced level, Code.org offers interactive lessons and games to improve students' coding skills.
PythonTurtle	Providing an interactive environment for those who want to learn the Python programming language, PythonTurtle teaches students basic programming concepts using turtle graphics.
Microsoft Azure Machine Learning	It is a cloud-based platform for developing machine learning projects. It attracts attention with its easy use and wide feature set.
Google Cloud AI Platform	It is a cloud-based platform for artificial intelligence projects. It is used for data processing, model training and deployment.
TensorFlow	It is an open source machine learning library developed by Google. It is widely used to build and train deep learning models.
PyTorch	It is especially used in the field of deep learning and attracts attention with its flexible structure.
Keras	It is a high-level deep learning library. It supports infrastructures such as TensorFlow, Theano and Microsoft Cognitive Toolkit.
OpenCV	It is an open source library for image processing and machine learning. Used for computer vision and video analysis projects.

Several AI tools and coding platforms, such as The Robot Factory by Tinybop, Cognimates, MIT App Inventor, Simulink, MATLAB/Simulink with AI Toolbox, Code.org, PythonTurtle, Microsoft Azure Machine Learning, Google Cloud AI Platform, TensorFlow, PyTorch, Keras, and OpenCV, were used in marine electronics courses. These tools help students grasp basic programming and AI concepts, enhancing their skills and preparing them for successful careers in the maritime industry.

In addition, the coding-AI supported sample course content using Arduino in the Ship Electronics course was conducted by me in my courses at ITU Maritime Faculty, as presented in the table 4.

Table 4. One of the sample lessons within the ship electronics course

Application Lecture of ARTIFICIAL INTELLIGENCE WITH ARDUINO (2 HOURS)
• Concept of artificial intelligence
• Current applications of artificial intelligence and examples of structures related to ship electronics
• Microprocessor and microcontroller structures
• Arduino circuit board, analog/digital input and output units
• Function of servo motor and addition to circuits
• Arduino coding/Coding with block commands
• Establishing a link between artificial intelligence and electronic structures
• Using electronic structures and sensors with artificial intelligence applications
• Areas of use of Artificial Neural Networks

As an example of this activity, an in-class project was carried out with the help of electronic circuit structure and webcam. In this project, Arduino Leonardo/UNO, Micro servo (SG90), Jumper cables, Webcam, and Activity Sheet were used. Figures 4 show the Arduino Uno, Servo motor and Arduino connection diagram and activity sheet, respectively.

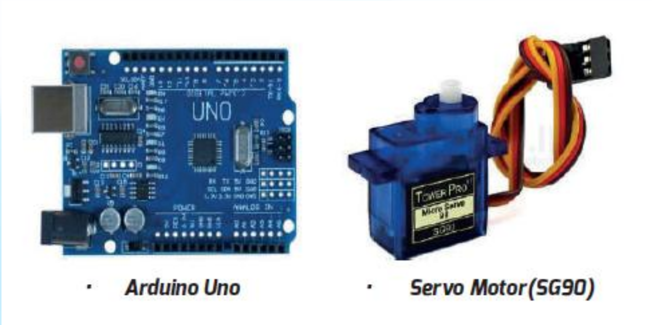

Figure 4. Structures required for the electronic circuit

We download the Arduino software from the link https://www.arduino.cc/en/main/software and install it. Afterwards, it enters the field of machine learning after recognizing the object placed through the webcam, connecting the Arduino and inserting the necessary codes into it, and then capturing the images of objects such as dry cargo ship, tanker, cargo ship, full ballast tank, empty ballast tank, etc. through the webcam. It can be distinguished through learning.

In the future of maritime education, the use of Python and similar programming languages is expected to become more widespread. The design and implementation of automatic ship control systems will become more efficient and reliable through the effective use of these technologies. Moreover, the application of AI and data analysis techniques in education will ensure that students are better equipped individuals.

Consequently, the integration of digitalization and programming languages in maritime education is crucial for training individuals who keep up with innovations in the industry and are prepared for the future. In this context, educational institutions and educators must integrate technological innovations and programming languages into their curricula, taking a significant step towards contributing to students' career success.

Conclusion

In conclusion, the integration of coding and AI in marine electronics education is a multi-faceted process influenced by socio-economic status, family support, technological literacy, infrastructure, and financial factors. While these integrations offer significant advantages, such as enhanced student engagement and the development of critical skills, they also present challenges that need to be addressed through financial support and continuous technological education for both students and educators. The adoption of coding and AI is expected to become more widespread, ushering in a new era of innovation and efficiency in automated ship control systems and maritime education.

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SHAPING INDONESIAN SEAFARERS' IDENTITIES ON MULTICULTURAL SHIPS

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Abstract: The intersection of language and identity on the high seas presents a unique set of challenges and opportunities, particularly for non-native English speakers like Indonesian seafarers. This study delves into how English shapes their professional identities amidst the diverse tapestry of multicultural ship crews. Through qualitative analysis involving seafarers with significant experience—from apprenticeships to officer roles—this research illuminates the pivotal role of English in not only everyday communication but also in career progression and social integration on board. Utilizing a mix of open-ended questionnaires and detailed interviews, we uncover how varied English dialects and language strategies influence seafarers' self-perception and community dynamics. The findings highlight the necessity for robust English and multicultural training within maritime education, preparing seafarers for a globalized workforce where language proficiency and cultural adaptability are key to navigating the complexities of modern seafaring. This study contributes to our understanding of language as a cornerstone of professional identity in the multicultural settings of the maritime industry.

Keywords: multicultural communication, professional identity, maritime industry

1. Introduction

Recent scholarly attention has focused predominantly on the interaction between language and identity within environments where English serves as the official language. This research has primarily been conducted in monolingual settings or where English dominates as a first language. However, the global nature of the maritime industry, where multilingualism is the norm rather than the exception, presents a unique context for examining these dynamics among non-native speakers. Specifically, this study explores the intricate role of English as a second language (L2) among Indonesian seafarers working on multicultural ships, investigating how they negotiate their native (L1) and English language identities within this diverse linguistic landscape.

English, as a lingua franca (ELF), is pivotal in global communication, bridging cultural and linguistic divides across international waters. It has evolved beyond its Anglo-American roots to serve a functional role that prioritizes mutual intelligibility over linguistic purity. The flexible nature of ELF allows it to be a tool not only for communication but also for personal and collective identity expression among speakers from varied backgrounds. This adaptability is crucial on multicultural ships, where communication must be clear and effective to ensure safety and operational efficiency. Researchers like Motschenbacher, as cited in Back (Back, 2014), and Jenkins (Jenkins, 2009) argue that the non-prescriptive, inclusive nature of ELF makes it particularly suited for environments where normative constraints might otherwise hinder communication and identity expression.

Despite concerns that ELF might strip non-native speakers of their linguistic and cultural identities, evidence suggests that it can enhance their ability to assert these identities. Kirkpatrick (Kirkpatrick, 2017) and Baker (Baker, 2011) provide insights into how ELF functions as more than a mere communication tool; it facilitates the expression of a shared yet diverse cultural identity, evident in the code-mixing practices that include local idioms and vocabulary, distinguishing it from more standardized English varieties. This nuanced use of ELF enables seafarers to maintain their cultural identity while engaging in effective, inclusive communication.

This study further investigates how ELF is employed aboard ships to manage not only the practical needs of communication but also the social and professional identities of the crew members. Within the confined and hierarchical space of a ship, language skills are directly linked to professional competency and career progression. English proficiency is often seen as a marker of professionalism and is a critical requirement for career advancement in the maritime sector. This perception is supported by field observations and the substantial presence of Indonesian seafarers in the international maritime workforce, which underscores the importance of English competency for employment on non-Indonesian vessels.

Moreover, this research examines the role of ELF within the seafarers' community of practice, where language use is part of the daily negotiation of identity and authority. According to Fitzgerald (Fitzgerald, 2020) and Rasmussen et al. (Rasmussen et al., 2018), the ability to communicate effectively is central to professional identity in high-risk environments such as maritime and medical fields, where teamwork and clear communication are essential for success and safety. The study explores how seafarers' English language practices, beliefs, and management strategies reflect and shape their professional identities, facilitated by their participation in a multilingual community that values both individual and collective linguistic expressions.

In sum, this analysis not only highlights the communicative importance of ELF in the maritime industry but also its integral role in shaping the professional identities of non-native English speakers within this global context.

2. Method

This study engages three seafarers currently active on their respective multilingual ships to explore the impact of English as a lingua franca on their professional identities. Each participant has completed a one-year apprenticeship and has served at least an additional year as an officer, ensuring a foundational experience in their professional development. The participants, graduates of the STIP with specializations in nautical (deck) and marine engineering (engine room) departments, were selected based on their willingness to participate and their alignment with the study's requirements.

Recruitment was facilitated through an invitation broadcast via social media, employing an open-ended questionnaire adapted from Vasilopoulos (Vasilopoulos, 2015) to gather preliminary data on the participants' backgrounds. This approach also served to introduce the subjects to the study's focus while prompting them to reflect on their experiences and perceptions regarding the use of English onboard. Following the completion of the questionnaire, semi-structured interviews were scheduled according to the participants' availability, taking into consideration their work commitments and internet access quality. These interviews were conducted using Zoom, recorded for accuracy, and subsequently transcribed.

The analytical approach of this study is twofold. Initially, an inductive analysis was employed to extrapolate general patterns from specific instances within the data, thereby constructing a coherent narrative from the isolated observations. Subsequently, an interpretive method was applied to delve deeper into the social dynamics at play, interpreting the data within the context of existing theoretical frameworks and empirical research as described by Hatch (2002 as cited in Vasilopoulos, 2015). This involved a meticulous process of data transcription, systematic identification within both the questionnaire responses and interview transcripts, and an integration of these findings with the broader research context to draw substantive conclusions about the role of English in shaping professional identities among seafarers.

3. Findings and Discussion

The study involves three Indonesian seafarers, each bringing a distinct level of experience and exposure to diverse crew compositions on multicultural ships. These participants, identified under pseudonyms, were selected for their professional roles and their willingness to contribute to the research on language and identity in maritime settings.

Abrar, aged 28, serves as a Senior Officer and has over seven years of sea-time. His extensive career has allowed him to work alongside crew members from various cultural backgrounds, including European, American, and Asian. This breadth of experience provides Abrar with a deep understanding of the dynamics of multicultural communication and professional identity development in diverse maritime environments.

Rio, also 28, holds the position of Junior Officer and has accumulated more than five years of experience at sea. Like Abrar, Rio has navigated the challenges and opportunities of working with an international crew comprising Europeans, Americans, and Asians. His experiences contribute valuable insights into the nuances of cross-cultural interactions and their impact on professional roles and responsibilities aboard.

Gian, the youngest at 25, is another Junior Officer but with over a year of sea-time. Unlike his peers, Gian's exposure has predominantly been with Asian crews. This more regionally focused experience offers a different perspective on the influence of cultural commonalities and variances on communication and professional identity within the predominantly Asian context of his maritime career.

Together, these participants provide a comprehensive view of how English as a lingua franca plays a role in professional identity construction across different levels of experience and multicultural settings. Their diverse backgrounds and insights are crucial for understanding the broader implications of language use in the global maritime industry.

Table 1 below provides a concise summary of the findings from the questionnaire and subsequent interviews, illustrating how the participants, Abrar, Rio, and Gian, practice, perceive, and manage the use of English. These elements are crucial for constructing their professional identities (Nguyen, 2018) within the multilingual community of seafarers, as they navigate and negotiate their roles on multicultural ships.

Table 1. Participants' Practice, Beliefs, and Management

Name	The practice	The belief	The management
Abrar	Prefers using English for all communications, regardless of the interlocutor's nationality.	Believes English is essential for career advancement and broadening worldviews.	Actively improves English through reading, movies, and interactions with senior officers.
Rio	Uses English solely for professional purposes.	Views English as important for professional status but not the sole factor.	Passively maintains English skills through media consumption.
Gian	Uses English with non-Indonesian crews; switches to Indonesian with fellow Indonesians.	Regards English as crucial for his professional and personal integration in a multicultural setting.	Actively enhances English by practicing thinking in English, writing personal notes, and maintaining a journal in English.

Abrar consistently uses English in all communications aboard, regardless of the nationality of his interlocutors, including fellow Indonesians. He believes that English is crucial for career advancement and has noted substantial improvement in his proficiency since he started working with multinational crews. His experience has also shifted his worldview, emphasizing the importance of using English to ensure inclusivity in a multicultural setting. To further enhance his English skills, Abrar actively engages with English media, such as books and movies, and prioritizes interaction with senior officers who are native English speakers.

Rio adopts a more compartmentalized approach to English, utilizing it strictly for work-related interactions. He recognizes the importance of English in achieving and maintaining his professional role but does not view it as the sole factor. Outside of professional contexts, Rio does not actively seek to enhance his English skills through structured strategies. However, he continues to engage with English-language media, which suggests a passive approach to maintaining his proficiency.

Gian expresses a desire to use English both during and outside of work hours. However, he adjusts his language complexity depending on the crew's composition, simplifying English when needed or switching to Indonesian with fellow nationals. Gian views English as a cornerstone of his professional and personal life, essential for integration into the broader seafaring community. He is proactive about improving his English, practicing thinking in English, writing personal notes and journal entries in English, and seeking out conversations in English to better his language skills.

Collectively, these insights illustrate varied but proactive engagements with English among the seafarers, underscoring its perceived importance in professional development and everyday interactions in a global and culturally diverse maritime industry. Each participant's approach to managing their English usage reflects their personal beliefs about the language's role in their professional lives and their adaptation strategies to their multicultural work environments.

Language practice, influenced by hierarchical and power relations within ship crews, significantly impacts how seafarers use English (Spolsky, 2004, 2017). For example, Gian, a 25-year-old junior officer on an Asian multinational vessel, faces constraints in using English, restricted mainly to simplified, work-related communication. He describes needing to adjust his English to simpler forms for better understanding by senior officers, limiting his use to necessary interactions. This scenario illustrates the influence of power-distance, a dimension prominent in many Asian cultures as described by Hofstede (Hofstede Insights, no date), which requires lower-ranking individuals to maintain respectful distance from their superiors.

Gian's experience highlights the limitations imposed on his professional development and personal satisfaction due to restricted communication styles: *"During my apprenticeship, the higher ranks taught me directly, but here they just yell, not explaining what I did wrong... I think it's because I'm seen as inferior. So, when told to use simple English, I just do it"* (Gian, 25). His interaction with English is minimal, used only when necessary, and he socializes primarily in Bahasa Indonesia with fellow Indonesians. This lack of engagement with English outside formal contexts inhibits his professional identity development, an issue noted by Davis (Davis, 2006) where a lack of community interaction can hinder identity formation within a profession.

Conversely, other seafarers like Rio and Abrar report more frequent use of English, not only for work but also for socializing, which enhances their linguistic fluency and professional interactions. Rio, for instance, adjusts his language use based on his audience, often incorporating English into his Indonesian conversations when specific terms are lacking. After a contract on an international ship, he found it challenging to revert to casual Indonesian, indicating a deep immersion in English during his tenure at sea. Abrar seeks to adopt American English, influenced by his interactions with American crew members: *"I try to imitate my American chief... After some initial awkwardness, he helped me. That's what I like about foreigners; they really help you grow"* (Abrar, 28).

In this multilingual maritime environment, language management involves strategic use depending on social contexts and interlocutors, showcasing a varied approach to maintaining and improving English proficiency. Abrar immerses himself in American culture to enhance his English, while Rio maintains a balance between his native and second languages, satisfied with his current linguistic capabilities. Gian, still adjusting to his environment, aspires to work in more diverse European settings, reflecting a desire to be part of a global community where English is crucial for communication and professional growth.

3.1. English and Identity Construction among Indonesian Seafarers

Seafaring, a high-risk profession requiring effective crew collaboration, is more challenging on multilingual and multicultural ships. The construction of a professional identity involves multiple facets such as self-image, job satisfaction, social relations, and professional competence (Montemayorr et al., 2020). English usage, as observed, both facilitates and reflects the identity of seafarers. Crews on diverse ships must navigate various English dialects, adopting phonological and lexico-grammatical structures familiar to non-native speakers (Dissanayake, 2017). The negotiation of language involves merging different English varieties and incorporating commonly used expressions, indicating a deep connection between the seafaring profession and English competency.

English serves as a vital communication tool and a medium for daily interaction on board, essential for both work-related tasks and socialization (Brenker et al., 2017). Abrar, a participant, noted, *“English is the common language at sea, necessitating my proficiency to effectively socialize and work with a multinational crew.”* This shared language supports not just professional operations but also the social integration process within the community of practice (CoP), defined by Wenger (Farnsworth et al., 2016; Wenger, 1998) as groups engaged in collective learning through shared endeavors.

English proficiency is crucial from the outset of seafarers' careers, influencing their opportunities and progression within the maritime industry. Participants associate English skills with higher economic and social status, viewing language proficiency as integral to defining competent seafarers. For instance, Abrar mentioned, “English connects me with foreign seafarer-friends, enhancing my professional network and opportunities.”.

3.2. Challenges and Strategies of English Usage on Multilingual Ships

Navigating English usage on multilingual ships presents unique challenges and demands strategic management to balance effective communication and identity preservation. Crew members often face linguistic and cultural barriers that can lead to misunderstandings and conflicts, necessitating strategies to foster mutual understanding and effective collaboration (Sampson & Zhao, 2003).

One common challenge is maintaining one's linguistic and cultural identity while using English as a lingua franca. Crews must adapt their language usage, sometimes simplifying speech or employing visual aids to ensure clarity. Building a shared language repertoire and developing intercultural competence are crucial for improving onboard dynamics.

Abrar shares, *“I use English consistently with all crew members, which has significantly helped in my professional advancement.”* However, not all experiences are positive; Gian's interaction with Korean crew members, for example, is hindered by limited English proficiency, affecting his job satisfaction and professional growth. He explains, *"I need to simplify my English with Koreans, which limits deeper interactions and professional development."*

The effectiveness of a multilingual crew's communication significantly impacts their collective identity and operational efficiency. Poor communication can lead to social isolation and hinder effective collaboration, as Brenker et al. (2017) noted, emphasizing that effective interaction strengthens social cohesion and facilitates smoother operations. In summary, while English is indispensable for communication and operations aboard multilingual ships, its use varies widely among crew members, influenced by individual and collective linguistic capabilities and cultural backgrounds. Effective management of this diversity is key to fostering a robust professional identity and ensuring safety and efficiency in seafaring operations.

4. Conclusion

The formation of a professional identity among seafarers is significantly influenced by the Community of Practice (CoP), solidarity across diverse backgrounds, and the use of English as the lingua franca. This study highlights that English proficiency is crucial for professional identity, affecting self-image, competence, expectations, social relations, and adaptability. Educational institutions play a key role by integrating English proficiency and multicultural awareness into their curricula, emphasizing language skills, practical skills, and cross-cultural competence. However, the study's small sample and qualitative methods limit generalizability, and future research should adopt mixed methods to increase reliability and explore the impact of English proficiency on career prospects and identity formation in a larger, diverse group of seafarers.

Acknowlegment

The extended version of this paper is currently under review in WMU's Journal of Maritime Affairs (JOMA) with a different title.

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ARE YOU SIMULATOR READY? A STUDY OF MARITIME COMMUNICATION COMPETENCE IN THE FULL-MISSION BRIDGE SIMULATOR

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Abstract: Perry (2012, p. 54), reflecting on different theories of literacy, notes that literacy is not used simply to denote whether an individual is literate or illiterate, but that literacy as a social practice {"is what people do with reading, writing and texts in real world contexts and why they do it"}. This study explores literacy as an access competence, or gateway, to the profession of merchant marine officer. In this article {access competence} may be understood to comprise the disciplinary literacy and communicative skills needed to perform duties on board. Building on sociocultural perspectives on literacy and multiliteracies, the role of {functional literacy} in an officer's education, specifically during formative assessment in maritime simulator training, will be discussed. Research pertains to MET institutions in Norway and Belgium and, through observation of simulator exercises, aims specifically to examine the full-mission bridge simulator as an arena for the language learning skills and communicative practices needed to facilitate the professional function of a maritime officer on board, primarily on the bridge. Following the exercise, semi-guided interviews were conducted with the students involved and, subsequently, with the instructors. These interviews draw on experience and attitudes with a view to extracting suggestions on how to implement maritime literacy in the simulator. Conclusions provide constructive options regarding formative assessment in the simulator.

Keywords: functional literacy, maritime English, full-mission bridge simulator, disciplinary literacy

1. Introduction

Research into the use of simulation as an arena for the training of maritime-related competences, including communication, has served previously as a matter for research (John et al., 2016). However, it is of importance to revisit this subject and explore how MET institutions currently approach the use of the full mission bridge simulator as a focal point not only for the technical skill of navigation but also for other competences, such as communication. Conversely it is advantageous to ascertain how these competences, including the ability to communicate effectively, may be facilitated to learners *in advance of* their simulator training to render them 'literate' in the discipline; in other words, to make them 'simulator ready'. In keeping with objectives in the healthcare sector, maritime training aims likewise "to better understand how a sound pedagogical approach that includes the use of simulation can maximize learning" (Erlam et al., 2017) Using coding methodology, this paper employs interviews to examine the pedagogical extent to which both learners and instructors extract and maximize the potential of the full mission bridge simulator, specifically in terms of communication on the ship's bridge. The paper concludes with suggestions as to how to improve communicative literacy amongst maritime students with a view to enhancing performance in the simulator and, ultimately, at sea, on the bridge.

In order to embed this research, it is worth reflecting briefly on disciplinary literacy and its meaning. Perry (2012), considering theories of literacy, notes that literacy is not used simply to denote whether an individual is literate or illiterate, but that, when regarded as a social practice, the concept "is what people *do* with reading, writing and texts in real world contexts and why they do it". Disciplinary literacy refers to the idea that each field or discipline has its own way of communicating, and thus creates meaning through text. In this sense, specialized ways of reading, understanding, and thinking should be taught according to each academic discipline. Airey (2011, p. 3) defines disciplinary literacy as "the ability to appropriately participate in the communicative practices of a discipline."

Participating in maritime simulator training requires access competence, namely the disciplinary literacy and communicative skills needed to perform the officer's duties on board. Whilst investigating how simulators and simulation exercises play a role in the broader navigational learning process, Sihmantepe et al. (2011) aptly describe communication as, merely, "an unintentional outcome of bridge or engine-room training". In other words, communication is not the main focus of maritime simulation, and arguably rightly so. Nevertheless, effective communication is an integral part of the safe navigation of ships and, as such, brokers a key role. It is a crucial skill that allows passage through the disciplinary gateway. Pekcan et.al. (2005) pose didactical questions about transfer of non-technical skills like communication, how to assess these skills, and different aspects to be taken into account during curricular design and training. Simulator training can provide students with the opportunity to develop and practice non-technical skills such as leadership, decision-making and communication (Elashkar, 2016; Kim & Gausdal, 2017; Kim, Sydnes, et al., 2021). Chen et al. (2019) hint that methods of teaching Maritime English in China could be enhanced. Instead of hunkering down in the classroom and using rote drilling to focus on the traditional four skills of language, learners should move into the simulator and be confronted with the real ship experience, including bridge communication, as provided by today's state-of-the-art devices and equipment.

Building on sociocultural perspectives on literacy and multiliteracies, the role of functional literacy in an officer's education, specifically during formative assessment in maritime simulator training, will be discussed.

Following a description of the research methodology, the article explores sub-topics such as simulator instructors' experiences with and attitudes towards the acquisition of literacy and communicative skills in the simulator, students' attitude to the same and, in general, the potential of the maritime simulator as a learning tool for literacy and language learning. The paper concludes with suggestions as to how to improve communicative literacy amongst maritime students with a view to enhancing performance during simulator exercises and, ultimately, at sea, on the bridge.

2. Methodology

The methodology used to collect data comprises observation of full-mission bridge simulator exercises, semi-structured focus group interviews with students and semi-structured individual interviews with simulator instructors at four different Maritime Education & Training (hereafter referred to as MET) establishments in Norway and Belgium. Initial contact with these institutions was through heads of departments, with a re-routing forward to the instructors. All further contact prior to the observations and interviews was through the simulator instructors. Three documents, consisting of information, consent form and interview guide were sent ahead of the interviews. In all institutions bar one, the instructors forwarded the documents to the students. Ethical considerations and data management are in line with the Norwegian Agency for Shared Services in Education and Research, Sikt.

2.1 Observation

Observation of a simulator exercise took place in all four of the MET institutions selected. The observation style chosen was the observer-as-participant. This involves more observation than participation, meaning that the researcher's involvement with the insiders is minimal (Baker, 2006; Gold, 1958; Pearsall, 1965). The exercises were not altered or changed in any way due to the observation but were executed as normal. This was explicitly requested beforehand with students being informed of the purpose of the observation and asked to conduct the exercise as they normally would. This resulted in observation of different simulations such as docking and mooring, day coastal voyage without Electronic Chart Display and Information System, hereafter referred to as ECDIS, night coastal voyage with ECDIS and a dynamic positioning exercise. The observation style chosen affords the observer the opportunity to intervene during the observation, for example when something has not been heard or fully understood. The main objective of the observations was to identify talking points and references for the interviews as necessary. Throughout the observations, the focus was on the students' communication, both internally on the bridge and externally on Very High Frequency radio, hereafter referred to as VHF.

2.2 Interviews

In defining interviews as a professional conversation (Kvale, 2007) the main objective is to encourage participants to talk about experiences and perspectives and gain insight into their use of language and the concepts surrounding a given topic (Braun & Clarke, 2013; Rubin & Rubin, 2012). Interviews are thus ideally suited to experience-type research (Braun & Clarke, 2013). In this particular case a combination of individual and group interviews is used, which proves not uncommon in the research literature (Lambert & Loiselle, 2008). In this study, the interview guide follows the same pattern of questions in both focus group interviews with students and in individual interviews with instructors. The pre-determined topics include experience with communicative skills, learning objectives and literacy in a full-mission bridge simulator, attitudes towards these, as well as potential and practical implementation of the same. In addition, consideration is given to communication competence and literacy as part of performing the officer's duties and to the (self)evaluation of students' language and communication competence in the simulator. A test interview was done with an instructor from an institution which was not part of the data material. To ensure a common understanding and to define the context in which the topic is discussed (Briggs, 1986), definitions and terms were explained to the respondents in the interview guide as well as prior to or during the interview.

In total, there were 20 respondents: 15 students and five instructors. All interviews but one were conducted face-to-face and were linked to the simulator exercise. One of the instructor interviews was done digitally three days after the exercise. Each interview lasted between 25 to 55 minutes, with a total interview time of six and a half hours. The interviews were audio recorded and subsequently transcribed.

2.2.1 Group interviews – students

Students were asked to participate in group interviews. Crabtree et.al. (1993) argue that it is reasonable to assume that when a group discusses a topic the outcomes will be different to those of a one-to-one conversation. This is due not only to group dynamics but also to the more extensive array of ideas which are inevitably expressed. The group composition was simply the actual bridge team being observed and the number of groups depended on how many students were on each simulator bridge. To ensure participation from all respondents during the group interviews, the groups had no more than four participants. This seemed advantageous given that conversations in groups of three to five participants is shown also by Peek & Fothergill (2009) to be the smoothest. The group interviews were performed in existing groups where the students are familiar with each other, due to their shared educational experience (Liamputtong, 2016) and thus may be considered homogenous in the context. At three of the MET institutions there were two students on each bridge, while one had three. At institutions with two students on the bridge, two teams were observed, whereas only one team with three students on the bridge was observed. The students observed and interviewed were randomly picked where possible. The students interviewed were at different stages in their education, ranging from able seafarers in their first year of higher vocational education to students in their fifth year of a master's degree. Students' sailing experience varied from none to five years.

2.2.2 Individual interviews – instructors

Instructors participated in individual interviews. The instructor's teaching experience varied from two to sixteen years and all instructors, except for one, taught other courses in addition to being simulator instructors. The educational level of the instructors ranged from two-year officer's education at higher vocational level to MSc in Nautical Sciences. The instructors' sailing experience ranged from five to twenty years and the rank from second officer to captain, representing both the navy and the merchant fleet.

2.3. Coding and categorization

In the context of qualitative analysis, Hsiu-Fang and Shannon (2005) explore specifically content analysis. Pointing out that an overriding lack of a clear definition and procedures has proved detrimental to the application of content analysis, the authors focus on "the systematic classification process of coding and identifying themes or patterns" (Hsiu-Fang & Shannon, 2005, p. 1278) as a means of the interpretating the content of text data. This method was deemed suitable and consequently adopted for the study in question, as follows.

The data gathered from the group interviews and individual interviews are viewed as complementary (Lambert & Loiselle, 2008). Starting with a conventional approach to content analysis, the first step in the analysis was an independent reading of all the interview transcripts to gain a comprehensive understanding of the material (Hsiu-Fang & Shannon, 2005) A second reading led to a preliminary labelling and naming of phrases and passages of interest. At this stage, anything and everything of relevance to the research question(s) was identified (Braun & Clarke, 2013, p. 206). The following step was to note first impressions, thoughts and initial coding, as described amongst others in Hsiu-Fang and Shannon (2005) Codes were then reviewed, redefined and, as a result, merged with other similar codes and as a result categorization into more specific themes started to emerge. Using what Charmaz (2006, p. 60) refers to as "axial coding", the themes were sorted and subcategorized. Summaries of each theme were set down individually before being discussed to ensure inter-code reliability (Charmaz, 2006).

As a result of the coding and categorizing, major themes emerged in answer to the research questions, namely experience with, attitudes towards and practical implementation of communicative learning objectives and literacy in the simulator training. These are encapsulated in the following four categories:

- Language competence in maritime operations - see 3.
- Need for effective communication – see 3.
- Practical application of language in simulation – see 4.
- Implementation and effectiveness – see 5.
- Practical challenges and potential outcome – see 6.

Language competence in maritime operations and the need for effective communication are discussed together, whereas practical implementation and effectiveness are dealt with on an individual basis. The respondents are presented as follows: MET institution and numbers 1-4, with students denoted by St and Instructors by In.

3. Language Competence in Maritime Operations and the Need for Effective Communication

More than a decade ago Trenkner, Cole and Pritchard (2013) emphasised that language, namely Maritime English, must be competently used to safeguard the ship, her crew and the environment in which the ship sails, as well as to ensure that sea transport procedures are efficiently undertaken. It is therefore not surprising that during the interviews the need for effective communication skills, primarily through mastery of English, emerges as indisputable. The importance of language competence in maritime operations through the lens of students' and instructors' experiences sheds light on the practical necessity of English language skills. The instructors are clear that effective communication is not just "valuable*"* but "absolutely necessary*":*

"It's half your job after all and 90% of the communication takes place in English (MET2in1)."

This instructor's observation may be compared to a survey conducted by (Noble, 2017, p. 79), which reveals the great extent to which English is employed on board. The dominance of English on board, where, as one instructor notes, *"*you speak more English than your own language from time to time!"(MET4in2)*,* stresses the necessity for strong English language skills and demands that, regardless of the seafarer's native language, s/he should communicate effectively, as per table A-II/1 of the IMO International Convention on Standards of Training, Certification and Watchkeeping for seafarers (STCW), 1978, as amended (IMO, 1978).

The expectation that students should perform excellent communication in the simulator, demands the establishment of a clear competence trajectory. The students interviewed note that maritime literacy consists not only of navigational communication and reporting but extends to various operational aspects:

"There are a lot of other things happening aboard a ship as well, yes, and different kinds of like deck machinery, heavy lifting, talking to harbour personnel and Port state for example. So there is not just the procedural talk about changing course or giving position (MET4st2)."

Moreover, they note that instructions and explanations to ratings must be clear. Hence the breadth of communicative tasks requires a high level of language proficiency. In addition, instructors point out the serious potential of miscommunication, whereby "misunderstandings get [sic] enormous consequences" (MET3in1). This underscores the need for precision and clarity to prevent misunderstandings leading to operational and safety issues.

The insights from both students and instructors reveal that effective communication, in English in particular, is, predictably, a practical necessity rather than a mere academic requirement, and that effective communication is fundamental to maritime operations and onboard duties. By fostering strong language skills, maritime simulators can potentially play an active role in preparing the students for the complex communicative demands of their professions as maritime officers.

4. Practical application of Language in Simulations

When asked about their experience of connecting simulation and communication, the respondents agree that language proficiency, particularly English, is part of being a maritime professional. The practical use of language in simulations should therefore bridge the gap between the theoretical classroom teaching of maritime communication competence and the real-world application of the skills, as simulated.

Transforming theory into practice and using knowledge is emphasised by several instructors, as exemplified by these two quotes:

> "Yes, it's the practical part, especially considering transforming the theory we do, especially in the first year, where there is a lot of chart work and reading up on laws and regulations, particularly the Rules of the Road, but also the meaning of various things. It consists of text that one has to deal with, in connection with beacons and all that, which is transformed into the practical. (MET1in1)"

> "It's all the practicality of the communication. But within our simulator and our learning objectives for regards to the communication, we require a clear communication as per what they have already learned. That's all there is to it. We are mostly focused on the navigation part. (MET4in2)"

These quotes emphasize the importance of translating theoretical knowledge into practical skills. When it comes to communication, the instructors stress the necessity of clear communication, building on the theoretical foundation laid in the classroom. This is no different to capitalising on other theoretical competences, such as chart work or Rules of the Road.

It seems, however, that instructors and students are not aligned on all points in this context. Given that the simulator provides a controlled environment where knowledge gained in the classroom can be applied to real-life scenarios, it should also reinforce an understanding of communication skills, leading to competence. However, it seems that the very objective of preparing students to communicate effectively at a later stage can create stress when applied to high-pressure environments such as the simulator. This is borne out by students' comments:

> "If we take the example from the week before that, when we were supposed to take on board an English pilot. No, it was just chaos (MET3st6)."

> We've probably had a couple of terms in English, like... 'starboard ten,' different helm orders, but it was just listed in the book, it's not something we've gone through. But I remember reading it when we went through some terminology and such, but very little focus on that aspect, yeah. (MET2st0)

> "Everything but the communication part, I feel we know. (MET2st1)"

Oblivious to this, instructors expect students to provide evidence of the transformation from theory to practical, also when it comes to communication, which is assessed in one way or another. One instructor states:

> ""They've seen everything in theory. They know how to work on a chart, they know the instruments, they know the rules of the road. They know ARPA, they know radar. But here everything comes together. By the time they really have an exercise here, most of them have already done maritime resource management. Because we consider ... Like I said, they've seen everything before they came here. (MET4in1)"

An interesting finding to emerge from interviews with the instructors is that the latter seem unsure of precisely when and where the theoretical knowledge is imparted, in other words at what stage during the student's programme or in which course/s the theory leading to the competence is given.

To summarise, the students interviewed report feeling that they are not as proficient in Maritime English as they should be. This view is shared; Cole and Zhang (2018) found that students at maritime academies do not have the level of proficiency in spoken English stakeholders require, and revealed a dissatisfaction with listening and speaking skills, particularly in emergency situations. If SMCP is a focus through the Maritime English course, which is not the case at all four institutions, it could be described as sparse at best. The relatively poor perception of Maritime English courses could also be decisive. The students themselves acknowledge that they are not simulator ready in this respect. It seems therefore that the idea of the smooth transition from theory to practice in the simulator, as clearly expected by instructors, is not always the case when it comes to communication and language.

5. Implementation and effectiveness

All respondents, both instructors and students, expressed a positive attitude towards implementing communicative learning objectives in the simulator exercises. As mentioned previously, the instructors emphasized the need for communicative competence, especially in English, to get the job done safely and efficiently. When asked about practical implementation, the two sets of respondents prove divided, with instructors citing logistical, administrative, or pedagogical constraints that the students are not concerned with.

Time is a factor which concerns instructors. They remark that time constraints affect both the overall time spent with students in the simulator, as well as the time available for each individual exercise. Instructors give the impression that time is inextricably linked to quality, and that having to integrate communicative learning objectives would only make the perceived pressure of time constraints even bigger. Other constraints highlighted by the instructors are exemplified as follows:

“Well, the navigation part of it is already so demanding that to include more learning objectives in a different part in a different domain like the communication I think that's going to prove hard to introduce that. (MET4in2)”

“And it's often challenging enough, you could say, without the language. And focusing on one thing at a time, adding another person, or a teacher, could possibly detract focus, in a way. The only downside I see with it is that it adds an element to the complexity of the exercises. (MET3in1)”

All quotes indicate that the challenges the instructors perceive in incorporating additional learning objectives are related to the complexity of navigation training. This is considered as being challenging enough as it is. The simulator training program is often limited to a specific number of exercises (12-25). Instructors seem to fear that students lose focus on navigation if presented with too many challenges, communication being one. This would appear to contrast with previous statements whereby instructors agree upon and emphasise the importance of clear communication. The responses thus present a contradiction in terms: effective communication is vital but including it in simulator exercises is questionable because this complicates the navigational learning process. Within this context, it is interesting to note that two of the institutions assess their students by giving them marks for their communication throughout the simulation course. This is exemplified by the following quote:

“And we also comment on their communication. So, while they communicate on a VHF with a coastal station or with another vessel if it happens, we will note every time what they did wrong, especially. But we also tell them when they did good. (MET4in1)”

Indirectly, it could therefore be said that there are already communicative learning objectives in these simulator exercises. Although an extensive exploration of feedback techniques goes beyond the scope of this paper, it is interesting to note that the simulator is an arena where feedback is given instantaneously, sometimes in real time when instructors visit the bridge, and always in the debriefing session after each exercise. From both observations and the interviews, feedback is perceived as natural and direct. The way in which the simulator exercises are structured, including preparations, leads to the notion that the full-mission bridge simulator has enormous potential to transform into an arena where the operational communicative competence needed at sea can be trained to a very high level.

The students have, like the instructors, mostly correlating views about the effectiveness of the training and how to implement communicative learning objectives in the simulator. In general, the students wish to integrate or implement the communicative aspects of a ship’s watch/simulator exercise as early as possible, as indicated in the following quote:

“But I imagine that if you had integrated the VTS right away, and maybe started in Norwegian, and then switched to English later, but starting in Norwegian, it would just become part of the routine, so it wouldn't be an extra challenge, it would just become a habit in a way. (MET2st1)”

A gradual introduction, with a phased approach to integrating the Vessel Traffic Services (VTS), and a transition from Norwegian to English, indicate that the student sees the benefits of becoming comfortable with procedures and routines in their native language first, without the added pressure of using a second language. The student’s suggestion also reflects a practical application of language learning theories, which can lead to better retention and application of skills. Some of the students even express a wish to visit the bridge simulator during other classes, to familiarise themselves with the VHF, in particular.

The implication is that students, at least at the institutions where the simulation is not continuously graded, view the simulator as a learning environment where they can try and, significantly, then fail. Making mistakes in a controlled environment like a simulator is invaluable for learning, which other research also highlights as one of simulation's main advantages (Håvold et al., 2015; Kim, Sharma, et al., 2021; Sharma et al., 2019). They also point out that the more knowledge and practice they have acquired, the fewer errors they will make later. It is only by being allowed to commit and correct mistakes that the student gains a deeper understanding of their future maritime workplace:

"I think that now is the best opportunity to make mistakes and learn from them. But it's exactly in those moments that I feel you learn the most, […] (MET3st6)"

"And that is also connected with reporting here, which is extremely relevant. And if you know what it involves when you get out in the field, you avoid the mistakes and what makes you unsure. (MET3st3)"

It seems that even if students would like to include communication elements in the simulator as early as possible, they do not want to be evaluated or assessed on how they communicate until later in their programme, admitting that the full-mission bridge simulator can be overwhelming and that there is a great deal of equipment and multiple instruments with which to familiarize oneself. A phased integration is more desirable, where exercises that involve complex communicative tasks are introduced after students have become familiar with the simulator equipment and basic operational procedures. This is indicated below:

"Yeah, I think it should be well thought about because when you take your first lesson on simulator, it is overwhelming to manage all the information you're getting and all the information you should remember for the debrief and what you should be doing to not break the rules. I think if there would be more communicative things involved, I think it should wait till probably the end of the simulator trainings to add these to the simulator so when you are familiar with the equipment and the bridge and everything. (MET4st2)"

Managing real-time tasks while adhering to rules and, in addition, preparing for a debrief can lead to overload and the overwhelming nature of the initial lessons suggests the need for a phased approach to training, where foundational skills are established before introducing additional layers of complexity, such as advanced communication tasks. It is worth noting that the authors do not recognize routine communication, such as reporting to the VTS or helm orders, as advanced communication tasks.

Some students experience stress associated with the early stages of simulator training, and the related complex communication tasks can be challenging for them. "Even calling all the ships is quite stressful" states one student, going on to emphasise the benefit of gradually escalating the complexity of the training, by initially focusing on simpler tasks and progressively introducing more challenges, also in terms of communication. A phased integration like this can help reduce cognitive overload and ensure that students are confident and competent with the fundamental aspects, such as navigation, before tackling additional complex tasks, such as improvised communication.

6. Practical challenges and potential outcomes

By way of discussion, this part of the paper explores the practical challenges and potential outcomes of integrating communication training into simulator sessions, in other words the practical implementation. When asked about this, one of the instructors stated, "Yes, one might be able to achieve it to a greater extent, but [this is] not fully implemented as one might have wished." (MET1in1). All the instructors mention Search and Rescue (SAR)-exercises as simulations where one could implement communicative learning objectives.

"In a search and rescue exercise, there is a lot of improvised communication. We incorporate a lot of procedural aspects. If such an exercise is combined with the GOC radio course, it provides a focus on both the procedures and routines, while also including a considerable amount of improvisation. This is usually conducted in English. This kind of training becomes somewhat more sophisticated than otherwise. It is so realistic that they [i.e. the learners] immerse themselves well in it and meet the challenges. (MET3in1)"

This quote highlights language development, the balance between procedural and improvisational communication, and twinning with the General Operators Course (GOC). Conducting these exercises in English forces students to expand their vocabulary and improve their language skills by way of the practical application of language learning so critical to real-world maritime communication. A combination of standard phrases and the need for on-the-spot communication helps students develop both disciplined communication habits, as well as the flexibility to adapt as situations evolve. The blend of procedural training with improvisation in English can create a training environment which is sophisticated and realistic, as highlighted by another respondent:

"The same applies when you are, how should I put it, conducting SAR exercises, and the SAR exercise is not taking place in Norwegian waters. When communicating with others in English, everything should be carried out according to the GOC in English. You also cover multiple subjects. You get English, navigation, and navigation simulator. I feel that those exercises are good. (MET2in1)"

Search and Rescue involves complex, high-stress communication scenarios with several involved parties, and highlighting this kind of exercise underscores the need for focused training to handle such scenarios in real life. The instructors indicate that these kinds of exercises are challenging for the students in terms of communication, as borne out by the following two quotes:

"I also have the teaching that covers search patterns. It is a bit difficult at the beginning. Very difficult in terms of communication. To maintain control on the bridge, and especially when you need to organize a lot of injuries on a passenger boat. It always turns into chaos, but you learn a lot. (MET2in1)"

"For example, in a SAR exercise, the communication in English can become completely jumbled for some. (MET1in1)"

The fact that the instructors point out that things become chaotic and that communication in English can become "jumbled" prove to be interesting findings. Firstly, because communication otherwise seems to be perceived as less important, and secondly because such comments might indicate that students are not well enough prepared for these exercises in terms of language and communication challenges.

In addition, the volume of communication can be immense in towing operations, where, as in SAR exercises/operations, multiple frequencies and extensive coordination are involved. Icebreaking operations or ice navigation are other examples brought up by the instructors.

"Another example could be a towing exercise, where you have multiple tugboats and something being towed, as there is a lot of communication and coordination involved. Different frequencies for speaking, both with the deck and with each other and so on. So, it's perhaps because of the volume of communication that I'm thinking that. For example, reporting to a traffic station and such involves very little, tiny, elements, and that might be what happens in that exercise. (MET3in1)"

A towing exercise involving multiple tugboats, requires extensive communication and coordination due to the use of different frequencies for various communication needs. The high volume of communication required in such exercises emphasises the need for clear and efficient communication and protocols, where the students must learn to manage multiple communication channels simultaneously, as well as perform other aspects of the job. Such 'multi-tasking' is a critical skill in maritime operations. This, in contrast to simpler tasks like reporting to a traffic station, also show how the level of communication varies in complexity. To train diverse situations, such as towing, can ensure that students are better prepared to handle both routine and complex communication tasks. When asked about other examples for practical inclusion, instructors mentioned the English Channel:

"We did the Dover-Calais route and reported to the Dover Coast Guard or Gris Nez Traffic. Then he could handle the English part, I could handle the GOC part, and we have the navigation aspect on top, so you can combine multiple subjects into the same exercise. That way, you get a good result. (MET2in1)"

This quote, as well as some others, highlights the integration of multiple subjects into a single exercise. A multidisciplinary approach where different aspects are combined into a single exercise can ensure that students are exposed to a holistic training environment where they can apply and develop various skills concurrently. This integrated approach can enhance students' overall competence and confidence in handling complex tasks. The instructor notes that this method gives a "good result", indicating that students benefit significantly from an integrated training approach. It suggests that such exercises are effective in a learning perspective.

7. Discussion

The study aims to examine the role of functional literacy in an officer's education, exploring students' and instructor's experience, attitudes and the potential of the maritime simulator as a learning tool for literacy and language learning. This sampling of instructors and students demonstrates clearly that good communicative skills, primarily in English, are a necessity when performing the job of an officer on board. The simulator is a proven learning arena where theoretical knowledge is integrated and practically applied, but when it comes to communication, current experience in the simulator shows that the transition from theory to practice is lacking.

Routine maritime communication seems to be less proficient than anticipated, and students experience both stress - even chaos! - because they are not as confident in the simulator as they should be. Instructors expect students to have crafted their skills in advance and to perform flawlessly once in the simulator but still acknowledge that the communication in English can become jumbled. The simulator is thus the arena where everything comes together. Underlying this expectancy, however, there is a lack of awareness about where and when different competences are taught. A suggestion derived from the data would be to better facilitate the student's learning process, especially when it comes to routine communication, by adopting a holistic approach with greater collaboration between lecturers of different courses, an approach to disciplinary literacy supported amongst other by Airey (2011). Constraints mentioned by the instructors, such as time and the complexity of navigational training, could be addressed by an increased collaboration and understanding of competences taught in other courses. A cross-curricular approach is also suggested in other literature (Cole et al., 2002; Gabrielli, 2016; Spada, 2007). Communication, which is considered vital for performing the officer's duties, could in this way be systematically integrated in simulator exercises without complicating other learning processes.

The students express a wish to include communication as early as possible, and introduce new elements step by step, as with other learning objectives in the simulator. Starting with simple routine communication, like reporting to the VTS, the students believe that gradually introducing and incorporating communication into the exercises will reduce stress and render communication a habit. The instructors, by contrast, suggest that communicative learning objectives could be integrated into large, complex exercises containing procedural as well as improvised talk. It could be assumed that the reason the instructors suggest this is related to their expectation that students should have substantial knowledge before entering the simulator, which, as discussed above, does not always seem to be the case when it comes to communication. It can be argued that a combination of the students' and instructors' suggestions would lead to the best learning outcomes. By gradually introducing more and more communicative elements, one can eventually combine these into larger, complex exercises that incorporate emergency, routine, and improvised communication.

8. Conclusion

Increased knowledge and better collaboration within MET institutions can potentially make it possible to overcome the challenges and constraints mentioned, thus resulting in better utilisation of both resources and time in the simulator. It is crucial to put down markers early in maritime studies so that students are aware of the various skills, both navigational and other, which will later be put to the test in the simulator, and to be explicit as to how theoretical knowledge must eventually be translated into practice. Through collaboration with others, simulator instructors can be instrumental in this process by initiating other colleagues into the demands and rigours of the simulator.

In addition, the very nature of the simulator environment, where feedback is instantaneous and direct, facilitates constructive and formative learning. It is therefore likely that an approach which adopts a gradual introduction of communicative learning objectives in the simulator, as favoured by students, and builds on this step by step will naturally result in engagement with complex, authentic exercises, as preferred by instructors.

Adopting such suggestions and procedures would most certainly enhance the students' communication skills on the bridge, rendering aspiring seafarers not only simulator ready but ultimately work ready!

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DIGIMAR PROJECT PRESENTATION: COMPILING AUTHENTIC ROUTINE VHF MARITIME COMMUNICATION DATABASE

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Abstract: The main objective of the DigiMar project is to enhance navigational safety, measured through statistically significant differences (gap analysis) in the maritime communication skills of shore service operators and higher education students before and after the implementation of the digital educational pilot study enacted through instructional videos and chatbots, and potentially to contribute to a reduction of human, environmental, societal, and/or economic losses resulting from maritime accidents. An important segment of the project involves compilation, analysis, and alignment of the authentic VHF exchanges in accordance with the relevant recommendations and guidelines. Thus, the paper describes the process and some of the challenges encountered so far. One of the challenges pertains to the analysis of expected and observed values in VHF exchanges and the definition of the relevant criteria governing this task. Another challenge has been observed in the process of aligning the sample of exchanges with the standard. The preliminary results seem to point to a discrepancy in the actual real-life routine VHF maritime exchanges in comparison to the prescribed standard and raise the question of (in)consistency in application of the relevant recommendations and its potential consequences.

Keywords: DigiMar project; routine VHF maritime communications

1. Introduction

Language of maritime VHF communications is considered a special subtype of maritime English. Although English does not officially have the status of a mandatory language in the maritime industry, it has been used as an internationally accepted language of maritime communications for decades. The various risks associated with the navigation of ships, the development of technology and the increasing number of multinational and multilingual crews require the language of maritime VHF communications to be standardized. For this purpose, the Standard Marine Communication Phrases (SMCP, 2001) were developed by the International Maritime Organization (IMO) to contribute to safety of navigation, i.e., to standardize the language used in communications at sea, in port approaches, fairways, ports, and on ships with multilingual crews. The application of Standard Marine Communication Phrases in external communication (ship-to-ship and ship-to-shore) must be strictly harmonized with the applicable radio-telephone procedures, as prescribed in the International Radio Regulations of the International Telecommunication Union (2016) and IALA *G1132 Guideline: VTS VHF voice communication* (2022). The SMCP phrases should be used as often as possible, giving them an advantage over other ways of expressing a similar meaning. As a minimum requirement, users are recommended to adhere to these phrases as much as possible in critical situations. In this sense, these expressions should be an acceptable language for achieving navigational safety (SMCP, 2001). Thus, the DigiMar project aims to enhance navigational safety by measuring statistically significant differences in the maritime VHF communication skills of shore service operators and higher education students before and after the implementation of the digital educational pilot study enacted through instructional videos and chatbots that are planned to be developed at a later stage within the project. The starting point of the project was to identify the standards and main variables to be observed in the VHF exchanges between shore-service operators and ships and analyze them in a database comprising authentic VHF exchanges gathered from Vessel Traffic Service centers across several geographical regions. The following paragraphs describe the process of assembling the Authentic Routine VHF Maritime Communication Database and results of the analysis.

2. The aim of DigiMar Project Work Package (WP) 2.3

The main purpose of the DigiMar WP 2.3 was to create authentic routine VHF maritime communication database encompassing shore service operators' communication with ships across several geographical areas in order to conduct a pre-educational pilot study. Next step was to extract typical samples of routine VHF maritime communication exchanges for each geographical area under investigation and align them with the standard protocol of routine VHF maritime communication with the aim of providing the content for the digital educational tools to be developed later in WP3, and for the development of student simulation tasks in WP2.4. However, this report will only describe the methodology of assembling the database of authentic maritime VHF exchanges and the results of the analysis carried out to determine to which extent the authentic VHF exchanges adhered to the standard recommendations and guidelines.

3. WP 2.3 number and profile of participants

WP2.3 activities took place in the countries and at the premises of the project partners, and involved the researchers, shore service operators, and other stakeholders involved in each project activity. The list of participants is as follows:

Higher education institutions:

- University of Rijeka, Faculty of Maritime Studies, Croatia
- CHALMERS TEKNISKA HOEGSKOLA AB, Sweden
- University of Montenegro, Maritime faculty Kotor, Montenegro
- UNIVERZA V LJUBLJANI (applicant), Slovenia
- AB YRKESHOGSKOLAN VID ABO AKADEMI, Finland

Maritime safety authorities:

- Fintraffic Vessel Traffic Services ltd, Finland
- Swedish Maritime Administration, Sweden
- Norwegian Coastal Administration, Norway
- UPRAVA POMORSKE SIGURNOSTI I UPRAVLJANJA LUKAMA, Montenegro
- Ministarstvo za infrastrukturo, Uprava republike Slovenije za pomorstvo, Slovenia

4. Methodology

The compilation of a database of authentic VHF maritime communication exchanges included the following stages:

1. collection and preparation of authentic exchanges,
2. transcription and marking the variables,
3. analysis,
4. identification of typical authentic routine maritime communication exchanges,
5. alignment of selected samples of authentic routine maritime communication exchanges with the standard protocol of routine maritime communication (defined in WP 2.1).

In order to compile a spoken specialized pre-educational pilot-study database of authentic routine maritime VHF communications, higher education institutions (HEI) collected authentic routine VHF maritime communication exchanges from maritime safety authorities (MSA) in their respective geographical areas:

Table 1. List of higher education institutions (HEIs) and maritime safety authorities (MSAs) participating in assembling the database of authentic routine maritime VHF exchanges.

	MSA		HEI
1.	Fintraffic Vessel Traffic Services ltd (E10330679 - FI)	▶	AB YRKESHOGSKOLAN VID ABO AKADEMI (E10166177 – FI)
2.	UPRAVA POMORSKE SIGURNOSTI I UPRAVLJANJA LUKAMA (E10329943 - ME)	▶	University of Montenegro, Maritime faculty Kotor (E10027767 – ME)
3.	Ministarstvo za infrastrukturo, Uprava republike Slovenije za pomorstvo (E10330447 - SI)	▶	UNIVERZA V LJUBLJANI (E10209243 – SI)
4.	Swedish Maritime Administration (E10329737 -SE) Norwegian Coastal Administration (E10330365 - NO)	▶	CHALMERS TEKNISKA HOEGSKOLA AB (E10209418- SE)
5.	Ministry of the Sea, Transport and Infrastructure (Republic of Croatia)	▶	University of Rijeka

The recordings were sent in audio/video file formats (.wav, .mp3, .mp4 or similar) to the corresponding HEIs, who transcribed the audio files according to the predefined template. In the preparation stage, the lead partner defined and described the guidelines and the format for transcription, analysis and alignment to achieve the comparability of results from different geographical areas.

The guidelines included the following:

a. In the transcription stage, exclude all exchanges in the local language, pauses and stutters from the written transcript (except when local language is used in the middle of the conversation in English; then it is placed in brackets).

b. Transcribe unintelligible words according to previously agreed transcription rules.

c. In case of pauses of significant length, transcribe them as (...)

d. Any entry, extralinguistic information (such as noise, interference, etc.) to be transcribed within double brackets (( )).

e. Transcribe numbers as words.

f. Anonymize the transcripts (according to the General Data Protection Regulation) by removing the names of vessels (replace with Vessel/Tug/Pilot according to the situation), names of places (replace with Place/Name) and shore services (replace with Station).

g. Segment the transcribed text into moves and turns.

h. Place the parts spoken by VTS operators in a separate column from the parts spoken by other participants (bridge crew, pilots, tugs).

i. Number each communication exchange and mark its purpose

j. Assign a value 0 or 1 to the variables in all turns; all variables will be evaluated at the level of the turn, except the variable entitled "completeness of conversation" which will be evaluated at the level of the entire conversation exchange.

k. Place the communication exchange in the appropriate tab in the excel sheet, add a tab if necessary

l. Communication exchanges should be grouped according to the dominant topic of the conversation

In the transcription stage, the HEIs used a speech-to-text tool. However, the transcripts still had to be checked manually to assure accuracy. In the following step, the typical routine maritime communication exchanges were identified by HEIs for each geographical area. The template for transcription contained a section in which the partners provided the total number of exchanges and the number of exchanges for a particular topic. The partners named the purpose of each exchange in the transcription, which included the following: Maritime Report, approaching port, traffic information, departure, pilot, berthing, anchoring, towage, reporting at a waypoint, speed limit in port, drills, bunkerage, ME immobilization, channel switching, entering sector 5 of AdriRep. Subsequently, the exchanges were analyzed to identify their alignment with the standard. Partner institutions analyzed the sample exchanges qualitatively according to the set variables and marked the turns that did not comply with the standard in a particular variable. HEIs evaluated each turn according to the variables, i.e., if the variable was expected in a particular turn, value '1' was entered in the cell, if it was not expected then value '0' was entered; if the variable was observed in a particular turn, value '1' was entered in the appropriate cell, if not, then value '0' was entered.

5. Results

HEIs collected and transcribed authentic VHF exchanges from their respective areas, resulting in a specialized spoken pre-educational pilot-study database of authentic routine maritime VHF messages. The database contains a total of 1654 exchanges.

5.1. Analysis of variables

HEIs evaluated the expected and observed values for all variables included in the template. The results show interesting trends and corroborate some intuitive findings and opinions by both HEIs and MSAs and results from previous research. The results are shown below.

5.1.1 Analysis of variables related to turn standards

According to the standard protocol, the initial call should start with addressing the other station and identifying the calling station. Some documents (e.g. IALA guidelines) explicitly state that it is not necessary to do that at the beginning of every turn, but other documents give examples of exchanges in which every turn starts with addressing and identifying (e.g. Seaspeak Manual). Another standard recommendation is the use of “over” at the end of the turn and “out” at the end of the exchange. In the corpus of authentic maritime exchanges collected by HEIs, there is a large discrepancy between the expected and observed values for these standard recommendations. The greatest discrepancy can be seen for “this is”, or the part where the station identifies itself. It is more frequently the case for the calling station just to state its name without using the phrase “this is”. Addressing is observed in 33% of the turns while identifying is observed in 22% of the turns. Also, “over” was used in 17% of the cases while “out” was used in 33% of the cases. The results are shown in Figure 1. It is also quite common to use “ok” or “thank you” instead of “over” and “out”.

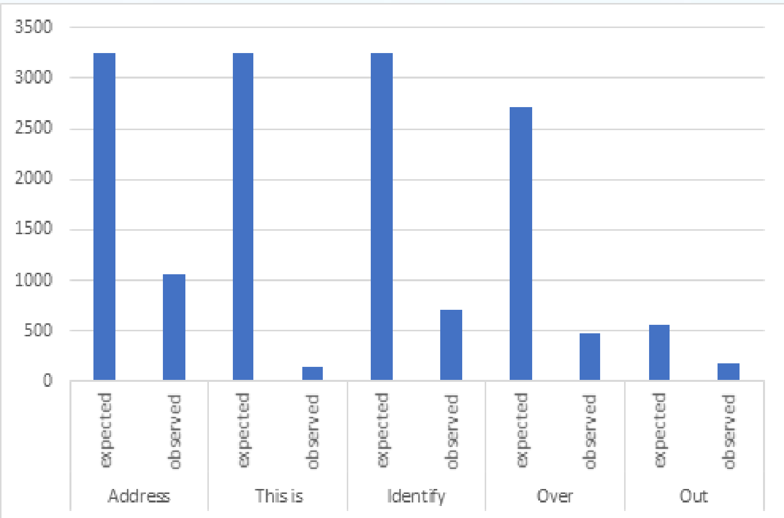

Figure 1. Results of the expected and observed values for turns

5.1.2. Analysis of variables related to message markers

Among the seven message markers observed, Intention, Instruction and Warning did not show significant results and were therefore removed from further analysis. The reason for this might be that the VTS operators understand those message markers as being very strict and rigid. The message markers that were expected the most were Question and Information but were observed in only 2% and 16% of the cases respectively. Figure 2 shows the results of the analysis of message markers. This shows that VTS operators use fewer message markers than expected, which corroborates the findings from previous similar studies conducted in other areas (cf. Jurkovič 2022, Raju 2020).

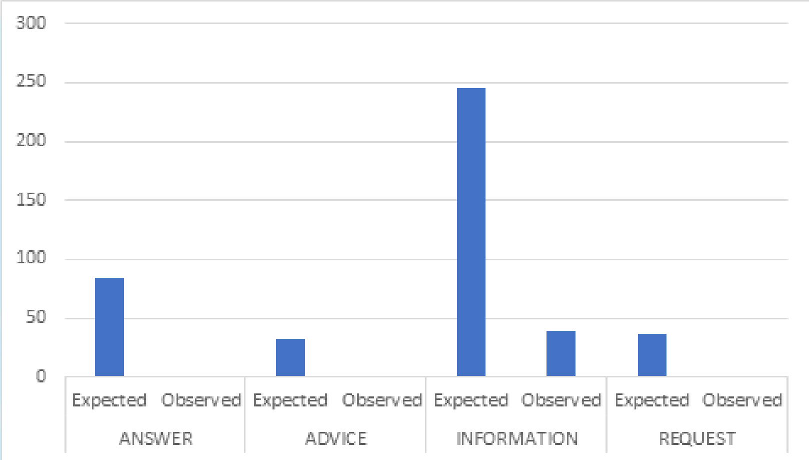

Figure 2. Results of the expected and observed values for message markers

5.1.3. Analysis of variables related to syntactic ellipsis

The variables "Fully worded question", "Fully worded answer", "Use of S+V+O structure" and "Simple sentence" refer to syntactic formation of sentences in maritime exchanges. The related documents recommend the use of full sentences with one piece of information per sentence. The results, shown in Figure 3, demonstrate that VTS operators follow the recommendation of one piece of information per sentence (85% of the turns) and subject + verb + object structure (56% of the turns), while fully worded questions are formed in only 17% of the turns. Questions are mostly indicated by rising intonation.

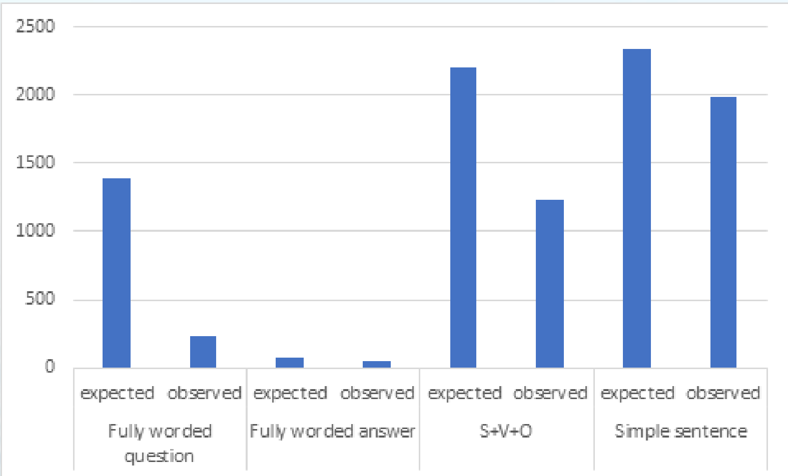

Figure 3. Results of the expected and observed values for syntactic ellipsis

5.1.4. Analysis of variables related to letters, digits, modal verbs and abbreviated forms

When it comes to letters and digits, all the relevant documents providing recommendations and guidelines on VHF communication agree on using Marine Alphabet for pronouncing call signs and spelling and reading numbers each digit separately. In the database, VTS operators read digits separately in most turns, but sometimes they do not use the Marine Alphabet when expected. Modal verbs and abbreviated forms are not recommended according to all the relevant documents. The database of authentic VHF maritime communications showed that VTS operators do use modals and abbreviated forms, but not to a great extent. However, a surprising result was the use of Marine Alphabet in only 23% of the cases. The results are presented in Figure 4.

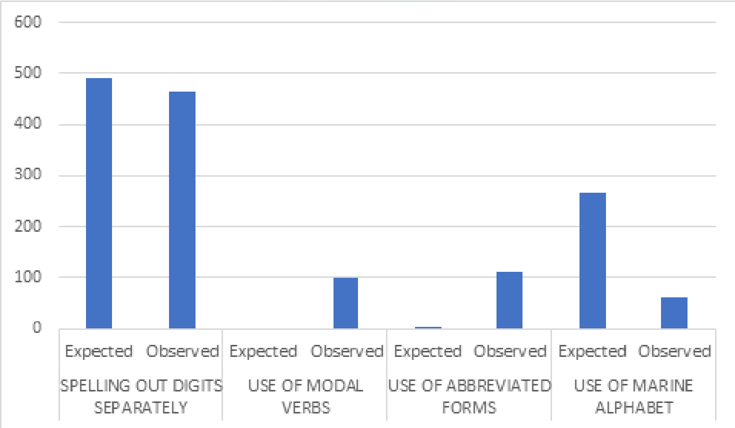

Figure 4. Results of the expected and observed values for pronouncing numbers in separate digits, letters, abbreviated forms and marine alphabet

5.1.5. Analysis of variables related to prowords

Prowords, or procedural words, have a commonly understood meaning and are used to make communication easier. In VHF maritime communications there are prowords that are recommended, e.g. *stand by*, *spell*, etc. and those that are not recommended by the relevant documents, e.g. *copy*, *roger*. There are instances of both in the corpus, with some prowords being very rare, e.g. *read back* or spell. These were thus omitted from the analysis. Figure 5 shows the results of expected and observed values for the selected prowords.

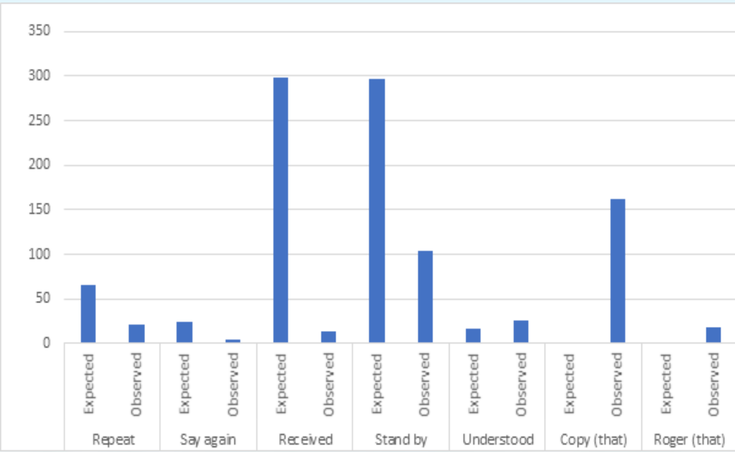

Figure 5. Results of the expected and observed values for prowords

The prowords that were expected in most turns were "received" and "stand by" and were observed in 5% and 35% of the cases respectively. The words "understood", and "copy" appear in many of the turns although these are not recommended by the relevant documents. The use of "repeat" and "say again" also deviates from the standard and it is often the case that the two are used interchangeably.

5.1.6. Analysis of variables related to extralinguistic aspects

HEIs also evaluated some extralinguistic aspects of maritime communications, e.g. "Formal tone of communication", "Pace of speaking" and "Clarity of speech". The results of the analysis are shown in Figure 6.

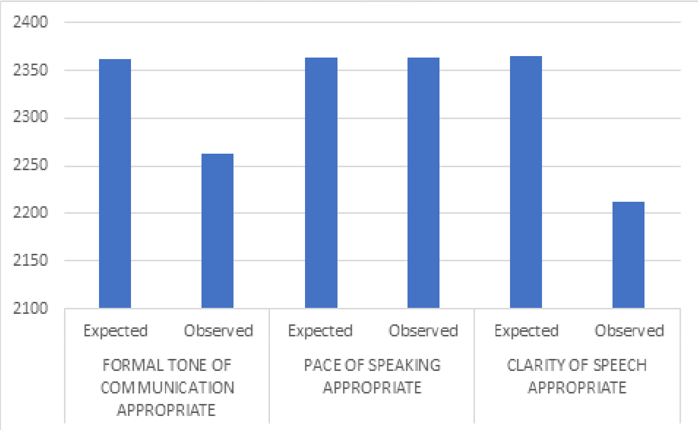

Figure 6. Results of the expected and observed values for tone, pace and clarity

The corpus has shown that VTS operators follow the guidelines regarding the extralinguistic aspects of communication, i.e., they are formal in their communication, do not speak too fast and try to speak clearly.

Another aspect that was observed was the use of the so-called forms of politeness, or expressions of politeness, e.g. greetings, wishes, expressions of gratitude. It seems that VTS operators feel the need to tone the formality of the situation down a bit and bring a certain tone of politeness, friendliness and ease to the conversation. Figure 7 shows the share of the expressions of politeness that were not expected in the conversation.

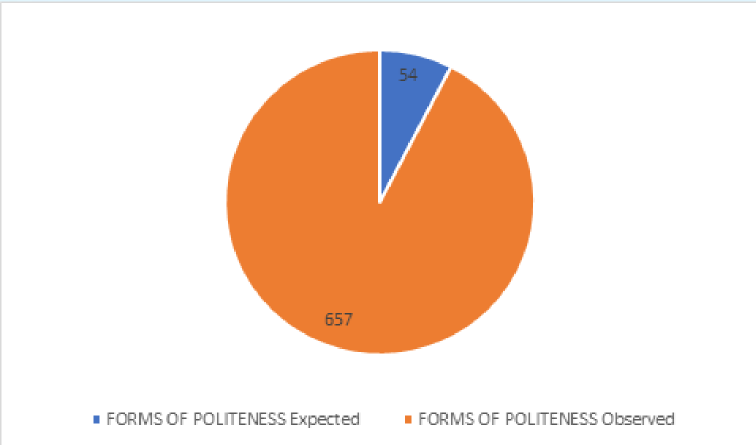

Figure 7. Results of the expected and observed values for forms of politeness

These expressions appear mostly in the initial call, when greeting the other speaker, or at the end of conversation, when wishing them a safe voyage or a good watch. In the central part, i.e., the actual exchange of messages, the speakers frequently use “please” to mitigate the imperative expression.

6. Conclusion

The DigiMar project Work Package 2.3, presented in this paper, included a very demanding task of transcribing authentic VHF maritime communication exchanges between shore-service operators and ships and evaluating the turns of the exchanges according to a pre-defined set of variables. The variables were not easily determined owing to several issues. Firstly, the variables evaluated in the transcripts refer to recommendations and guidelines as to how the maritime VHF exchange should be formed. As these are recommendations and guidelines, and not rules, the question is how strictly they are to be followed. Secondly, some variables were differently defined and understood by partners as these have not been precisely defined in the relevant regulatory documents. For example, whether the “address and identify” part was necessary at the beginning of every turn or only in the initial making-contact stage of the conversation (IALA guidelines recommend addressing and identifying only in the initial making-contact stage, while the Seaspeak Manual provides examples with addressing and identifying included at the beginning of every turn) or how often message markers should be used since there are also different interpretations in the regulatory documents. It seems that imprecise definitions and divergent recommendations in the relevant regulatory documents lead to different understandings and interpretations of the selected variables. Thirdly, MSAs had their own views about the adherence to the standard protocol as they found that some recommendations are not in line with practice since they seem inefficient and time-consuming (e.g. addressing and identifying at the beginning of every turn and the use of 'over' at its end). The MSAs also provided their own interpretation of message markers, which considered them as being on a scale from less formal or obligatory, e.g. Advice or Information, to more binding and stricter, e.g. Warning, while the message marker Instruction was reported as not being used by some VTS stations or being used rarely by others.

Authentic VHF maritime conversations show deviations from the standard protocol especially in some elements, e.g. addressing and identifying, the use of over and out, fully formed questions, modal verbs, etc. However, this did not hinder communication or cause communication issues in the VHF exchanges. The omissions seem to be for reasons of language economy, while the repetitions, although sometimes necessary, take a lot of time. The expressions which are not recommended by the relevant documents (e.g., modal verbs or prowords such as *copy* or *roger*) are used and clearly understood by the other speakers. Therefore, this analysis of authentic recordings implies that it would be necessary to reconsider some parts of the standard VHF maritime protocol and to (re)define them.

Acknowledgements

DigiMar project is co-funded by the European Union.

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MARITIME PSYCHOLOGY – AN INTEGRATED TRAINING APPROACH

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Abstract: This paper is opening initial research regarding the need for the maritime industry to train their own, specialized psychologists. In the maritime field the term "human element" is commonly used to designate "a complex multi-dimensional issue that affects maritime safety, security and marine environmental protection involving the entire spectrum of human activities performed by ships' crews, shore-based management, regulatory bodies and others" (https://www.imo.org/en/OurWork/HumanElement/Pages/Default.aspx). But the study of this factor is done by specialists educated outside the maritime training environment. The author is making a short review of the literature concerning the influence and the importance of the human factor in the maritime industry. The paper is drawing attention on the different perceptions around this concept. Some professionals associate the human factor with performance and recommend parameters to evaluate it. Other approaches insist on the fact that the welfare of the seaman, the diversity and the inclusion eliminate the stress, the fatigue, and the accidents. The essential is that we need to look at the human factor in a new and detailed perspective. For the author, which is trained as a Master of seagoing vessels but also as a psychologist, the "human element" means the psychology of the seaman. This article is presenting some facts that are indicating a need for an increased number of psychologists in the maritime domain. These new professionals need to be thoroughly familiar with the marine environment and with the seaman behavior. This paper aims first at establishing a common vocabulary between the maritime and the psychology fields. Furthermore, the author makes an inquiry on the opportunity of developing transdisciplinary curriculum between psychology, maritime training and education. During the presentation of some facts and figures, the participants will be invited to answer a brief online questionnaire which will uncover an initial general opinion on this new concept of Maritime Psychology.

Keywords: human element; maritime training and education; transdisciplinary curriculum; maritime psychology

1. Introduction

During the last 5 years an increased activity of the IMO subcommittee for the Human Element was noticed, counting for example 241 issued documents between 1st January 2019 and 1st June 2024, representing almost 50% of all the documents issued by the same working group on the IMO Docs database according to my last search in June this year. This indicates that there is an increased focus on the study and regulation of the human impact in the maritime industry.

The IMO describes "a complex multi-dimensional issue that affects maritime safety, security and marine environmental protection involving the entire spectrum of human activities performed by ships' crews, shore-based management, regulatory bodies and others" by using a famous keyword "the human element".

The ICAO (Doc 10151 Manual on Human Performance (HP) for Regulators, 2021) gives a definition of the term "human factor" issued by the Human Factors and Ergonomics Society in 2008 which "is concerned with the application of what we know about human beings, their abilities, characteristics, and limitations, to the design of equipment they use, the environments in which they work and the jobs they perform."

The American Psychological Association on their website (https://dictionary.apa.org/psychology) defines psychology in their dictionary as "the study of the mind and behavior" and gives as one of their research directions the study of the human factor. It has become obvious that we should ask the assistance of ~~the~~ psychologists if the maritime industry wants to benefit from the thorough knowledge of the human being.

Considering the increasing activity of the IMO Human Element subcommittee and observing the industry trends regarding the management of human resources, this paper tries to discover who is presently involved in the study of the mind and behavior of the seafarer and raises some questions regarding the training of the psychologists working in the maritime industry.

2. Who works with the human factor in the maritime industry?

The author has been trying to answer this question for the last year searching mainly on the LinkedIn professional network. The search was performed using the key words "human factor" and "maritime" and it was the names of the authors that declared in their "Info" section that they work with or in connection with the maritime human factor that were recorded. The author tried to connect with them to create a network of maritime psychologists. So far, 197 resumes have been studied and only 28 licensed psychologists have been found. Their number is not exactly known since the study group is not a sample because the population of human factor workers is not known exactly since there are no demographic research in this direction as far as the author is aware.

For the Human Factor activity background, the results of the study are showing that out of 197 professionals:

Number of professionals	Percentage from the total of 197 maritime human factor professionals	Activity field
99	50.25 %	Human Resources
51	25.89 %	Training
20	10.15 %	Mental Health and Psychological support
12	6.09 %	Crew welfare and charity
7	3.55 %	Research
6	3.04 %	Performance
2	1.01 %	Resilience and Safety

Let us analyze each concept with a focus on what is the workers educational background for each field.

2.1 Specialists working in Human Resources

According to the online Cambridge Dictionary, the Human Resources is "the department of an organization that deals with finding new employees, keeping records about all the organization's employees, and helping them with any problems". For the 99 resumes of people working in the Maritime Human Resources field, the author found the following educational background categories:

Number of professionals	Percentage from the total of 99 HR professionals	Educational background
21	21.2 %	Human Resources education
26	26.3 %	Maritime Academy
6	6.1 %	Psychology
46	46.5 %	Other type of education

What we finally observe is that out of 99 maritime HR professionals only 21.2% have HR education and only 6% were educated as a psychologist.

Even if it is not our purpose to investigate the maritime HR field, it is alarming to see that a lot of HR professionals come from outside the industry. The fact that psychologists work in the HR departments is, in the author's opinion, an advantage and a trend for the future development of the human factor management.

2.2 Professionals working in Maritime Training

The training field was considered by the author as an activity intended to increase the knowledge about the human factor or the soft skills of an employee. These training activities include STCW courses with strong human factor impact like:

- 1.21 Personal Safety and Social Responsibilities,
- 1.22 Bridge Resource Management,
- 1.29 Proficiency in Crisis Management and Human Behavior training including passenger safety, cargo safety and hull integrity training for passengers, ro-ro and ro-pax ships.
- 1.30 Onboard assessment (of a seafarer)
- 1.39 Leadership and Teamwork
- 1.40 Use of Leadership and Managerial Skills
- 1.41 Passenger Ship Crowd Management Training
- 1.42 Passenger Ship Crisis Management and Human Behavior Training

- 6.16 Train the Simulator Trainer and Assessor
- 7.17 Engine Resource Management

From a total of 51 maritime professionals working in training the human factor, the author found the following distribution of their educational background:

Number of professionals	Percentage from the total of 55 training professionals	Training background
30	58.8 %	Maritime Academy
5	9.8 %	Psychology
2	3.9 %	Ergonomics and Safety
1	2 %	Pedagogy
13	25.5 %	Other types of education background

Starting with this step of my research the figures and stats are becoming unreliable. However, the author is asking himself whether the human factor in the maritime sector should be trained by seafarers or by psychologists.

2.3 Professionals working with the seafarer's mental health.

Mental health is "a state of mind characterized by emotional well-being, good behavioral adjustment, relative freedom from anxiety and disabling symptoms, and a capacity to establish constructive relationships and cope with the ordinary demands and stresses of life" according to the online dictionary of the American Psychological Association, accessed in June 2024 (American Psychological Association, 2024). In the same dictionary the term psychological counseling was found, assimilated with the term psychological support which means an "interaction with a client to explore and offer direct advice about affective, cognitive, or behavioral problems and to reach solutions". In this field the educational background is very well regulated by the public health sectors in every country although there are some important differences between the competencies of a professional coach and a psychologist.

Out of a total of 197 resumes of professionals working with the maritime human factor, the author found a total of 28 licensed psychologists, meaning 14.2%. These professionals in psychology have studied different specialties like:

- Organizational Psychology
- Clinical Psychology
- The psychology of resilience and performance
- Military Psychology
- Occupational health and psychology
- Mental health, sociology, and well-being
- Coaching
- Psychology of sport
- Ergonomics
- Resilience
- Neurolinguistic programming

Following this diversity of educational backgrounds, the author considers that even if there is a trend to employ psychologists from outside the maritime industry, there is no clear option of what kind of psychologists we need for the maritime human factor.

2.4 Professionals working with the seafarer's welfare and charity.

The crew welfare and charity are activities to "improve the lives of seafarers and their families with services, resources, strategies and advocacy" according to the International Seafarers' Welfare and Assistance Network website (ISWAN, 2024). Out of 197 resumes studied, the author found 12 professionals working in this domain with different educational backgrounds such as chaplains, theologists, HR and HSE professionals, marketing, MBA, coaching or human rights specialists. They only have a support mission for the well-being of the seafarers; they are financed by different religions or NGOs, and they only have a limited impact on the human factor. This impact seems to be centered on the personal well-being and not on the work performance.

2.5 Professionals doing research work on maritime human factors.

Out of a total of 197 maritime human factor professionals the author found only 7 researchers. Their educational background is completely heteroclite. They received education in ergonomics, psychology, sports psychology, applied languages, air operations, human factor engineering, sociology, transport, and logistics. I did not notice a constant focus on the maritime human factor but occasional research in association with other maritime professionals. I cannot further comment these figures due to the characteristics of my study group.

However, it seems common knowledge that very few researchers publish articles on the maritime human factor and the author cannot properly explain why. It remains a subject for further studies.

2.6 Professionals working with the performance of the human factor in maritime.

The author found in his study group 6 professionals working to optimize the performance of the seafarers. These professionals also have different educational backgrounds and are part of the Human Resources departments. They measure the performance through key indexes and sometimes they perform interventions similar to a therapy to optimize the work results of different leaders. The term "leaders" can vary from company to company and usually includes the Captains and the Chief Engineers. Their educational background originates in: MBA, Organizational Learning, Maritime Academy, NLP training, Organizational development, Organizational Psychology, and coaching.

2.7 *Professionals working with the resilience and safety of the human factor.*

These specialists perform similar work as the performance specialists, but they focus on preventing mental health problems and increasing the motivation towards a safe working behavior.

2.8 Summary of findings

As shown previously, the human factor management is done with the assistance of different kind of specialists with different educational backgrounds.

The best adapted for this kind of work seems to be the HR specialists and the psychologists. The HR specialists are trained more on the administrative part of the HR management, they watch over the recruitment, the preservation, and the improvement of the human resources from the legal point of view and from the perspective of performance. The psychologists are mostly individual-centered, except the organizational ones.

The general figures regarding the educational background of the entire study group shows another trend:

Number of professionals	Percentage from the study group	Educational background
56	28.4%	Maritime Academy
28	14.2%	Psychology
21	10.7%	HR education
92	46.7%	Other type of educational background

Recalling the definition of psychology as being "the study of the mind and of the behavior", it is easy to notice that out of 197 maritime human factor professionals, only 14.2% are psychologists and 10.7% are HR specialists giving a total of 24.9% of professionals that have a master's degree in connection with the human factor.

In addition, as the author notices, NONE of these specialists are trained in the Maritime Human Factor Management.

Do we have a training program for Maritime Human Factor Management? The answer is negative according to the author's knowledge.

3. A quick review of what is the Human Factor in the maritime industry

According to a study carried out by the SAFEMODE project to establish a taxonomy of the human factor in aviation and in maritime (Stroeve et al., 2023), there are several categories of human factor elements, each with their own elements:

1. Perception
2. Planning and decision making
3. Intentional deviation (from the agreed plan, n.a.)
4. Response execution (wrong execution of the plan, n.a.)

5. Communication
6. Physical environment (that influence certain abilities of the operator)
7. Equipment and workspace (ergonomics, working positions, layout of equipment, etc.)
8. Interpersonal communications
9. Team and group conditions
10. Misperception
11. Awareness
12. Memory
13. Mental workload
14. Personal factors (emotional state, personality, confidence level, motivation, etc.)
15. Physiological condition (illness, injury, sickness, fatigue, burnout, etc.)
16. Drugs and nutrition
17. Competence, skills, and capability
18. Personnel leadership
19. Operations planning
20. Task leadership
21. Culture
22. Safety management
23. Resources
24. Economy and business

In another review of the publications on the maritime human factor, Senbursa and Dunder (Senbursa & Dunder, 2024) illustrate the mediating effect of well-being, happiness and trust in the relationship between work and life balance and work effectiveness in seafarers. In this study, several scales are used that measure parameters of "Psychological well-being", "Work-life balance", "Organizational trust", "Work effectiveness" and "Organizational happiness".

In 2023, Ma et al. (Ma et al., 2023) published an interesting review that summarises the concept of "human factor" versus the concepts of "human element" and "human error ", giving for each concept various causes such as:

- Personal, group and organizational factors plus the drive as "human factor"
- People, ship, environment, management, organization and working conditions as components for the "human element" and
- Individual and team management errors in perception, decision, and execution.

Several studies have shown that the seafarers' working environment influences the seafarer's mental health but one of the most recent ones is more explicit, (Svetina et al., 2024). In this study, the authors found that parameters such as bullying, vibrations, physical injuries, homesickness, viruses, diseases and working alone are factors that contribute to the development of anxiety and depression symptoms. The variables that have some importance in the seafarer's decision to quit their job seemed to be related to social problems like isolation from family or friends, cultural differences at the workplace, supervisor's demands and bullying by colleagues.

4. Who is going to manage the Maritime Human Factor in the future?

Looking at all the key concepts mentioned above and recalling the definition of the Human Resources and the concept of psychology, the author suggests that now the human resources management is done by a very small group of specialists. In addition, nowadays, the concept of Human Resources Management is a lot closer to Psychology that it has ever been.

Considering that an important part of the maritime HR professionals has their main education done in a Maritime Academy which teaches according to the STCW requirements, the author considers that there is a need for a new product on the training market for satisfying the need for maritime human factor specialists. The author suggests that the IMLA organization develops in a joint project with one or more Psychology faculties a curriculum for training Maritime Psychologists.

The concept of Maritime Psychology is not new. It was first published in a volume edited by Pr. Malcolm MacLachlan in 2017 and defined as the study and practice of the interplay between human behavior and the maritime environment (Malcolm. (Ed.). (2017) MacLachlan, 2017). This definition refers to the maritime environment and the human behaviour and, in Psychology, when one refers to both concepts, uses the Cognitive and Behavioral perspectives.

The American Psychological Association explains in their dictionary that Cognitive Psychology is "the branch of psychology that explores the operation of mental processes related to perceiving, attending, thinking, language, and memory, mainly through inferences from behavior", and the human behavior as "an organism's activities in response to external (i.e. the environment, n.a.) or internal stimuli, including objectively observable activities, introspectively observable activities (…), and non-conscious processes" (American Psychological Association, 2024).

Recalling the IMO definition of the human element as "a complex multi-dimensional issue that affects maritime safety, security and marine environmental protection involving the entire spectrum of human activities performed by ships' crews, shore-based management, regulatory bodies and others" the author is able to observe a close connection with the Maritime Psychology concept of the interplay between human behaviour and the maritime environment.

As a logical conclusion of this series of similarities between the concepts, it would be interesting to offer to the maritime industry an educational program that would train new HR specialists, the Maritime Psychologists. These professionals will work in the future with the HR management, and they will not be limited to the study of the human factor, but they will carry out interventions for creating a balance between the performance at the workplace, well-being, mental health, and social comfort.

5. What would a typical training strategy for a Maritime Psychologist be?

The author suggests that the cycle of education for a Maritime Psychologist is to be designed according to the Bologna process. The first three years of undergraduate or licence degree will be obtained in a University for Human Sciences at a Faculty for General Psychology or equivalent, then the candidate will be recruited for the Master program developed by the IMLA team, hosted at one of the members Maritime University or at one of the Psychology Faculties connected with the maritime industry. The Master program will take 2 years to accomplish, and it will open the way to a PhD in Maritime Psychology with post-doctoral studies.

Ideally, the Marine Psychologist would be trained in Cognitive and Behaviour theories of Psychology because seafarers live half of their life or more in a different environment which influences their cognitions and creates a different behaviour compared to the shore industry.

According to the educational background that I found for the existing psychologists that work in the maritime industry, our new psychologist would require training in:

- Human Factor Engineering – for working in the HR department.
- Psychometrics and personality assessment – for recruiting personnel.

Psychometrics is the branch of psychology concerned with the quantification and measurement of mental attributes, behaviour, performance, and the like, as well as with the design, analysis, and improvement of the tests, questionnaires, and other instruments used in such measurement. Also called psychometric psychology, psychometry (American Psychological Association, 2024)

- Cognitive and Behavioral group therapy or coaching – for carrying out interventions on crews or for BRM/ERM courses and evaluations.
- Organizational Psychology with focus on maritime organizations
- Developmental Psychology with focus on adults
- Clinical Psychology only with focus on stress-related syndromes like anxiety, depression, addiction, etc.
- The psychology of resilience and performance
- Occupational health and psychology
- Psychological first aid
- Conflict management
- Crew well-being.
- Maritime English
- Code of Ethics for psychologists – to keep a balance between the owner's interests and the seafarer's well-being, the Marine Psychologist will have to be trained in ethics and to be subjected to a code of conduct.

The author considers very important that the Marine Psychologist knows the maritime environment therefore suggests introducing a sailing time during the training and after graduating, giving the opportunity to observe the seafarer's behaviour and do some research that will be presented as the graduation project. Therefore, the new specialist will have a Seaman's book and all the STCW training required for a rating.

The list remains open to modifications or new entries following the market requirements and further research.

6. What would a typical career path for a Maritime Psychologist be?

The young Marine (or Maritime) Psychologist will be typically an employee of a HR department in a shipping company, of a seafarer's mental health centre or will work with different organizations that regulate or provide services in connections with the seafarer's mental health, performance, and well-being.

He or she will start their career in a Crewing department working with the recruitment process of the personnel, mainly using psychometrics. The next step would be to manage the training of the personnel (STCW human factor-related courses and psycho-educational campaigns), then to manage the performance of the personnel, to manage the safety drive and motivation, to investigate human errors, then to manage stress-related issues, to build resilience, to carry out individual and group interventions for development, behavioural assessments and finally to become the Human Factor Manager of an organization.

The author suggests that for keeping in contact with the maritime environment, the Marine Psychologist should keep their Seaman Book valid and sail several months within a period of 5 years or before moving up in the organization.

7. Is there a need for Marine Psychologists?

It is difficult to answer this question. In my opinion, we need psychologists for the seafarers because they spend a significant part of their life at sea, in special conditions, different from our normal environment. Following the logical association that a different environment causes a different behaviour and different cognitions it seems normal to have a special psychologist to study the maritime human factor.

If we only think of the COVID crisis and the number of mental troubles and suicide cases, the hotlines for mental support for seafarers were rapidly developed. The idea is excellent, it still works for different other issues like bullying or harassment, with one little problem: the psychologists at the other end of the line know very little of the seamen's life.

Let us consider the total number of seafarers for the merchant fleet. Their number is around 1.9 million according to the data provided by the International Chamber of Shipping in 2021 (International Chamber of Shipping, 2021) According to the data provided by the World Health Organization, in 2016 the number of licensed psychologists for every 100,000 group of population ashore ranges from Argentina – 222 and Australia – 103, going down to 29.86 in the USA and to 0.85 in the Philippines (World Health Organization, 2019). Considering an average of 50 licensed psychologists per 100,000 group of population, we might think that we need 950 psychologists for our 1.9 million seafarers.

However, all our seamen do not spend 100% of their ~~entire~~ time at sea. According to my knowledge in the maritime sector, the best ratio of sea time versus leave time is 50 per cent, usually for Management Officers or for developed countries. In the worst-case scenario, seafarers can spend up to 80-85 % of a year on board, especially the ratings. Considering that for 100,000 seamen we would initially need 950 mental health workers, supposing that these people are at sea on average 67% of their total active lifetime, it seems that we need a slightly reduced number of psychologists for the seafarers. Focusing on the people that are sailing, for their psychological support, it seems that we would need only 630 mental health professionals (67% out of 950). This figure is just for the merchant fleet and only for the people at sea, not considering the seafarers at home or the psychologists working for the HR departments of different maritime organizations.

If my estimation is correct, a permanent body of 600 maritime psychologists would be created with the introduction of a 20-student international master's degree in Maritime Psychology. If one of the Maritime Universities implemented this curriculum, we would have, every year, 20 graduates in Marine Psychology for 30 years in a row, finally reaching the desired body of professionals. During all these years the maritime industry would benefit from research on the "Human Element" done by the specialists in maritime psychology. After gaining experience, these marine psychologists would take over the missions as consultants for IMO Human Element, Training and Watchkeeping subcommittee or other organizations managing the human factor. The trend in the maritime industry is to evolve from the HR management and Crewing departments into a new Human Capital Management, according to a study by Thetius published in April 2024 (Macdonald, n.d.)

Also, as previously shown, the author of this paper noticed a discrepancy between the training background of different maritime HR professionals, recalling that only 25% of the study group had received some kind of education as HR or psychologist. Following this suggestion, the author came up with the idea of this new training product the Master of Marine Psychology which would improve the educational offer for this domain.

Later, if the project continues, the team will have to find out if the customers really need our product. By customers I understand ship owners, shipping companies, government organizations for the seafarers' mental health, Non-Governmental Organizations dealing with the maritime human factors, welfare and well-being, regulators such as the IMO, Classification Societies, OCIMF, Maritime Safety Authorities and Accident Investigation Branches and many others. Before the training platform is implemented, the new psychologists will have to have an already secured place to work and at the same time, with this investigation, the project will be marketed to the clients.

8. Comments

There are many uncontrolled variables that were not taken in account such as:

- The characteristics of the study group. Due to the sensitivity of this research, the author could only check the resumes that were made available by their owners. It is quite sensitive to comment one's educational background without creating frustrations. For this reason, the study group is not representative of the entire population. However, this has not stopped me from seeing in the statistical noise something to be considered, or reasons to continue this research.
- The need for a new professional. From my experience, I have the intuition that ship owners are not preoccupied right now with the improvement of their human factor management. The main subjects now are decarbonization and alternative fuels. This is quite normal and urgent, but the revolutionary ideas are coming from your human resources. There are special trained professionals only dedicated to conducting brainstorming meetings. Creativity is a human capacity that can be developed by psychologists. New ideas can be generated very easily in special environments but except brilliant minds, one usually needs a group facilitator that can be a psychologist or a coach (Gogatz & Azavedo, 2023).
- Also considering the need for this new job: usually ship owners focus on their profit. Obviously, the profit is an essential objective for the activity of a maritime business organization. All the other purposes are secondary. Human resources in terms of priority have a variable rank for different companies. At first, if the employee is not happy, he or she will quit the employer (Wen et al., 2022). If the seafarers are having mental health problems, the owner will have expenses with repatriation, treatment, and insurance (Sampson & Ellis, n.d.). If the employee is not happy, their emotional state will impact their performance (Senbursa & Dunder, 2024). In addition, we have new concepts in economy like "sustainable development", "corporate social responsibilities" etc., all involving the preservation and the optimization of both the performance and well-being of the employees. In the author's opinion, even if there is a justified strategy to cut the budget for HR to maintain the company's profit, there is a need for a professional to use solid scientific arguments for defending the human element. In case of financial difficulty, the same person will optimize interventions on the organization's human factor to keep a balance between performance, safety, mental health, welfare and well-being of the crews and other employees. The failure of this balance will induce, in the long term, the failure of the organization.
- The work for creating a new curriculum is a complex interdisciplinary project that will probably take years to finish, and that, if we find Psychology teachers that are willing to help. Furthermore, recruiting undergraduate psychologists and asking them to sail is not an easy thing to do. There is a particular segment of young people that are attracted to the study of psychology and, because the maritime environment is quite harsh, there is a good chance that this program becomes less interesting for the future psychologists. It would be nice to promote this project at the students' educational fairs to find out how many candidates would be interested. It would also be very nice to offer them attractive incomes.

9. Conclusion

Bearing in mind that the study group is not a sample, the various educational backgrounds of the specialists working with the maritime human factor it is however signalling a need for a special training curriculum that would regulate and standardize their education. The author is suggesting initiating a team of maritime lecturers, working with psychology teachers at the creation of a new job: the maritime (or marine) psychologist. This new specialist will study the maritime human factor and will work with the ship owner in the HR department to keep the balance between the performance, mental health and the well-being of the seafarers and any other employee in the maritime industry.

The next steps in this project would be to find out if the maritime training organizations can host such a master's programme and if the maritime industry really needs it. This paper was created only to investigate the initial validity of this project. Your critics and your suggestions are more than welcome. This project, if it is started, may be stretched on a period of several years. It can result in a considerable amount of work for a team of maritime and psychology professors, and it does not make sense to start it unless there is a good use for its outcome. If you would like to contribute to the birth of a new profession or if you would like to improve the project or to stop useless energy consumption, please express your opinion by filling in the 1-minute questionnaire to be found at the following link: https://forms.gle/AfooNRQtDCu63mZ79 . Also, if after checking all the figures and comments, you or your organization are interested in participating to this process, please send an email to octavian.postolache@supmaritime.fr.

The future of shipping seems to be in direct connection with the decarbonization but also with the evolution of the human element.

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JURISDICTION OF COASTAL STATES IN MARINE ACCIDENTS/INCIDENTS OCCURRING IN INTERNATIONAL MARITIME AREAS

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Abstract: The seas have been the most effective means of international trade for thousands of years. In addition to trade, the resources obtained from the seas, including energy, resources from living organisms between the seabed and the sea surface, and underground resources beneath the seabed, have increased the economic importance of the seas. Seas have been important not only in economics but also in the security of states with coastlines. With the understanding of the socio-economic and strategic value of the seas, the need arose for coastal states to determine maritime boundaries. There have been many attempts throughout history to determine maritime boundaries and jurisdictional areas, but this issue was partially resolved with the 1982 United Nations Convention on the Law of the Sea (UNCLOS). The delimitation of seas begins from the imaginary lines known as the Baseline (BL) and is determined at a certain distance from the sea structure and the border of other states. In the areas formed at distances from the Baseline, the coastal state has various rights. International customs and laws have been established to determine and defend these rights. Neutral courts have been established as judicial authorities. The procedure by which the boundaries, jurisdiction, and responsibilities are determined within the maritime zones of UNCLOS, not recognized by some states, has led to disputes between states involved in maritime boundaries or any maritime incident/accident.
This study examines the jurisdiction and responsibilities of coastal states in maritime incidents or accidents that may occur in international waters. Issues such as freedom of navigation for ships, uninterrupted tracking, human trafficking, piracy, environmental pollution, and illegal radio broadcasts that could disrupt a country's political integrity are addressed.

Keywords: Maritime Jurisdiction Areas, Coastal State Jurisdiction, UNCLOS, Marine Accidents/Incidents

1. Importance of Maritime

1.1 Economic Importance

International Trade: Seas have been one of the most important routes for international trade for thousands of years. Ships deliver over 80% of world trade, so disruptions in ports and on shipping lanes mean food, energy, medicine and other essential items don't reach those in need (United Nations Conference On Trade And Development, 2023). Maritime trade is expected to grow 2.4% in 2023 and more than 2% between 2024 and 2028. (United Nations Conference On Trade And Development, 2023) This highlights the critical role of the seas in the global economy. If we consider maritime with economic perspective, we should consider Blue Economy.

The Blue Economy is regarded as the decoupling of socio-economic activities and development from environmental degradation and optimizing the benefits which may be derived from marine resources. The attitude of achieving long-term prosperity by a country or a region befitting the wellbeing of all citizens and the mankind preserving the environment, especially the sea is the basis of the Blue Economy (Bari, 2016).

Fishing and Seafood: Seas are an indispensable source of fishing and other seafood, which are crucial protein sources for a significant portion of the world's population. Additionally, the seafood industry holds a significant place in the economies of many countries. The total first sale value of the global production was estimated at USD 406 billion. (FAO, 2023).

The fisheries and aquaculture sectors have been increasingly recognized for their essential contribution to global food security and nutrition in the twenty-first century (FAO, 2023).

The overall production of aquatic animals, over 157 million tonnes (89 percent) were used for human consumption. The global fisheries and aquaculture sector provides direct employment for approximately 59.5

million people. This figure represents the number of people working directly in the sector, while millions more depend on it indirectly for their livelihoods (FAO, 2023).

On the other hand, consumption of seafood, especially fish, is very important in healing mental illnesses/diseases as well as physical illnesses/diseases. It has been shown that people are less likely to suffer from depression in diets that include these in a balanced manner(Güney, 2024)

Energy Resources: Seas are important not only for fossil fuels like oil and natural gas but also for renewable energy sources such as wind and wave energy. Offshore oil and gas fields, in particular, constitute a significant portion of the world's energy supply. Mostly, conflict occurs between countries because of this reason. Especially, east mediterranean sea is one of the main regions of these areas. Because, throughout mediterranean sea there are a lot of countries where have border to sea. Hydrocarbon Potential of the Nile Delta Basin was shown below.

Table 1. According to the United States Geological Survey's Research, the Hydrocarbon Potential of the Nile Delta Basin (Egypt) (United States Geology Survey, 2010)

Region	OIL (Million Barrels)	NATURAL GAS (Billion m³)
Nile Boundary	1,288	45.22
Nile Delta	475	6,152.69
Total	1,763	6,320.55

1.2 Environmental Importance

Biodiversity: Seas are one of the largest reservoirs of biodiversity on the planet. Habitats such as coral reefs, mangrove forests, and seagrass beds provide living spaces for numerous species and help maintain ecosystem balance. Tropical forests are primarily found in the humid regions near the equator in South America, Africa, and Asia. Although these forests make up only 7% of the world's plant cover, they are estimated to harbor half of the world's species. In addition, coral reefs, large tropical lakes, and deep seas are considered as sources of biodiversity waiting to be discovered (Erten, 2004).

The ocean, the lungs of our planet, is in a state of emergency driven by climate change and plastic pollution causing biodiversity and habitat loss. Carbon emissions from human activities are causing ocean warming, acidification and oxygen loss. Toxic chemicals and millions of tons of plastic waste are flooding into coastal ecosystems, killing or injuring fish, sea turtles, seabirds and marine mammals, and making their way into the food chain and ultimately being consumed by humans (United Nations, 2023).

Carbon Cycle: Seas play a crucial role in the global carbon cycle. They absorb a significant portion of the carbon dioxide from the atmosphere, helping to mitigate climate change.

Water Cycle: Seas are central to the global water cycle. A large part of the water in the atmosphere comes from the evaporation of seawater and returns as precipitation.

1.3 Social and Cultural Importance

Although coastal areas cover only a small percentage of the world's habitable land, according to 2017 global figures, approximately 2.4 billion people (nearly 40% of the human population) live within 100 kilometers of coastal areas. It is estimated that this trend of migration to coastal areas will continue in the future (United Nations, 2017).

Tourism and Recreation: Seas and coastal areas are popular destinations for tourism and recreation. These regions offer millions of people opportunities for relaxation, entertainment, and cultural experiences.

Recreation may also lead to increased social interaction, an important component of well-being. Coastal ecosystems are likely to contribute to social interaction through the provision of common space that is aesthetically pleasing, attracts residents and provides a convenient setting for casual contact. It is therefore hypothesised that recreation in coastal areas contributes to overall well-being through enhancing social interaction and networks, increasing sense of place and improving physical and mental health. (Cox, Johnstone, Robinson, 2004)

1.4 Strategic and Security Importance

Maritime Security: Seas are critical for national security. Naval forces operate to ensure the security of sea routes, combat piracy, and protect maritime borders. Main reason of the security is protect the rights and subject mentioned above. If a country demands their rights in any maritime area, this country should provide security and make clear borders and limitations. It can only obtain with strong and effective sea power. Main element of sea power is strong navy and coast guard.

Maritime Rights and Jurisdiction: Rights and jurisdiction over maritime areas are regulated by international law. These rights are essential for protecting the economic and security interests of states. Every coastal states have their own maritime jurisdiction areas.

2. Maritime Jurisdiction Areas

Throughout the ceturies, coastal states always benefited from seas. With improvement of navigation and ships, these states demanded more jurisdiction area for their benefit and this caused to conflict. That's why international authorities made some laws and regulations about this subject.

In 1930, at The Hague, territorial sea and jurisdiction was discussed. Then the concept of the 'continental shelf' was introduced into maritime law by a proclamation of the President of the United States ('U.S.') Truman in 1945 and soon found widespread application (Demir, 2020).

The 1958 Geneva Convention on the High Seas and the subsequent 1982 United Nations Convention on the Law of the Sea have delineated maritime areas under the sovereignty of coastal states to protect their rights and interests. Within these areas, states have jurisdiction and can utilize economic resources. The legal status of these maritime areas has been established by the aforementioned conventions. Coastal states operate in areas such as internal waters, territorial sea, contiguous zone, continental shelf, and exclusive economic zone, each with its own specific characteristics and boundaries as defined by these conventions.

Coastal states aim to maximize their benefits from these maritime areas for their interests, but international rules limit their sovereignty in these areas to ensure the uninterrupted conduct of maritime trade. To facilitate international maritime trade without disruption, ships are granted the right of innocent passage. Under this right, ships gain immunity as long as they navigate through another state's territorial waters without posing any threat. In such cases, even if the ship is in another state's territorial waters, it remains under the sovereignty of the state whose flag it flies.

3. Maritime Security

Maritime Security is one of the latest buzzwords of international relations. Major actors in maritime policy, ocean governance and international security have in the past decade started to include maritime security in their mandate or reframed their work in such terms (Bueger, 2015).

Maritime security is however also linked to economic development. Throughout history the oceans were always of vital economic importance. The majority of trade is conducted via the sea and fisheries is a significant industry. Both global shipping and fisheries have developed into multi-billion industries.

Following the delineation of maritime jurisdiction areas by international conventions, states have strengthened their navies and established coast guard commands to protect the values derived from these maritime areas and ensure law and order within them. The idea that "he who rules the seas, rules the world" has made establishing dominance at sea increasingly important. Strategically, the ability to rapidly deploy a large-scale military force and the extensive length of maritime borders contribute significantly to the defense doctrine of a state, ensuring sufficient defense lines along its coast.

The notion of maritime security communities integrates current thinking about security communities and develops this concept further in arguing that an appropriate understanding of security has to go beyond the traditional understanding of the absence of war (Bueger, 2015).

While the state benefits from these maritime areas, it is also responsible for ensuring security within and beyond them.

Historically, maritime security was defined as "the absence of a situation where one state perceives another state as a military and political enemy, and consequently feels threatened and fearful from the sea." In modern times, maritime security is understood to mean ensuring that societies and individuals within those societies do not feel fear and threat. In the past, ensuring maritime security involved a state using its conventional military power to combat and establish dominance over another state.

Today, it encompasses combating issues that affect society in various ways, such as marine pollution, illegal fishing, and smuggling via maritime routes. Modern maritime security involves using legal frameworks and regulations to prevent such illegal activities and ensure safety and order at sea.

4. Maritime Accidents/Casualities and Incidents

The concept of 'marine safety' addresses the safety of ships and maritime installations with the primary purpose of protecting maritime professionals and the marine environment. Marine safety in the first place implies the regulation of the construction of vessels and maritime installations, the regular control of their safety procedures as well as the education of maritime professionals in complying with regulations. Marine safety is closely linked to the work of the International Maritime Organization and its Maritime Safety Committee1 which acts as the core international body for developing rules and regulations (Bueger, 2015).

According to IMO, a marine casualty/accident means an event, or a sequence of events, that has resulted in any of the following which has occurred directly in connection with the operations of a ship:

1. the death of, or serious injury to, a person;
2. the loss of a person from a ship;
3. the loss, presumed loss or abandonment of a ship;
4. material damage to a ship;
5. the stranding or disabling of a ship, or the involvement of a ship in a collision;
6. material damage to marine infrastructure external to a ship, that could seriously endanger the safety of the ship, another ship or an individual; or
7. severe damage to the environment, or the potential for severe damage to the environment, brought about by the damage of a ship or ships.

According to circumstances mentioned above, some accident types are represented below;

Capsizing, Collision, Contact Damages to ship or equipment, Dropping into the sea, Fatal accident due to cargo loading, Fire or explosion Hull failure / failure of watertight doors / ports, Intoxication Missing: assumed lost, Occupational accident, Stranding / grounding

2023 Maritime Casualties Key Figures (EMSA, 2023)

- Occurrences: 2560
- Ships Involved: 2769
- Ships Lost: 10
- Very Serious Casualties: 42
- Pollution Events: 52
- Navigational Accidents: 44.0%
- Persons Falling/Slipping: 26.6%
- Injured Persons: 792
- Lives Lost: 27
- Investigations Launched: 66

A marine incident means an event, or sequence of events, other than a marine casualty, which has occurred directly in connection with the operations of a ship that endangered, or, if not corrected, would endanger the safety of the ship, its occupants or any other person or the environment (IMO, 2008)

In any case of any marine accident/incident, evaluation of marine accident professionally conducted and any necessary action should be immediately taken by crew. Risk management plays important role to remove risk of any accident. Primarily precautions must be taken.

5. Coastal State Jurisdiction

At a conference held in The Hague in 1930 under the auspices of the League of Nations, numerous issues concerning maritime law were addressed. Although agreements were reached on matters such as freedom of navigation in territorial waters, the rights of coastal states, the baseline, freedom of navigation, and the contiguous zone, no international convention was achieved due to the lack of consensus on the breadth of territorial waters (Demir, 2020) until UNCLOS.

The sovereignty of a coastal State extends beyond its land and inland waters to the extent of its territorial sea. This jurisdiction gives the coastal State an inherent right to investigate marine casualties and marine incidents connected with its territory. Most national Administrations have legal provisions to cover the investigation of a shipping incident within its inland waters and territorial sea, regardless of the flag (IMO, 2008).

When maritime accidents occur, a ship may be within the maritime jurisdiction areas of any state. The consequences of maritime accidents emerge after the accidents, and among these consequences, there may be those that oppose the interests of the coastal states near the accident area. Therefore, the ship involved in the accident is subject to the jurisdiction of the coastal state, and the parties are tried in the courts.

Also according to IMO, following matters can be conducted by coastal state;

1. take steps so that any investigation they conduct to determine the cause of a maritime accident that occurs within their jurisdiction is conducted in a fair and expeditious manner;

2. ensure that seafarers are treated in a manner which preserves their basic human dignity at all times;

3. take steps to ensure/verify that adequate provisions are in place to provide for the subsistence of each detained seafarer including, as appropriate, wages, suitable accommodation, food and medical care;

4. ensure that due process protections are provided to all seafarers in a non-discriminatory manner;

5. ensure that seafarers are, where necessary, provided interpretation services, and are advised of their right to independent legal advice, are provided access to independent legal advice, are advised of their right not to incriminate themselves and their right to remain silent, and, in the case of seafarers who have been taken into custody, ensure that independent legal advice is provided;

6. ensure that involved seafarers are informed of the basis on which the investigation is being conducted (i.e. whether it is in accordance with the IMO Code for the Investigation of Marine Casualties and Incidents (resolution A.849(20) as amended by resolution A.884(21) or as subsequently amended), or pursuant to other national legal procedures);

7. use all available means to preserve evidence to minimize the continuing need for the physical presence of any seafarer;

8. ensure decisions taken pursuant to the Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73/78) are consistent with the provisions of Annex I (Regulations for the prevention of pollution by oil), regulation 11;

9. promptly conduct interviews with seafarers, when done for a coastal State investigation following a maritime accident, taking into account their physical and mental condition resulting from the accident;

10. take steps to ensure that seafarers, once interviewed or otherwise not required for a coastal State investigation following a maritime accident, are permitted to be re-embarked or repatriated without undue delay;

11. promptly conclude its investigation and, if necessary, charge seafarers suspected of criminal actions and ensure that due process protections are provided to all seafarers subsequent to any such charge;

12. take steps to ensure that any court hearing, when seafarers are detained, takes place as expeditiously as possible;

13. take steps to ensure decisions taken are consistent with generally applicable provisions of the law of the sea;

14. take steps to respect the generally accepted provisions of international maritime law regarding the principle of exclusive flag State jurisdiction in matters of collision or other incidents of navigation.

5.1 Internal Waters

According to Kuran (1990, as cited in Demir, 2020) Internal waters are under the sovereignty of the coastal state. Internal waters are regarded as no different from the land territory of the state. The powers of the coastal state in these waters are full and absolute. If there are limitations accepted by international law for the land territory of the state, these are equally applicable to internal waters. Exceptions to the absolute sovereignty of the coastal state may be introduced by domestic law provisions and certain international agreements to which it is a party. Right of innocent passage as provided in this Convention shall exist in those waters (UNCLOS, 1982).

5.2 Territorial Sea

The sovereignty of a coastal State extends, beyond its land territory and internal waters and, in the case of an archipelagic State, its archipelagic waters, to an adjacent belt of sea, described as the territorial sea (UNCLOS, 1982)

Passage of a foreign ship shall be considered to be prejudicial to the peace, good order or security of the coastal State if in the territorial sea it engages in any of the activities (UNCLOS, 1982). One of these activities is ‘’any other activity not having a direct bearing on passage’’ thus we can evaluate all maritime accidents and incidents scope of coastal state jurisdiction authority.

5.3 Contiguous Zone

In a zone contiguous to its territorial sea, described as the contiguous zone, the coastal State may exercise the control necessary to:

(a) prevent infringement of its customs, fiscal, immigration or sanitary laws and regulations within its territory or territorial sea;

(b) punish infringement of the above laws and regulations committed within its territory or territorial sea.

(UNCLOS, 1982)

5.4 Continental Shelf

According to Article 77 of the United Nations Convention on the Law of the Sea (UNCLOS), the coastal State has sovereign rights over the continental shelf. These rights are inherent and do not require the coastal State to make any proclamation or take any action to assert them. The rights of the coastal State over the continental shelf exist ipso facto (by the fact itself) and ab initio (from the beginning).

The rights of the coastal State over the continental shelf are exclusive to it. However, these rights are limited to the exploration and exploitation of natural resources. In other words, the coastal State has sovereign rights over the continental shelf solely for the purpose of investigating and economically utilizing its natural resources(Demir, 2020)

5.5 Exclusive Economic Zone

The coastal State may, in the exercise of its sovereign rights to explore, exploit, conserve and manage the living resources in the exclusive economic zone, take such measures, including boarding, inspection, arrest and judicial proceedings, as may be necessary to ensure compliance with the laws and regulations adopted by it in conformity with this Convention. Arrested vessels and their crews shall be promptly released upon the posting of reasonable bond or other security. Coastal State penalties for violations of fisheries laws and regulations in the exclusive economic zone may not include imprisonment, in the absence of agreements to the contrary by the States concerned, or any other form of corporal punishment. In cases of arrest or detention of foreign vessels the coastal State shall promptly notify the flag State, through appropriate channels, of the action taken and of any penalties subsequently imposed (UNCLOS, 1982). Exclusive Economic Zones must be declared by coastal states.

5.6 High Seas

The provisions of this Part apply to all parts of the sea that are not included in the exclusive economic zone, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State(UNCLOS, 1982).

Whether a state has a coastline or not, it does not affect the rights of coastal state over the continental shelf and high seas. Such as; navigation freedom, benefits from economic resources, lay submarine cables and scientific research.

1. Except where acts of interference derive from powers conferred by treaty, a warship which encounters a foreign merchant ship on the high seas is not justified in boarding her unless there is reasonable ground for suspecting:

(a) That the ship is engaged in piracy; or

(b) That the ship is engaged in the slave trade; or

(c) That though flying a foreign flag or refusing to show its flag, the ship is, in reality, of the same nationality as the warship.

2. In the cases provided for in subparagraphs (a), (b) and (c) above, the warship may proceed to verify the ship's right to fly its flag. To this end, it may send a boat under the command of an officer to the suspected ship. If suspicion remains after the documents have been checked, it may proceed to a further examination on board the ship, which must be carried out with all possible consideration.

3. If the suspicions prove to be unfounded, and provided that the ship boarded has not committed any act justifying them, it shall be compensated for any loss or damage that may have been sustained (UN, 1958).

5.7 General Implementations

5.7.1 Innocent passage

1. Passage is innocent so long as it is not prejudicial to the peace, good order or security of the coastal State. Such passage shall take place in conformity with this Convention and with other rules of international law.

2. Passage of a foreign ship shall be considered to be prejudicial to the peace, good order or security of the coastal State if in the territorial sea it engages in any of the following activities:

(a) any threat or use of force against the sovereignty, territorial integrity or political independence of the coastal State, or in any other manner in violation of the principles of international law embodied in the Charter of the United Nations;

(b) any exercise or practice with weapons of any kind;

(c) any act aimed at collecting information to the prejudice of the defence or security of the coastal State;

(d) any act of propaganda aimed at affecting the defence or security of the coastal State;

(e) the launching, landing or taking on board of any aircraft;

(f) the launching, landing or taking on board of any military device;

(g) the loading or unloading of any commodity, currency or person contrary to the customs, fiscal, immigration or sanitary laws and regulations of the coastal State;

(h) any act of wilful and serious pollution contrary to this Convention;

(i) any fishing activities;

(j) the carrying out of research or survey activities;

(k) any act aimed at interfering with any systems of communication or any other facilities or installations of the coastal State;

(l) any other activity not having a direct bearing on passage.

In 1995, Chile blocked the passage of the "Pacific Pintail". As a reason for this action, Chile also cited Article 234 of the United Nations Convention on the Law of the Sea (UNCLOS,1982). Article 234 states that in ice-covered areas, where harsh climate conditions and navigation hazards exist, the right of innocent passage can be restricted to prevent marine pollution. This is because pollution in these regions could cause irreversible ecological damage. Article 234 serves as an exception to the principle that "the coastal state cannot impede innocent passage"(Yılmaz,2010).

5.7.2 Flag Rights

In order to maintain administrative and judicial order on the high seas and other maritime jurisdiction areas and to avoid any legal vacuum, states are assigned certain responsibilities. Within the framework of these responsibilities, states can, as a rule, exercise their authority only over vessels flying their own flag. (Derinde, 2020).

5.7.3 Notifying

States shall promptly notify the flag State and any other State concerned of any measures taken against foreign vessels, and shall submit to the flag State all official reports concerning such measures(UNCLOS, 1982).

5.7.4 Right of Approach

States may conduct a maneuver to approach a vessel sailing on the high seas to verify its nationality. This is known as the right of approach. Since the purpose of this right is to verify the vessel's nationality, it is also referred to as flag verification to avoid confusion with the right of visit. This right is recognized by customary international law and can be exercised by any state against suspicious vessels. However, the execution of this right is strictly limited to identifying the vessel's nationality (Derinde, 2014).

5.7.5 Right of Visit

Also coastal states have rights to boarding ships at seas in any situation determined UNCLOS Article 110, Right of Visit.

(a) the ship is engaged in piracy;

(b) the ship is engaged in the slave trade;

(c) the ship is engaged in unauthorized broadcasting and the flag State of the warship has jurisdiction;

(d) the ship is without nationality; or

(e) though flying a foreign flag or refusing to show its flag, the ship is, in reality, of the same nationality as the warship.

(UNCLOS, 1982)

5.7.6 Struggle with Terrorism

One of the incidents that occur at sea is terrorism. Terrorist activities are evaluated from different perspectives by various communities. These groups or individuals conducting terrorist activities are considered freedom fighters or heroes by some states, while they are regarded as criminals and terrorists by others. The existence of such differing views prevents international consensus and hinders the development of adequate international regulations.

In 1985, the hijacking of the Achille Lauro ship by terrorists and the subsequent uncertainties and disorder led to the creation of an international convention. Thus, the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (SUA) was established.

Article 4 of the SUA Convention specifies that the convention applies if a vessel is navigating beyond the outer limit of a single state's territorial sea or beyond the lateral limits of its territorial sea with adjacent states, and if the vessel is scheduled to enter, pass through, or navigate within those waters. The convention requires a connection such as territoriality, registration, or the involvement of a national for a state to exercise jurisdiction over the offenses enumerated. The condition of territoriality implies that the coastal state has the authority to intervene and exercise jurisdiction.

If it is proven that an individual or group is likely to engage in behavior that endangers a ship, its cargo, or its passengers, or attempts or exhibits similar conduct, they will be prosecuted by the relevant parties.

5.7.7 Marine Pollution

In the maritime jurisdiction areas extending up to the territorial waters where a country holds sovereignty rights, the state fully enforces its own environmental pollution regulations. However, the need for international regulations becomes evident when marine pollution occurs beyond these territorial waters.

Within this scope, Coastal States may in respect of their exclusive economic zones adopt laws and regulations for the prevention, reduction and control of pollution from vessels conforming to and giving effect to generally accepted international rules and standards established through the competent international organization or general diplomatic conference(UNCLOS,1982).

In practice, Coastal state may require the vessel to give information regarding its identity and port of registry, its last and its next port of call and other relevant information required to establish whether a violation has occurred(UNCLOS,1982). If the vessel refuses to provide information or if the information provided by the vessel is found to be false, the coastal state authorities will carry out the necessary physical interventions to clarify the situation.

If the vessel has caused serious marine pollution that damages the exclusive economic zone, territorial waters, or shores of the coastal state where the state's economic interests are located, the coastal state has the authority to detain the vessel and impose penalties on those responsible. However, if the vessel responsible for the marine pollution provides a guarantee that it will pay the fine deemed appropriate by the coastal state, it may be allowed to continue its operations.

6. Conclusion

Since the dawn of civilization, the seas have captured human interest, and their significance has grown with technological advancements throughout history. Their importance spans various sectors, including International Trade, Fishing and Seafood, Energy Resources, Biodiversity, Tourism and Recreation, and Strategic concerns.

As the importance of the seas increased, so did the interest of states in maritime affairs. This led to international regulations, most notably the Geneva Convention on the High Seas and the United Nations Convention on the Law of the Sea. These regulations grant coastal states certain sovereign rights in specific maritime areas, making the issue of maritime security increasingly significant.

Maritime security is now recognized not only in the context of conventional threats but also in its impact on society. All illegal and extraordinary events at sea indirectly affect the well-being of the community, highlighting the importance of a strong legal system and an effective maritime force to enforce these laws for states.

When accidents and incidents occur within the jurisdiction of the coastal state, they are investigated and examined by the judicial and control authorities of that state. The article defines the types of accidents and their classifications according to the International Maritime Organization (IMO).

The subsequent section examines the judicial and intervention authorities of the coastal state in maritime areas, covering internal waters, territorial seas, the contiguous zone, the continental shelf, the exclusive economic zone, and the high seas.

In the final section, the specific rights and authorities of coastal and flag states are discussed, along with a detailed examination of terrorist activities and marine pollution occurring at sea, and the unique exceptions to these situations as outlined in international legislation.

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NEW ERA STANDING ON BEYOND THE HORIZON FOR MARITIME TRANSPORTATION: INDUSTRY 5.0 (MARITIME 5.0)

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Abstract: Throughout history, industries have evolved in response to the growing demands of suppliers and consumers. This progression is often categorized into different "Industrial Eras." In Industry 4.0, automation became internet-based, leading to fully automated factories. However, Industry 4.0 has faced criticism for potentially sidelining human involvement in production processes. To address these concerns, the Japanese government introduced the concept of Industry 5.0, also known as Smart Society, emphasizing a symbiotic relationship between humans and technology for the betterment of society. This shift towards Industry 5.0 principles is becoming relevant in various sectors, including the maritime industry, where autonomous ships, unmanned equipment, and port management systems have increasingly integrated Industry 4.0 technologies, enhancing efficiency. This study aims to explore the limitations of Industry 4.0, investigate the potential benefits offered by Industry 5.0, and evaluate its applicability within the maritime domain. To achieve this, a comprehensive literature review was conducted, collecting relevant information to present a perspective that promotes the positive implementation of Industry 5.0 principles in the maritime industry, thereby maintaining a focus on human well-being and societal progress.

Keywords: Industry 5.0, Human Factor, Smart Society, Maritime 5.0

1. Introduction

The development of production in history has shaped societies and people's lifestyles and created new needs. It can be said that this situation occurs due to the income and production needs of societies, supply-demand relations, and trade relations between countries. The mentioned advances have given birth to and advanced the capitalism in which we are also living. In the literature, this situation is called an "industrial revolution”.

Industry 1.0, the machine production process, marked the beginning of the industrial revolution. This led to increased worker capacity and speed. Industry 2.0, the technology revolution, saw mass production and new business divisions emerge. Industry 3.0, the digital revolution, emphasized the internet and computers. Industry 4.0 represents the fourth wave of industrial transformation, combining information technologies and the manufacturing sector. This paradigm relies on intercommunication of devices and a shared communication infrastructure. Key technologies include the Internet of Things (IoT), cyber-physical systems (CPS), digital manufacturing techniques, 5G mobile communications, robotics integration, big data processing, data analytics, system integration, modern manufacturing systems (FMS), and cloud computing. This comprehensive spectrum defines Industry 4.0's scope and essence in an academic context (Phuyal et al., 2020). Another technology in this scope, digital twins, digitizes the shape and condition of the products together with the sensors and creates a copy (Negri et al., 2017).

Technological developments brought about by Industry 4.0 have affected the maritime sector as well as many other sectors. With the integration of Industry 4.0 into the maritime industry, concepts have emerged such as smart port, smart ship, smart container, and automated operations (Douaioui et al., 2018). Some of the applications that led to the emergence of these concepts include unmanned vehicles and autonomous ships, the use of automated guidance vehicles and automated yard cranes in ports, and the use of robots in shipyards (Liu et al., 2002; Sanchez-Gonzalez et al., 2019).

The benefits of implementing Industry 4.0 are substantial, but every industrial revolution brings with it some disadvantages. Cyber threats that have emerged as a result of increased data density and the use of information technologies in Industry 4.0 remain a serious problem that cannot be solved and affect all sectors (Ervural &

Ervural, 2018). In the same way, the inadequacy of cyber security in navigation systems used in autonomous ships and smart port applications shows that the systems that are exposed to attacks will be more and more numerous (Bielawski & Lazarowska, 2021a; de la Peña Zarzuelo, 2021). Digitalization and automation, the main driver of Industry 4.0, may lead to unemployment and a shortage of qualified personnel. At the same time, the proliferation of autonomous ships may render traditional maritime skills and maritime training non-functional (Mallam et al., 2020; Petekci, 2021).

Industry 4.0 focuses on technology and machinery's transformative impact on the industrial landscape, but it has little consideration for the role of individuals and society. The lack of control over human employment and high costs of Industry 4.0 have led to problems like the absence of human factors. Industry 5.0 emerged due to societal and societal concerns during the industrial transition. Research is ongoing to define the scope, objectives, and methodologies of Industry 5.0, aiming to safeguard societal and environmental benefits while aligning with economic advancement (Breque et al., 2021, Doyle-Kent & Kopacek, 2020).

Industrial revolutions and technological developments have always been intertwined with the maritime sector. In this study, the main goal is to provide a perspective on how Industry 5.0 can benefit the maritime industry. To achieve this purpose, a state-of-the-art literature review was conducted, and the findings were analyzed. In addition to the innovations and technologies brought by Industry 4.0 to the maritime domain, its advantages and disadvantages were also mentioned. Finally, potential applications in the maritime sector from the Industry 5.0 perspective were examined, and proposals were made.

2. Industrial Revolutions

The Industrial Revolutions spurred industrialization, accelerated economic growth, and fundamentally changed societal structures. Today, modern industrial production technologies continue to have revolutionary effects, and their impact on the world economy is increasingly significant. The following is a concise enumeration of the industrial revolutions that have transpired from historical times to the contemporary day.

In the late 18th century, mechanical manufacturing plants were introduced, allowing for increased labor and social welfare. However, this led to issues like unequal working conditions and injustice. The Second Industrial Revolution (Industry 2.0) began in the 19th century with advancements in electricity and assembly line manufacturing techniques. This era focused on increasing product quantity while minimizing production costs, leading to economic expansion and productivity. However, it also led to an escalation of unemployment due to automated machinery. This accelerated the adoption of Industry 3.0.

In the 1970s, automation became more prevalent due to technological advancements. The delayed onset of Industry 3.0 can be attributed to the Second World War, which facilitated automation in production. The software industry's advancements led to significant progress in sectors like nuclear, bio-agriculture, telecommunications, laser technology, fiber optics, microelectronics, and computers, enhancing production capabilities (Harahap & Rafika, 2020).

The 4.0 era, also known as the fourth industrial revolution, is characterized by automation and digitalization in production. Germany initially developed Industry 4.0, which introduced the term "Internet of Things" in 2011. This technology enables seamless collaboration across production lines, business processes, and teams, regardless of geographical location or network limitations. It accelerates performance enhancement and increases income for production plants. Industry 4.0 integrates cloud computing, big data analytics, IoT, and Industrial IoT devices, enhancing user experience and establishing efficient production processes. Cloud storage offers flexibility, real-time updates, stability, efficiency, and a wide range of features, allowing for faster capital production while becoming cheaper and more reliable. (Barreto et al., 2017, Javaid et al., 2022).

Industrial change will impact the economy and society, particularly for those in the sector. As societal roles evolve and technology dependence increases, the acquisition of new skills becomes crucial. Workforce organization changes will impact education, employment, and retirement. Automation may challenge the industry's traditional role as a job provider and economic well-being provider (Breque et al., 2021). Moreover, the expeditious rate of transformation necessitates the adoption of novel technologies and the reconfiguration of production and commercial procedures to effectively handle the extensive quantities of accumulated data (Sharma et al., 2020). Breque et al., (2021) contend that the phenomenon of heightened globalization has yielded both global prosperity and amplified local inequality. The aforementioned circumstances have rendered vital supply networks and infrastructure more susceptible and delicate, exacerbating our overuse of natural resources and contributing to heightened environmental degradation.

The concept of Industry 4.0 was initially associated with improving the efficiency of industries in the future, with the aim of maintaining a stable workforce and meeting the economic and ecological demands of sustainable production. Nevertheless, the trajectory of Industry 4.0 has shifted from its original emphasis on social equity and environmental sustainability to a greater prioritization of digitization and the integration of artificial intelligence (AI) technology in order to optimize production efficiency and adaptability. Therefore, Industry 5.0 can be seen as a reintroduction of the "human/value-centered Industry 4.0" aspect that was neglected (Aquilani et al., 2020; Breque et al., 2021).

Society 5.0, also known as Industry 5.0, is a revolutionary and inclusive framework that focuses on sustainable development goals centered on human, environment, and social issues. It differs from previous industrial revolutions in its focus on increasing efficiency and profit, neglecting nature, people, and resources. Society 5.0 aims to address social and environmental problems, focusing on human and robot cooperation to achieve these goals. It is often referred to as the transition to super smart societies (Deguchi et al., 2020). Industry 5.0 is a paradigm shift that emphasizes human-machine interaction, enhancing the connection between virtual and physical realms. This approach prioritizes individuals and provides a robust connection between the virtual and physical realms. Industry 5.0 has the potential to redefine the term "robot" by creating a new generation of "cobots" that can perform repetitive tasks through programming and serve as human-like companions. These advanced machines possess pre-existing knowledge and can rapidly acquire new skills, detecting human presence and prioritizing safety. Cobots can also understand and empathize with human objectives and expectations, similar to apprentices. Similar to apprentices, cobots can observe and learn from human work, performing tasks in a manner similar to human operators. This shift is suitable for management within Industry 5.0 (Chander et al., 2022, García Olaizola et al., 2022).

The document titled "Society 5.0" published by the European Commission outlines a vision for directing the role of technology in society by adopting a sustainable, human-centric, and resilient approach. The concept of sustainability holds a central place in Society 5.0, emphasizing the need to preserve natural resources and use them in a sustainable manner to meet the needs of future generations. In this context, renewable energy, energy efficiency, and waste management projects are encouraged to achieve this goal (Breque et al., 2021).

In summary, Society 5.0 presents a conceptual framework that promotes the ethical and conscientious utilization of technology within the fabric of society. Society 5.0 endeavors to use technological advancements for the collective benefit of society through the adoption of a sustainable, human-centric, and resilient strategy. The concept emphasizes the importance of balancing economic growth with social progress and environmental sustainability, while also addressing potential challenges associated with emerging technologies.

2.1. Industry 4.0 in the Maritime Transportation Domain

Industry 4.0 technologies are being used to improve the efficiency, safety, and sustainability of ships and their operations. It is transforming the maritime domain by integrating advanced technologies into various aspects of ship design, construction, and operation such as; Smart Ports, Shipbuilding 4.0, Autonomous Ships, and the result is a more efficient, safe, and sustainable maritime industry.

3. Necessity of New Perspective About Industry 5.0

Industry 5.0, an extension of Industry 4.0, focuses on social and environmental dimensions, incorporating the role of humans in socially sustainable technological transformations. It aims to improve interaction between humans and machines, while considering the technical aspects of Industry 4.0, which includes smart factories, interconnected systems, and unique smart products. Industry 5.0 can be applied in different industries such as smart cities and smart homes as well as smart factories. This concept aims to benefit all segments of society by expanding it from production to a wider ecosystem (Flamini & Naldi, 2022). In Industry 5.0, along with the development of cyber-physical systems, businesses need to adopt a human-centered design approach. Thus, it is thought that by improving people's skills and knowledge, businesses can increase their competitiveness (Nahavandi, 2019).

As a result, Industry 5.0 is an approach that complements the missing aspects of Industry 4.0 by emphasizing the importance of the human factor. Industry 5.0 aims to maximize the interaction between humans and machines, increase productivity, minimize environmental impact, and benefit all segments of society.

3.1. Cyber Security

Cybersecurity is a crucial challenge for companies pursuing Industry 4.0 to maintain their competitive edge. Despite numerous proposed solutions, none adequately address security issues by linking critical assets to cyber-attack impacts and providing a metric for measuring these impacts. Despite numerous methodological solutions, a gap exists in addressing these security concerns (Corallo et al., 2020).

Before Industry 4.0, cybersecurity focused on securing private computer networks and using firewalls, anti-malware software, and intrusion detection systems. However, this approach has become outdated in industrial settings. Industry 4.0's integrated and decentralized structure makes it difficult to achieve absolute security against cyber threats due to factors like data sharing, points of attack, convergence of information and operational technology, and playing catch-up (Ayuya, 2020). In order to tackle these issues, Stouffer et al. (2015) suggest that companies should conduct a vulnerability assessment to identify and evaluate potential system weaknesses. The National Institute of Standards and Technology (NIST) defines vulnerability assessment as a methodical evaluation of a product, aiming to identify security flaws, predict the effectiveness of recommended measures, and verify their appropriateness. These assessments can be conducted using network or host-based methods.

The advancements of Industry 4.0 have also made their way into the maritime transportation sector, which brings about a significant challenge of ensuring the cybersecurity of ships. Within the context of the maritime sector, Industry 4.0 involves integrating intelligent subsystems that interconnect various ship components into a single network. This network will eventually allow for complete ship management from a remote location, with all data transmission occurring wirelessly. However, this also raises concerns regarding the potential manipulation of data exchanged between the ship and the Shore Control Station (Bielawski & Lazarowska, 2021). In June 2017, the maritime industry experienced its first significant global cyber-attack when the Danish shipping company Maersk was targeted by the NotPetya attack. The attack involved malicious software that posed as ransomware and caused the Maersk vessel management system to crash. As a result of the attack, Maersk incurred losses amounting to 300 million USD (Lika et al., 2018).

Due to their crucial role in the worldwide distribution network, seaports and terminals are classified as critical infrastructures, along with other transportation, energy, and telecommunication systems. Consequently, they are susceptible to being targeted by criminal activities and acts of terrorism. Cyberspace comprises a vulnerable ecosystem comprising interconnected networks, information, and Cyber-Physical Systems that utilize electronic, computer-based, and wireless connections (Boyes et al., 2016). Due to the ease with which attacks can be launched through Wi-Fi or other data networks, ports are especially susceptible to cyber threats, necessitating the safeguarding of data and ensuring the integrity of systems (Dingeldey, 2017). This is particularly pertinent in contemporary container terminals, which heavily rely on information and communication technologies, and even more so in automated terminals, where automation is contingent upon numerous control systems that manage operations, complex networks, and sensors. Additionally, the extensive supply chain and the multitude of individuals present in ports, coupled with the interconnected systems and sensors in Smart Ports, create numerous opportunities for cybercriminals to launch attacks, thereby heightening the susceptibility of these assets to security breaches. In the context of a globalized world, if a cyber-attack were to impact a single terminal, its repercussions could swiftly propagate throughout the entire supply chain, causing harm to numerous other stakeholders who would also bear the brunt of the adverse effects (Louppova, 2018). As Duck (2017) has noted, the repercussions of a cyber incident can spread throughout an organization and even beyond, amplifying the extent of its consequences.

3.2. Unemployment

Throughout history, technological advancements have raised concerns about unemployment and societal instability. The 19th and 20th centuries saw less employment reductions, but concerns have arisen about the potential displacement of jobs by machines due to the advent of robotics and artificial intelligence. Concerns arise as machines can now address cognitive and epistemological challenges, demonstrating superior speed, proficiency, and accuracy in these tasks, potentially initiating a "second century of machines" (Autor, 2015; McAfee & Brynjolfsson, 2014). Following the publication of the World Economic Forum's first report on "The Future of

Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution", a new wave of discussions began, involving not only scientists, but also businesses, governments, and trade unions. These discussions focused on the challenges and opportunities presented by the rapid pace of technological change and its impact on the labor market and workforce competencies.

Despite technological advancements that delegate production to artificial intelligence, robots, and smart machines, human intelligence is still crucial to ensure the proper functioning of these technological marvels. In all fully automated production and service units, technicians and engineers will always be essential to work behind the scenes to guarantee flawless operation of the technology. Moreover, the adoption of Industry 4.0 technologies, which necessitate high-level skills, may result in job migration from developing to developed countries in developed nations. This is due to the diminishing cost advantages of labor in developing countries (Balliester & Elsheikhi, 2018).

The utilization of new technologies on ships is becoming increasingly crucial in the maritime sector, which may result in a reduction in the number of seafarers needed in the future. According to Kim et al. (2017), the implementation of a Maritime Autonomous Surface Ship (MASS), could potentially lead to job losses for seafarers or a downsizing of the workforce, where unskilled labor is no longer required, and only able seamen or officers are in demand. Therefore, the seafarer-related industry is expected to experience a gradual decline in employment opportunities due to the advancement and proliferation of MASS. However, the technological development and expansion of MASS are also expected to create new types of jobs that require highly advanced skills among seafarers. These changes will shape the future of the shipping industry.

3.3. Environmental Sustainability Issues

The primary emphasis of implementing Industry 4.0 in industrial sectors has been on augmenting production and optimizing financial gains. However, this approach has given rise to a range of concerns in other domains, including the depletion of natural resources, adverse environmental consequences, unequal distribution of wealth, and substandard working conditions. The aforementioned issues have the potential to culminate in an unsustainable trajectory of consumption, encompassing environmental, economic, and social dimensions (Bonilla et al., 2018). In order to achieve environmental sustainability, it is important for the production system to employ natural resources at a consistent pace that does not surpass their replenishment rate, while also taking into account the environmental capacity for waste assimilation. The primary emphasis should be placed on exploring renewable resources as viable substitutes for non-renewable resources. (Zhu et al., 2015). Industry 4.0 has brought about significant transformations in the realm of enterprises and industrial procedures while encountering several obstacles like regulatory harmonization, organizational norms, skilled labor, and legal framework compatibility. Nevertheless, there is a growing awareness among corporations regarding the advantages and strategic edge associated with engaging in proactive environmental initiatives (Sen et al., 2015). The aforementioned advantages encompass the satisfaction of stakeholders with environmental concerns, the eradication of pollution and environmental liabilities, the enhancement of financial performance through the exploration of new overseas markets, and the bolstering of reputation through the adoption of environmentally friendly practices (Sambasivan et al., 2013).

3.4. Human Element

The rationale behind the development of Industry 4.0 undoubtedly offers numerous advantages. All processes are interlinked and exchange data with one another. The primary driving force appears to be technology for technology's sake. Figure 1 illustrates an example of the Industry 4.0 design concept, in which humans only have a role as consumers, with everything else functioning entirely without human intervention. Failure to consider the human element in a complex system like Industry 4.0 could result in a complete breakdown of the concept.

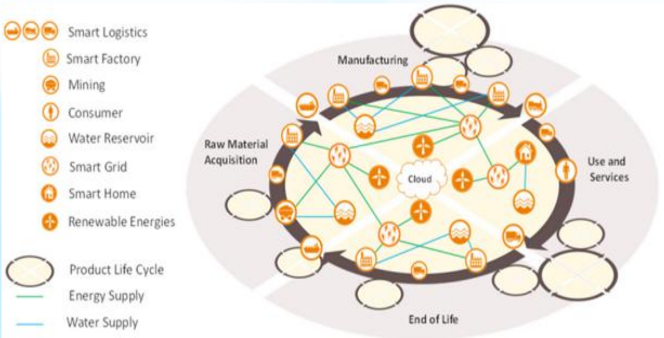

Figure 1. Macro Perspective of Industry 4.0 (Stock & Seliger, 2016).

According to Schwab (2016) ultimately, "the success of the Fourth Industrial Revolution hinges on human beings and their values. At its most negative extreme, the Fourth Industrial Revolution could potentially strip us of our humanity and reduce us to mere robots. However, if we embrace the positive aspects of human nature such as creativity, empathy, and responsibility, the Fourth Industrial Revolution has the power to elevate humanity to a new level of collective consciousness based on shared goals and values. It is our responsibility as a society to ensure that this positive outcome is realized".

As a result, most workers in any industry touched by the Industry 4.0 concept will experience changes in their work processes. To ensure these workers are satisfied, it is essential for them to comprehend the new requirements and identify any potential benefits. The critical factor is to engage the human element in the new procedures as quickly as possible (Edwards & Ramirez, 2016).

Industry 5.0 is a perspective in which people become more centralized with the use of digital technologies in industrial production. While it includes technological innovations that provide flexibility, efficiency, and quality increase in production, it also aims to increase the contribution of people to the production process by using their skills and creativity. Simultaneously, Industry 5.0 will transform the factory into a conducive environment for innovative individuals to engage in the creation of a more customized and human-centric experience for both workers and customers. (Ngo, 2019).

In this context, one of the most important features of this industrial revolution is the human factor working together with digital technologies. This provides opportunities for employees to do more creative, intelligent, and valuable work to replace the work lost with the spread of automation and robotic systems in industrial production.

3.5. The New Roles of Humans in Industry 5.0

Industry 5.0 also called Society 5.0, represents a transformative shift in industrial production, redefining traditional roles while introducing novel responsibilities. This paradigm shift not only redefines conventional jobs within the industry but also introduces new and innovative duties. The growing jobs in question revolve around the augmentation of operational agility, productivity, and product excellence by means of incorporating digital technology into the manufacturing process. The primary objective is to enhance individuals' standard of living through the activation of the productive and technical capabilities inherent in Industry 4.0 (Harayama, 2017). Industry 5.0 poses challenges for managers in prioritizing the integration of individuals' skills and creative potential within the production process. Consequently, managers are compelled to assume more dynamic roles in domains including human resource management, business expansion, innovation, and strategic development. The paradigm of Industry 5.0 necessitates continuous enhancements aimed at fulfilling critical business imperatives such as efficiency, quality, and adaptability. Individuals assume pivotal responsibilities in functions such as data analysis, troubleshooting, and process refinement. In this manner, the synergy between stakeholders can foster economic progress and engender a society characterized by the identification of solutions to societal issues (Hayashi et al., 2017).

3.6. Human Element in Maritime Domain within the perspective of Industry 5.0 (Maritime 5.0)

The maritime industry is constantly evolving with new technologies, aiming to make it safer, more efficient, and sustainable. However, the human element is crucial for effective deployment. Individuals are responsible for ship safety, cargo transport, environmental protection, and vessel management. Maritime 5.0 focuses on elevating maritime personnel's education and proficiency while advancing ship safety, environmental preservation, and sustainability objectives. Maritime 5.0 refers to a collaborative endeavor involving both non-human agents, such as intelligent or AI agents, and human actors, including seafarers and maritime operators. This collaboration aims to facilitate various tasks across all stages of maritime operations, encompassing design, integrated decision-making, and implementation (Shahbakhsh et al., 2022).

According to the SkillSea Project of the Erasmus Program of the European Union, maritime experts are presented with fresh prospects to augment their abilities and expertise, in light of the advancements in digitalization, globalization, and sustainability within the shipping industry. This implies acquiring knowledge in simulation-oriented education, utilization of IoT, implementing sustainable practices, attaining advanced training via simulators, refining personal managerial abilities within teams, and enhancing transversal competencies through lifelong learning initiatives.

The development of autonomous systems in the maritime industry is altering the duties and obligations of seafarers, leading to a new classification of seafarers. Although physically present crew members are no longer required, the human element remains significant in designing, constructing, testing, and predicting system responses in various operational circumstances (Ahvenjärvi, 2016). The remarkable progress of technology within the domain of autonomous systems consistently alters and defines the human function in systems involving work duties that necessitate a fresh array of knowledge, abilities, and proficiencies (Mallam et al., 2020). Furthermore, both onshore and offshore employment will be affected, as an ordinary able seaman who works onboard or offshore could be substituted by autonomous systems and skilled operators situated in onshore control centers as decision-making authorities (Streng & Kuipers, 2020). Studies indicate that the shipping industry will necessitate crew members who possess the ability to utilize information and communication technology (ICT) tools, as well as outstanding teamwork and leadership proficiencies (Belev & Daskalov, 2019). Additionally, it has been suggested that forthcoming seafarers might not embark on voyages and instead receive training for ship operations via simulator exercises or shoreside facilities (Wahlström et al., 2015). Nevertheless, researchers have underscored that the role of seafarers on the bridge and in engine rooms will be transformed into that of shore-based control center operators, who are responsible for decision-making processes based on real-time data sharing conveyed by remote operators (Lee et al., 2019).

4. Conclusion

Industry 4.0 is a transformative phase in industrial processes, focusing on robust digitalization and automation. Industry 5.0, a natural progression, integrates these elements with human-centric considerations, fostering flexibility and sustainability in production. This new era allows people to contribute more to the production process and changes roles. However, businesses will face challenges during this transition. To overcome these, businesses must invest in digital technologies, enhance workforce competencies, and remain agile in response to business methodologies' evolution.

The Industry 5.0 framework emphasizes employee involvement in decision-making and reduced human involvement in production. This is based on cost-effectiveness analyses and is crucial for managing transformation. Human involvement can hinder the optimal use of technologies, such as collaborative robots and artificial intelligence, which are part of Industry 4.0. This separation of human factors from operations is essential for future needs and aims to minimize human losses and environmental impacts.

The human element is crucial in establishing meaningful connections with robots, and maritime education must instill this awareness among seafarers. This aligns with Industry 5.0 principles, emphasizing the importance of the human factor. Seafarers should stay updated on technological advancements, develop their skills, foster collaboration, and adopt environmental stewardship. Leaders in the maritime domain who emphasize the human element will significantly influence the trajectory of emerging seafaring professionals. Industry 4.0 has introduced a significant vulnerability in cyber security, requiring a strategic shift in enforcement. This involves removing human oversight from enforcement and leveraging human oversight to enhance security controls in production processes. A governing body for production processes is also proposed. Maritime educational institutions are urged to revise regulations in line with Maritime 5.0 principles, potentially implementing mandatory regulations and specialized cyber security training.

In summary, the transition from Maritime 4.0 to Maritime 5.0 signifies an epoch where technology is synergistically harnessed in conjunction with human expertise. Maritime 5.0 not only emphasizes the integration of novel technologies but also envisions the diminishment of direct human involvement in production processes, with individuals assuming roles characterized by intellectual supervision. This shift places a heightened emphasis on skill and competency development among maritime professionals. Such a transformation holds the potential to augment operational efficiency, enhance safety protocols, bolster environmental sustainability, and underscore the significance of human engagement. The collaborative paradigm envisioned within Maritime 5.0 not only safeguards employment within the maritime sector but also fosters partnerships with diverse stakeholders, thereby catalyzing the genesis of innovative solutions that redound to the benefit of the entire maritime industry. Consequently, the maritime domain may find itself traversing toward a future where technology and human collaboration redefine established paradigms.

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THE IMPACT OF CARBON EMISSION REDUCTION REGULATIONS ON SHIPPING IN MARITIME TRADE CONTRACTS

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Decarbonization, or Carbon Dioxide Removal, is the process of eliminating carbon dioxide (CO2) emissions from ships, which ensures a reduction in the amount of greenhouse gases (GHGs) released into the atmosphere. Through the efforts of the International Maritime Organization (IMO) and the European Union (EU) in particular, it has been added to the agenda as a novel measure dealing to ships. The IMO evaluated its plan to cut ship-related greenhouse gas emissions at the 2023 MEPC 80 summit. The total abolition of greenhouse gas emissions from international ship trading by 2050 (relative to 2008 levels) is therefore considered a common goal. Regionally-based carbon footprint reduction initiatives in the maritime transportation sector has introduced by the European Union Emission Trading System (EU ETS) in tandem with the IMO's target studies. The EU ETS is an integral component of the policy of the European Union (EU) to mitigate the impacts of climate change. The organization has established "Fit for 55 targets" which stipulate the attainment of a 55 percent decline in greenhouse gas emissions from their levels in 1990 to 2030. Regardless of flag, cargo and passenger vessels with a gross tonnage (GT) of 5,000 or more will be affected by the EU ETS. On January 1, 2024, the reporting mechanism for these vessels was implemented. This research will examine the potential effects of new regulations aimed at reducing carbon emissions from ships on maritime contracts, including bareboat, time, and voyage charterparties. Compared to other types of charter parties, the time charter contract is expected to be greatly affected. Actually, the BIMCO was the one who first issued the "EEXI Transition Clause for Time Charter Parties 2021" condition. The research will include further options that the parties to the contract should think about pursuing accordance with the revised regulations, in addition to possible legal and commercial actions. The regulations adopted by the International Maritime Organization (IMO) since 2016, the commission's implementation regulation (EU) 2023/2122 dated October 12, 2023, and the new clauses that BIMCO has proposed for inclusion on charter parties will be assessed during our review. The consequences of these legal advancements on charter parties will have a significant impact on the maritime sector. Furthermore, potential research initiatives undertaken by ship operating companies in accordance with the ISM Code will be evaluated. Legal liabilities as well as commercial expenses will be incurred in connection with the implementation of the new regulations mandating the decarbonization of ships. One potential measure that ship operators may take is the implementation of new provisions respecting charter parties. The current target dates for reductions in emissions will be moved forward if it is found that ships greatly adhere to and get advantages from the new rules.

Keywords : Charter Parties, Decarbonisation, EU-ETS, CII, EU MRV Maritime.

Overall Concept of Carbon Emission Reduction on Shipping

International Maritime Organization (IMO) and the European Union (EU) envision a new important challenge for the shipping industry. A ship's commercial operations are anticipated to have a direct and major impact on its carbon intensity. It is envisaged that carbon emissions from ships will be gradually reduced and eventually zero by 2050 at the latest. Both organizations aim to achieve their environmentally friendly "***green ship***" missions by making frequent updates. IMO bases its new regulations on MARPOL Annex IV. As of 01.11.2022, MARPOL Annex VI has 105 Parties, representing between them 96.81% of world merchant shipping by tonnage (IMO Treaties). The EU has expanded the scope of the Emissions Trading System (ETS) to include the maritime industry as of January 1, 2024. It is important to explain the main concepts of the regulations prepared by IMO and the EU for zero carbon emissions on ships. With the introduction of our study, it would be instructive to briefly review the fundamental concepts behind ship decarbonization.

IMO Regulations on Carbon Emissions on Ships

IMO began considering operational and technical approaches to increase ship energy efficiency in the early 2000s (IMO, Energy). At this point, it should be noted that IMO regulations are aimed at ships of states party to the MARPOL Convention, Annex VI (Prevention of Air Pollution from Ships). On January 1st, 2013, the requirements for the Ship Energy Efficiency Management Plan (SEEMP) and the Energy Efficiency Design Index (EEDI) entered into force. Reducing ship-related greenhouse gas emissions has been a primary goal. The following section is a summary of the main concepts of the IMO for reducing carbon emissions from ships.

(i) The EEDI provides a specific figure for every individual ship design. It is expressed in grams of carbon dioxide (CO2) per ship's capacity-mile, and is calculated by a formula based on the technical design parameters for a given ship. The smaller the EEDI, the more energy efficient the ship design. In 2014, MEPC adopted amendments to the EEDI regulations to extend the scope. With these amendments, ship types that carry international cargo and are responsible for approximately 85% of CO2 emissions have been included in the regulatory regime (IMO, MEPC.251(66)).

(ii) The SEEMP is a management system that can be used to increase a ship's energy efficiency while keeping costs down. The ship owners are urged by the SEEMP to explore innovative technologies and methods in order to maximize the operational performance of a ship. The 2022 guidelines developed for SEEMP includes the most efficient practices for fuel-efficient ship operation (IMO, MEPC.346(78)).

(iii) The DCS is requirement of the IMO ship fuel oil consumption system (DCS), (IMO, MEPC.278(70)). The system requires that ships must report their fuel oil consumption to their flag state at the end of each year, and that the flag state must report it to IMO by the end of June, was regulated in 2016. From January 1, 2019, ships of 5,000 GT and above must begin gathering data on fuel oil consumption and report. In 2019 European Commission made proposal to take appropriate account of the global fuel consumption of ships data collection (EU- COM (2019) 38 Final).

(iv) The EEXI is a framework for evaluation the energy efficiency of in-service vessels as designed and built. IMO's the Energy Efficiency Existing Ship Index (EEXI) describes the CO2 emissions per cargo ton and mile. At this point should be emphasized immediately that the EEXI is a ***design index*** and the only refers to the design of the ship (IMO, MEPC. 328(76), MEPC.333(76); MEPC.334(76); MEPC.335(76)). EEXI determines the standardized CO2 emissions related to installed engine power, transport capacity and ship speed. The EEXI is applied to almost all oceangoing cargo and passenger ships above 400 gross tonnages. The EEXI is not an operational index. This index is directly related to the technical and design efficiency of the ship. For different ship types, proper adjustments of the formula have been performed by different correction factors. The CO2 emissions are calculated based on the power of the main engine, the corresponding specific fuel oil consumption of the main and auxiliary engines of the ship and a conversion factor between the fuel and the corresponding CO2 mass. The EEXI certification requirement entered into force on 01.01.2023 (The amendments to MARPOL Annex VI entered into force on 01.11.2022). For existing vessels, it is a one-time certification. January 1, 2026 has been set as the deadline to review the effectiveness of this implementation and make developmental changes if necessary. Owners of existing ships have different opportunities to have the required EEXI index rate which should be equivalent to required EEDI levels for 2020. For example; wind-assisted propulsion, engine power limitation, waste heat recovery, etc. The calculation of the EEXI follows the calculation of the EEDI (EEXI formula, see: MEPC.333(76), article 2.1).

(v) The CII (Carbon Intensity Indicator) is a measure for a ship's energy efficiency and is given in grams of CO2 emitted per cargo-carrying capacity and nautical mile. CII applies mandatory to ships 5,000 gross tonnage and above ((IMO, MEPC.352(78); MEPC.353(78); MEPC.338(76); MEPC.354(78); MEPC.355(78)). According to the MARPOL Carbon Intensity Regulations, a ship's carbon intensity must be reduced by 2% annually from the 2019 baseline. The CII is derived from the Annual Emissions Ratio (AER): **The formula CII** is = Annual Fuel Consumption x the CO2 Emissions Factor / Annual Distance Sailed x Design Tonnage of the Vessel (DWT or GRT), (the transport work) (use gross tons (gt) instead of dwt, where applicable to the vessel type). It should be noted that The CII calculation does not consider the mass of the actual cargo carried on a voyage. EU MRV requires the vessel to report actual cargo carried, which may also impact upon the calculation for the EU ETS (EU MRV 2017/0517).

CO2 factor is determined by the IMO and is based on fuel type (CO2 emission factors: 1 mton HFO = 3,114 mton CO2; 1 mton VLSFO = 3,206 mton CO2; 1 mton MGO = 3,206 mton CO2, see: Royal Wagenborg, 2022). The values are expressed in grams of CO2 emitted per cargo-carrying capacity and nautical miles travelled. The actual annual carbon intensity (CII) attained is verified and documented. Then it will decide to make sure the ship's annual reduction factor meets against the necessary annual CII level. CII rating is an operational index. The ship's Administration determines the operational carbon intensity rating of the ship having target to reach gradual reduction on carbon emissions. The CII rating requirement entered into force on 01.01.2023. From that touchstone date, ships are mandated to collect their fuel consumption data. Owing to this data, a carbon intensity rating is assigned to the ship from A to E (5 performance levels). The enforcement of carbon intensity rating is that if a ship is rated poorly, such as D level (minor inferior) for 3 consecutive years or E level (inferior), it should develop a "Plan of Corrective Actions" and the ship company will be regularly audited for incentives to provide rate level A or B. For ships to receive a rating of A (major superior), B (minor superior), or C (moderate), various operational methods are recommended. In order to achieve the desired CII grade, owners may employ the subsequent techniques, such as: speed optimization, weather routing, just-in-time arrival, ship's draft and ballast optimization. Through 2026, each CII Rating of A–E will have a narrower range of values; after that, the IMO will set new targets. Up to 2026, CII thresholds will get stricter annually to promote continuous improvement. Year after year, CII emissions do not accumulate. In other words, each ship's "emissions counter" is reset at the end of the calendar year.

EU Regulations on Carbon Emissions on Ships

On December 11, 2019, the European Union (EU) announced the European Green Deal (EC, COM (2019) 640). By 2050, EU wants to be the first *continent* to be completely climate neutral and use green technologies to make the EU's economy competitive and resource-efficient. After acknowledging that "negative climate change" is one of the major issues of our day, the EU states that this offers a unique opportunity to create a new economic model for EU and its citizens (EC, COM (2019); EU 2024). The main EU regulations that reduce ship carbon emissions are outlined below.

(i) EU ETS – One of the major instruments of the European Union's policy for reducing greenhouse gas emissions from industry and power generation is the EU Emissions Trading System (EU ETS). It is established under Directive 2003/87/EC and amendments (EU, Directive 2003/87/EC). The EU ETS operates in all EU countries and the European Free Trade Association countries (Iceland, Liechtenstein and Norway) (plus with protocol Northern Ireland for electricity generation). It covers major energy-intensive industry sectors such as oil refineries, steel works, and the production of metals and chemicals. The policies implemented by the EU are ideal for reducing net greenhouse gas emissions from 1990 levels by at least 55% by 2030 (EU, Directive 2003/87/EC). It is called namely "*Fit for 55 packages*" (Vierth et al., 2024). With the use of green technology, it hopes to become the first continent to be the first climate-neutral and carbon neutral continent by 2050 (net zero).

The EU ETS is based on the "*cap and trade*" mechanism in which firms can exchange emission rights within a specific geographical region and a limit (the cap) is set on the right to release certain pollutants through that area. This cap is gradually reduced in order to motivate the use of alternative fuels and better effectiveness in reducing greenhouse gas emissions. The EU ETS supports new investment in low-carbon technologies by putting a price on each ton of carbon released by covered industries. The core of the EU ETS is the unified trading currency for emission allowances (EUAs). One allowance gives the right to emit one tonne of CO2. A certificate or permit called as an "emissions allowance" allows an organization the right to legally emit a specific quantity of tons of greenhouse gas emissions. These allowances are usually given to organizations for free or purchased through auction. Any allowances that are not in use can be sold to other organizations that require them in order to cover excess carbon emissions. Based on data from 2018, maritime transportation caused approximately 2.9% of all emissions worldwide (EU, Shipping 2024). From January 1, 2024, maritime transport emissions are also covered. Regardless of the flag they fly, all large ships (5,000 gross tons and above) that call EU ports are now subject to the EU ETS for CO2 emissions. Regarding CO2 gas from maritime transport activities specifically 50% of emissions from voyages starting or ending outside of the EU and 100% of emissions from voyages between two

EU ports and when ships are within EU ports are measured. For shipping sector EU ETS system provisions has been revised (EU-2024 MRV Maritime Regulation). By 30 September 2025 at the latest, every member state will report their emissions for the year 2024. Emission allowances must cover the 40% of reported emissions for 2024 (for 2026 70% and for 2027 %100).

(ii) EU MRV Maritime - The EU Monitoring, Reporting and Verification (MRV) Maritime Regulation (EU- MRV Maritime Regulation (EU) 2015/757) applies to ships of 5,000 GT and above in respect of the greenhouse gas emissions released during their voyages from or/and to ports in the European Economic Area (EEA) for transporting for commercial purposes cargo or passengers. It should be emphasized that the actual cargo carried is taken account (EU MRV 2017/0517). From 1 January 2025, the amended EU MRV regulations will also apply to general cargo ships between 400 and 5000 gross tonnage (GT) and offshore ships of 400 GT and above (non-commercial governmental ships and fish-catching or fish-processing ships and ships not propelled by mechanical means are excluded). Carbon dioxide (CO2), Methane (CH4) and Nitrous oxide (N2O) types GHSs will be covered by the regulation as of 1 January 2024. The IMO's Data Collection System (IMO DCS) is an emissions monitoring and reporting scheme and runs in parallel with the EU MRV Maritime. The differences are: while EU MRV' scope is limited with EU waters, IMO deals with global shipping emissions; IMO publishes reports general ship base without identifies individual ships, EU MRV does; IMO as part of SEEMP, requires from shipowners a Ship Fuel Oil Consumption Data Collection Plan, EU MRV has a separate emissions monitoring plan requirement; IMO DCS plans are subject to flag administration approval while the EU MRV requires from an accredited legal entity IMO DCS entered into force in 2019 while EU MRV Maritime is in force from 2024 (EU MRV for other sectors is into force in July 2015 and became mandatory in 2017). The monitoring and reporting of verified emissions for each ship under their control is the obligation of shipping companies. Mostly obligations apply in respect of each ship individually. Shipping companies need to submit for assessment a monitoring plan for each of the ships under their responsibility to an independent accredited verifier. The verifiers are legal entities accredited by a national accreditation body under Regulation 765/2008, carrying out verification activities to assess the conformity of the documents transmitted by the Company. As of 1 January 2024, the monitoring plan is to be submitted through THETIS-MRV by shipping companies to be in conformity with the requirements of the amended MRV Regulation (EU Regulation (EU) 2023/957). THETIS-MRV was developed to assist in the Regulation's implementation, providing flag states with a platform for emission report consultation and assisting verifiers in issuing the Document of Compliance (EU- (2024 MRV Maritime Regulation (EU) 2015/757). Revised monitoring plans must first be assessed by an independent accredited verifier. From 2025, by 31 March of each year, companies must, for each ship under their responsibility, submit an emissions report for the entire reporting period of the previous year (EMSA, 2024 MRV Regulation). Either the registered shipowner or the ISM Company may be in responsible for ensuring EU ETS and MRV compliance, provided they are the same ((EU) 2015/757 and 2023/2599).

(iii) Fuel EU Maritime, The FuelEU Maritime Regulation (EU) 2023/1805), introduces the use of renewable, low-carbon fuels and clean energy technologies for ships, essential to support decarbonization in the sector. The MRV Maritime Regulation governs ballast journeys that begin and/or conclude in ports located in the European Economic Area (The EEA includes all 25 EU member states, as well as Iceland, Liechtenstein, and Norway). The regulation does not directly mandate the use of a specific type of fuel on ships. Instead, it requires that the yearly average intensity of the energy used on board ships does not exceed a specific GHG intensity limit, with the aim of achieving an 80% reduction by 2050. According to Article 21 of the Regulation, the compliance balance of two or more ships may alternatively be "pooled" together. Improving energy efficiency through reduced fuel consumption and replacing of cleaner fuels for renewable and low-carbon fuels is necessary to reduce maritime emissions. Additionally, implementing specific technologies to comply with FuelEU Maritime is on the agenda, like zero emission technologies (based on low-carbon units, hydrogen, fuel cells), solar sails, rigid sails, onboard electrical energy storage (battery system) onshore electricity power supply, advanced multi-fuel engines, fuel cells (with technologies for methane slip mitigation), renewable and low carbon fuels. While they are not currently well known, several technologies may become important in the near future. Some technologies—like onboard carbon capture and storage and non-CO2 Tank-to-Wake emission —need to be recognized. Ships can also benefit from the other technical solutions, including propeller and rudder optimization rudder, air bubbles hull lubrication, improved hull paints, bulbous bow (EMSA, FuelEU). FuelEU Maritime Regulation, which comes into effect on 01.01.2025. BIMCO works on a draft clause for Fuel EU Maritime for time charter parties (BIMCO, Fuel EU 2024).

(iv) ETD (Energy Taxation Directive, 2003/96/EC), Taxation initiatives can encourage the use of cleaner energy, which can aid in the achievement of climate policy objectives. The Energy Taxation Directive (ETD) is considered to be of primary importance. There are two primary reform areas at the core of the EU's ETD update (EU, COM (2021) 563 Final). First, a new tax rate structure based on the energy content and environmental suitability of fuels and electricity is proposed. Second, it expands the taxable base by bringing in additional products and eliminating some of the current exclusions and reductions, such the EU's complete exemption of aviation and maritime transport from energy taxation.

The IMO and EU determine the people who will be held responsible for CO2 emissions based on the principle of "polluter pays!". In our view, identifying a single polluter is not feasible. As ships and cargo sides collaborate, the maritime industry as a whole need to reduce its footprint.

The Effect of Carbon Emission Reduction Regulations in Maritime Trade Contracts

The maritime industry has largely complied with IMO's practice of restricting the use of fuels with high sulphur content ((IMO, MEPC.320(74)) in 2020. Demonstration of the same compliance with EEXI and particularly CII and EU-ETS regulations for CO2 will depend on addressing commercial concerns. All ships constructed before 2010, which use quite more fuel than ships with contemporary designs, will be impacted by the new rules. Taking into accounts the types abt. 5,000 GT, bulk carriers (mainly above Panamax 60,000 mt DWT or 6,000 TEU and >), and a significant percentage of tankers (LNG carriers and Aframax 650,000 barrels and >) will be particularly affected. The ship's obligation to comply with the new regulations will depend on the requirement to comply with MARPOL and whether the ship calls at European ports. The regulations made by IMO and the EU regarding the reduction of carbon emissions of ships are summarized in the first section. In this section, the potential effects of the new regulations on shipping trade agreements will be examined in light of the BIMCO-proposed clauses. The IMO's Carbon Intensity Regulations and the EU Emissions Trading System are both part of the new environmental regulatory framework for today. BIMCO's recommended additional clauses for various charter parties and contracts should aim to ensure trade balance and cooperation between all maritime industry stakeholders.

Bareboat Charter Parties

It is in the nature of a bareboat charter that beyond delivering the vessel in the agreed condition and allowing the charterers quiet possession for the duration of the charter period, the owners take on few if any obligations under the charter. The owners' main concern in this regard will be their potential liability for pollution incidents. The central issue in determining whether a charter is a bareboat charter is whether possession and control of the vessel passes from owners to the charterers (Davis, 2005).

A bareboat charterer cannot be considered as the shipowner within the meaning of the ETS Directive. This consideration also applies in the case where the ship is subject to a "parallel registration" in the registry of two administrations (EU – Shipping 2024). Directive (EU) 2023/959 has introduced a definition of "shipping company" in Article 3. In addition to the ship owner, the other entities operating the ship, such as the manager or bareboat charterer, are also defined as shipping companies. In determining the other persons, it was sought that the responsibility arising from the operation of the ship be taken from the shipowner. By assuming this responsibility, it is accepted that all obligations brought by the ISM Code have been undertaken (EU-Directive 2023/959). On January 30, 2024, the Commission approved an implementing act specifying responsible administrative authority for the list of shipping companies (EU Decision 2024/411). Either the registered shipowner or, if properly mandated, the ISM Company may be responsible for ensuring EU ETS and MRV compliance, provided they are the same ((EU) 2023/2599). In a bareboat charter party, parties should make sure that the intended entity is specifically assigned responsibility.

The costs arising from the new regulations for reducing carbon emissions from ships will be liable to the charterer due to the nature of the charter contract. Nonetheless, the charterer may include a provision in the contract allowing the owner the right to supervise and control the charterer's fulfilment of such responsibilities at all times during the contract period. If needed, modifications to the ship's structure in compliance with the emission scheme are planned for long-term contracts; a clause allowing the owner to make these modifications should be included to prevent breaches of contract.

Voyage and Mixed Charter Parties

Freight contracts can be classified into two types. Voyage and mixed charter parties. In terms of the subject of our study, interpretations will be made without taking this distinction into account. Voyage charters, are those by which the owner agrees to perform one or more designated voyages in return the payment of freight and (when appropriate) demurrage; the costs of, and responsibility for, cargo handling should be done according to the terms of the particular agreed-upon terms (Cooke et al. 2014). The clauses added to the charter parties are expected to be incorporated into the bills of lading.

As in container liner shipping, in mixed charter contracts, shippers have started to reflect the allowance costs, which they accept as an additional new cost under the EU ETS scope as a standalone surcharge (known as an 'Emissions surcharge') directly to the shippers at the time of booking (see: Maersk, 2024). For this reason, in our study, only the legal effects on voyage charter parties are examined.

"Port of call" means the port where a ship stops to load or unload cargo or to embark or disembark passengers, or the port where an offshore ship stops to relieve the crew (EU-Directive 2023/959). Some stops are not considered to be a "port of call," specifically: stops for the sole purposes of refuelling; obtaining supplies (included cargo animals' fodder); relieving the crew of a ship other than an offshore ship; entering dry-dock for repairs; in distress, emergency situations; for ship to ship transfers at outside of ports; shelter from adverse weather or rendered necessary by search and rescue activities; stops of containerships in a neighbouring container transhipment (at East Port said and Tanger Med ports as stated by Implementing Regulation (EU) 2023/2297. The MRV Maritime Regulation governs ballast journeys that begin and/or conclude in ports located in the European Economic Area (The EEA includes all 25 EU member states, as well as Iceland, Liechtenstein, and Norway). Within EEA ports greenhouse gas emissions must be also reported.

Among others, three different ETS emission scheme clauses have been proposed for voyage charter parties. It should be considered which clause regarding Emission Allowance would be in the commercial interest of the shipping company (BIMCO Voyage 2024). Considering new regulations on carbon emissions, the following clauses have been recommended for the voyage charter contracts (BIMCO 2024):

(i) ETS – Emission Scheme Freight Clause for Voyage Charter Parties 2023: The key concept of the clause is that the owner will actually receive payment for the emission allowances needed for the voyage from the charterer included in the freight. Basically, the clause includes into the freight rate the emission allowances arising from the voyage (Björk et al. 2023). In simple terms, the clause includes in advance the emission allowances, arising for the voyage into the freight rate. After then, the owners still remain responsible for surrendering the appropriate number of emission allowances in accordance with the applicable emission scheme (BIMCO, Voyage 2023). The clause provides two definitions for clarity and four sub-clauses. The definitions are (a) "Emission Allowances" means an allowance, credit, quota, permit or equivalent, representing a right of a vessel to emit a specified quantity of greenhouse gas emissions recognised by an Emission Scheme and (b) "Emission Scheme" means a greenhouse gas emissions trading scheme which for the purposes of this Clause shall include the European Union Emissions Trading System and any other similar systems imposed by applicable lawful authorities that regulate the issuance, allocation, trading or surrendering of Emission Allowances". The owner shall have no right of recourse against the charterers with respect to emission allowances (EUAs), if freight is paid in full. In cases of partial or no unpaid freight, the owner may claim damages from the charterer in breach of the charter party, including costs resulting from non-payment of allowances (subclauses b and c).

(ii) ETS – Emission Scheme Surcharge Clause for Voyage Charter Parties 2023: The clause provides that the charterer is guaranteed the option to pay the emission scheme surcharge as a separate fee, in an amount agreed upon by the parties, in either EUR or USD, and without incurring any commission. The legal nature of this surcharge is accepted as freight (subclauses, a and e). There are options under subclause (b) for the payment period. The default period is 14 days in situations where it is not specified. Upon full payment of the Emission Scheme Surcharge to the owners, the charterers are released from any liability for costs related to EUA surrender. Conversely, in the event that the ship has to pay more emission allowances than agreed upon due to the charterer's negligence, the ship may make a claim against the charterer for this additional sum. It must be noted that this clause just determines the parties' respective obligations. The owner must remain entirely liable for compliance with any applicable EUAs, without limitation, even in the event that the charterer breaches this clause. When the spot price of an emission allowance has changed over time, the optional clause in subclause (g) permits a price adjustment. It does not permit adjusting the real quantity of Emission Allowances. Comparable to a bunker adjustment clause, the purpose of the optional price adjustment provision is to counter any market volatility related to emission allowances.

(iii) ETS – Emission Scheme Transfer of Allowances Clause for Voyage Charter Parties 2023: This clause establishes the calculation of the ***quantity*** of emission allowances. The other surcharge clause accounts for ***amount*** and currency. Inserting a quantity in subclause (a) is an estimate; therefore, it doesn't necessarily represent the total quantity of emissions allowances. Subclause (b) offers a process for reconciliation, which the parties rely on if they want to deal with the actual number of Emission Allowances. This is established by the fact that the ***longest port stays*** are the main factor influencing the length of a voyage and, in turn, the quantity of Emission Allowances. It is considered that unanticipated delays in ports require a new laytime regime and demurrage provisions. The basis of the transfer clause is that the voyage charterer will be the one transferring emission allowances to the owners for the voyage. Contractually speaking, the owners are still in charge of surrendering the necessary amount of emission allowances. Failure on the part of the charterers to transmit any quantity of emissions allowances shall be considered non-payment of freight under the terms of the charter party. The owners continue to have an obligation to solely comply with all applicable emission schemes, including the surrender of emission allowances. The clause includes a definition of a default voyage (s) for the case where the ports of the relevant voyage have not been agreed upon by the parties. Encompassed is the ballast leg that sails from the ballast port to the load port. Here, the parties are given flexibility to determine what the voyage's scope is. If the charterers do not transfer the Emission Allowances, it will be assumed that they have neglected to pay freight in the same way. Legally meaning that the owners are entitled to take the same actions against the charterers in circumstances where the freight is unpaid.

(iv) BIMCO- **CII Clause for Voyage Charter Parties 2023**: In the voyage charter party, the ship owner is the decision-maker regarding the speed of the ship. It is thought that this clause was developed against claims of low speeds that would be accepted outside of the ordinary in order to reduce CO2 emissions. Essentially, this clause allows the parties to agree mutually to an adjustment of the vessel's course and/or speed, or RPM, within certain parameters. Those techniques serve as means for assisting the parties comply with the IMO's Carbon Intensity Regulations. The practical application of the clause is possible with the parties' mutual consent based on the definitions of "good weather" and agreeing on a "minimum speed". The "laycan" specified in the contract will remain valid. On behalf of the owner, the exercise of the rights in this clause should be regulated in a way that will not be considered a breach of contract under the bill of lading and similar contracts of carriage. Upon completion of the ship's final discharge, the owner shall notify the charterer of the type and quantity of fuel consumed and the distance travelled on the voyage, including the ballast leg. The underlying rationale for transferring this information, if requested, is information in order to perform charterers' own CII calculations and sustainable operational practices in CO2 emission reduction. This clause does not prevent the ship from proceeding at a lower speed than agreed upon in cases where maritime practice requires it, such as going in and out of ports or following a convoy, modifying course in response to severe weather, or in any emergency situations. Delays at the ports may negatively impact a vessel's performance, as per the Carbon Intensity Regulations. Demurrage and/or damages for detention have traditionally been applied to account for delays at the ports by laytime. When unplanned port delays occur, it should be decided whether or not the demurrage fee will cover losses brought on by the applicable new regulations, including any potential CII rating losses. The BIMCO subcommittee working on this issue did not construct a new proposed clause, as it was a very complex issue due to different ship types and different commercial interests. In addition to the standard demurrage regime, the charter party may also provide for additional damages that the charterer is liable for, such as revising the voyage route to enter an intermediate port or giving a "stop and wait" order for the discharge port, which may also occur under the charter party. These days, there's also an expectation that such events will result in further losses from CO2 emissions. Since these additional CO2 damages will not be predicted in advance, some rates and amounts can be requested together with traditional damages by taking into account some criteria to be determined according to ship operation experiences (e.g., day, distance, negative effect on CII basis).

(v) BIMCO - **Just in Time Arrival Clause for Voyage Charter Parties 2021**: Charterers may request that ship owners optimize the ship's speed in order for it to reach a destination by the specified time under BIMCO's the Just in Time Arrival (JIT) Clause 2021. Under this clause, the ship's arrival time will be notified and obtained by the owners and charterers using best efforts. A new cancelling (laycan) date needs to be decided upon if the ship's arrival later the original date of cancelling is due to the charterers' request to change the ship's speed. The charterers shall not be entitled to submit a request for a speed adjustment that is outside the ship's ordinary safe operational limitations. Extra time used on a sea voyage speed, pursuant to the charterers' request, shall be compensated by the charterers to the owners as agreed amount or calculated taking into account the savings in fuel by the owners. Insofar as bills of lading and other similar documents proving contracts of carriage are issued as stated, the charterers shall indemnify the owners against any claims and liabilities resulting therefrom. As is traditional with voyage charter obligations, proceed with due or least dispatch and without deviation when carrying the ship's cargo to the port of destination. JIT is a legal clause that prevents the owners from breaching their contractual responsibilities. A variety of benefits will result from the widespread use of the JIT principle, including reduced emissions, fuel consumption, and waiting periods in ports and anchorages.

In order to start the laytime period, the owner who signed the voyage charter contract as a disponent owner needs to arrive at the port early and give priority to earning the demurrage money. On the other hand, if the vessel has chosen the option of slow steaming into the port **just in time** for berthing, considering the preparation of the port and the consignee readiness, it can also provide CO2 emission savings. Therefore, it will be encouraging for both parties to the contract if a **new demurrage method** is implemented in voyage charter parties. As a suggestion, the new demurrage method can be arranged with rational thought as follows: The ETA, which is calculated by using a lower speed that will reduce CO2 emissions, is notified by the ship/owner to the port of destination/consignee. Taking this arrival time into consideration, the consignee responds to the owner within a reasonable time (12–24 hours) as to whether the ship can berth immediately upon arrival or not. The owner should decide whether or not to increase the ship's speed if it is practicable for it to berth before the specified ETA date. There may not be any CO2 emission savings if the owner speeds up the ship. On the other hand, if the ship's berthing will be possible at a later date than the relevant ETA date, the ship adjusts its speed accordingly. However, in this scenario, as a novelty, the laytime period is started by accepting the arrival on the first ETA date (prior to the ship has yet arrived at the port). Data provided by the AIS tracking system can be used to verify the ship's actual voyage movements. As an example; a 17,266 DWT, 14,036 GRT, loaded bulk carrier departing from Istanbul at 00:00 hours on 01.07.2024, with a speed of 10 knots and has noticed an ETA to the discharge port of Ravenna in 4.6 days (on 05.07.2024 and 14:24 hours). Due to the congestion in the Ravenna port, in the event that the ship is informed that it can only berth when it arrives on 07.07.2024, at 14:24 hours, the ship will reduce its speed to 7 knots, in order to arrive 6.6 days later (just-in-time) and can berth directly. As is natural in sea practice, the captain will reduce the ship's speed without endangering the ship's safety and by taking into account current weather and sea conditions. According to this suggested new demurrage method, laytime will now start at 05.07.2024, 14:24 hours, while the ship is still in navigation and has not arrived. In this regard, the "Virtual Arrival Clause for Voyage Charter Parties 2013" clause proposed by BIMCO in 2013 may be re-examined and taken into account in practice.

It is important to carefully figure out if lowering ship speeds would result in more ships being used or in a higher carbon footprint. Also considering that the voyage may take longer than planned, the ship must have enough supplies of food, medication, fresh water, etc. Fuel savings resulting from speed reduction may be disregarded in favour of the owners, or alternatively, a reduction in demurrage rate may be foreseen at rates to be determined in the contract (such as a 10% reduction in demurrage when fuel savings up to USD 1000 are made). Our opinion is that it should be disregarded in order to encourage owners. The other relevant point is that after berthing, the delays during the handling of cargoes at ports may also have an adverse impact on CO2 emissions. Losses incurred by the CO2 restrictions should be compensated for, with a separate sum allocated for the traditional demurrage cost regime. Consequently, the cargo interest side will directly contribute to the reduction of CO2 emissions.

Time Charter Parties

Time charters, whether for a period or for a trip, are those under which, in return payment of hire, the vessel's employment is put under the orders of the charters, while possession remains with owners who provide the crew and pay the ordinary running costs such as fuel and cargo handling and port charges, which are paid for the charterers (Cooke et al. 2014). A time charter is not a lease. Under a time charter, the charterers do not acquire possession of the ship or any other right of property in her. They acquire, rather, the right, within the limits set by the charter the use to which the owners put their ship. What the charterer gets is right to have use of the vessel. Under a time charter party, the owners' obligation to ensure that the ship is fit for the service when she is delivered does not relate only her physical condition. The owners must also ensure that the ship is "legally fit" for the services, what then is extent of the owners' obligation to maintain the legal fitness of the ship? (Coghlin at al.2014). Our opinion is that this concept is compliance that does not contain any administrative or legal obstacles to the ship's sailing clearness. It should be noted that the requirement that a vessel be legally fit does not obligate an owner to renovate a vessel so as to render charterers' operations more profitable.

Considering new regulations on carbon emissions, the following clauses have been recommended for the time charter contracts (BIMCO, 2024):

BIMCO ETS – Emission Trading Scheme Allowances Clause for Time Charter Parties 2022: The clause's essential concept is that, according with the time charter, the party providing and funding the fuel is also the one in charge of providing and paying emissions trading allowances. Naturally, since the charterer has the obligation for the supply and provision of bunkers in the conventional time charter party, the emissions resulting from the fuel's burning are also the charterer's responsibility. Monitoring the ship's emissions (for verification by an independent verifier) and giving the charterers access to relevant emissions data as well as the basis for calculations are the owners' responsibilities. The timely exchange of correct data and information is the foundation of parties' cooperation. The charterers use this data to provide the owners the required allowances on a monthly basis. Fuel emissions for crew heating or air cooling are not taken into account in this clause. This clause also covers circumstances in which the charterer breaches to pay its allowances, as well as adjustments to allowances resulting from off-hire events. Charterers may demand that the owners return a certain amount or offset any outstanding Emission Allowances during any off-hire time. The clause provides for a serious leverage in the event of a breach by the charterer of a vessel to pay its allowances. In such a case, the owner, by giving five days' notice, shall be right to suspend performing any or all of their charter party responsibilities. The charter hire will be paid throughout this time. The owner shall not be held responsible in any way for any consequences that result from the lawful use of this right. The ship's use being suspended probably would cause cargo damage and other financial losses; thus, charterers will not easily accept such a severe enforcement.

BIMCO- EEXI Transition Clause for Time Charter Parties 2021: This 2021 clause states that, regarding the EEXI Regulations to be followed as of January 1, 2023, it is stipulated that the owners have the right to be taken out of time charter service in order to make the necessary modifications to its structure. The modifications should be on engine power limitation (EPL) or shaft power limitation (SHAPOLI). EPL is a system to improve a ship's energy efficiency by limiting the ship's engine power within the optimum engine setting. As a result, the ship speed will be limited. A ship's propulsion and blade design are maximized by SHAPOLI, which also results in further fuel savings and a reduction in CO2 emissions. Additional other modifications shall be subject to charterers' approval. The owner should plan the dates of the modifications in close cooperation with the charterer, taking into account the charterer's employment intentions. The modifications and trials should be completed without appreciable loss of time in ship's service. The modifications will be surveyed by the ship's classification society. Following the implementation of modifications, any reduction in the vessel's maximum speed and corresponding consumption must be *notified* immediately in writing to the time charterer. Charterers will not be able to require the vessel to exceed its new maximum speed.

BIMCO CII Operations Clause for Time Charter Parties 2022: It is projected that the parties will collaborate in good faith to reduce the carbon intensity of ship operations, regardless of the fact that they have separate financial objectives in the time charter context due to the CII regime. Commercial activities are likely to have a direct and significant impact on a ship's carbon intensity and on maintaining the energy efficiency of the vessel. Traditionally, the owners have no control over commercial management. Therefore, it must encourage cooperation, transparency, and flexibility amongst all parties involved. The clause was developed with this in mind as a "stand-alone" to incorporate into time charter parties. The key principle of it is the transparent sharing of ship data. Until end of 2026 year parties should include a table in the charter party showing the "Agreed CII" values by year. BIMCO recommends using the IMO's "Required CII" values as set out in MARPOL Reg. 28.6. If the charter party extends beyond 31.12.2026 the parties shall review and incorporate the "Agreed CII" in accordance with new targets. The "Delivery Attained CII" and the details of the types and quantities of fuels consumed and distance travelled to date for the current calendar year are to be provided by owners accurately and fully to charterers upon ship delivery. The nature of the time charter requires that charterers, at their discretion, give written instructions to the master as to the ship's speed and engine speed (RPM). Such instructions should always be given, subject to the following conditions: the safety of the ship, crew and cargo and the protection of the environment; the existing safe operational limits of speed, consumption or RPM. Through the captain, the owner exercises due diligence to minimize the ship's fuel consumption and maintain the ship's hull, including the machinery, for energy efficiency, to correctly adjust passage plans and ship trim, to use navigation equipment at optimum levels, and to steer the ship along the safest. Another important component is the routing of the ship's efficiency. Owing to the nature of the AER measure, longer voyages may occasionally be more advantageous to CII than shorter on. Under the charter party, existing warranties as to despatch, speed, and consumption or to maintain the ship's description continue to apply. The charterers cannot claim a breach of any warranty if the owners are in breach of it because of the CII regulations. Alternatively, the charterers may bring a different lawsuit against the owners. The "C/P Attained CII" value will be calculated and compared with the "Agreed CII" based on the owner's data. Thus, the purpose of this clause is for the owner to monitor and calculate the actual consumption of the ship on a daily basis, as well as the types and quantities of fuel consumed and distance travelled, and to provide the charterer with that information. The" Agreed CII" is a fixed figure to be agreed between the Parties for the relevant year(s) of the charter. It is advised that the parties include an appropriate margin in the "Agreed CII" setting to cover unexpected events such unplanned port stays and delays, off-hire, and severe weather. During the charter period, if there is deviation from the Agreed CII, the owners shall give the charterers advance notice of this. In this case, the parties will agree on a new, adjusted written plan for the next voyage or voyages. Until a new plan is achieved, the ship will remain on time charter, and the owner may reduce speed or give other requisite instructions to bring the C/P Attained CII in line with the Agreed CII for the relevant calendar year. Owners will not be in breach of any obligations if they comply with an updated (agreed) plan. It is advised that charterers regularly monitor a ship's "C/P Attained CII" and other data supplied by the owners. In order to be safe, the charterers should take "corrective" activities, like reducing speed or using additional techniques to bring the "C/P Attained CII" in line, without waiting for the end of the year or the redelivery date, if appropriate. Off-hire times should be considered by the parties when determining the "C/P Attained CII". The charterers are obliged to ensure that bills of lading, waybills, or other documents evidencing the contract of carriage contain terms that protect both parties against a claim raised for not proceeding with due despatch or for deviating. If not, the charterers will be liable for covering the owners' losses. Compared to most MARPOL regulations, the CII regime is substantially different. It won't be enough simply to fulfil the requirements once to maintain them up under this regime. It's an operational instrument that's used to measure the ships' yearly carbon intensity, and ships have to meet increasingly strict new CII standards every year.

Contract of Affreightments

In maritime law a contract of affreightment (COA) is a legally binding agreement between two parties, i.e., the ship owner and the cargo charterer. A COA generally states that the shipowner will carry a specific quantity of cargo on a particular voyage for a specific period of time on behalf of the charterer. Typically, a COA covers several shipments during a specific period of time. A bill of lading (B/L), on the other hand, is a contract that applies to an individual cargo. *The voyage charter, time charter, trip charter, and contract of carriage* are the most popular four forms of affreightment contracts. A trip charter is a combination a time and a voyage charter, wherein the shipper covers the shipments with pre-planned trips. A contract of carriage does not identify the exact voyages or vessels; rather, it is used for several shipments over an extended period of time. Regarding Emission Trading Schemes (ETS), BIMCO released three additional new ETS clauses in June 2024 inside the COA framework (BIMCO COA 2024). To put it briefly, these are the inclusion of additional costs resulting from emission reductions in the freight rate (ETS – Emission Scheme Freight Clause for COAs 2024)) or the parties determining a surcharge or the quantity of emission allowances for each voyage with a prior agreement (ETS – Emission Scheme Surcharge or Transfer of Allowances Clause for COAs 2024) and finally covering the costs as the actual quantity of allowances post-voyage after the end of the sea carriage (ETS – Emission Scheme Transfer of Actual Allowances Clause for COAs 2024). These clauses, which are essentially similar to the above types of voyage charter party clauses, could not be examined in detail due to the limitations of our study.

Ship Management Agreements

Ship management is: "*The professional supply of a single or range of services by a management company separate from the vessel's ownership in support of the primary objectives of the shipowner*." (Willingale 1998). BIMCO Standard Ship Management Agreement forms are generally used in contracts made for these services. Shipping companies that have their registered place of business in an EEA country, must open a compliance account (Maritime Operator Holding Account (MOHA) in that same country (EU, 2023/2904). The companies outside the EEA, they must be assigned a competent EEA administering authority (EU Decision 2024/411). If a company does not appear on the list of shipping companies (EU Decision 2024/411), there are two options: it may contract an assigned ISM company, or it will be assigned a competent administering authority based on the first voyage within the scope of that EU ETS Directive ((EU) 2023/2599). Considering new regulations on carbon emissions, the following clause and agreement have been recommended for the ship management contracts (BIMCO, SHIPMAN 2024):

BIMCO- ETS – SHIPMAN Emission Trading Scheme Allowances Clause 2023: This clause is intended to allocate the costs and responsibilities for obtaining, transferring, and surrendering emission allowances for ships that are part of an emission program. There are two alternatives; (i) The owners are the responsible entities for compliance, and (ii) the managers are the responsible entities because the applicable emission scheme makes them responsible. By agreement between the parties, the managers have taken on the responsibility (SHIPMAN 2024, EU 2023/2599). In cases where the owners are responsible entities (with reference to the ISM/ISPS Code), the managers are required to timely provide the owners with emission data in order to facilitate compliance. Such emission data needs to be verified by an accredited verifier. The following responsibilities fall on managers (or managers' nominees) in cases where they are designated as the entity party: To provide the owners with emission data, together with the calculation of the emission allowances, it is required to monitor and report emission data to the administering authority, and each month to prepare and present to the owners, in writing, their estimates of the emission allowances for the vessel for the ensuing month. The final settlement of allowances is regulated in detail. The parties will decide for themselves about the allowances in respect of the vessel and the process for the transfer of allowances from the owners to the managers. The management company may charge a separate management fee for this service. The greenhouse gas emissions trading scheme matters included in this clause are also regulated in detail within the scope of the newly updated Standard Ship Management Agreement (SHIPMAN 2024) (especially under the title of article “10. Emission Trading Scheme Allowances”).

Conclusions

In the maritime sector, especially for shipping companies, two new concepts of the new age are seen as quite radical. Both developments are sufficiently complicated and outside the traditional structure of the maritime sector. The first of these novel ideas is the quickly advancing technology of "*uncrewed ships*," or *autonomous, unmanned ships*; the other is the new regulatory framework concerning "*reducing emissions from ships*”, which is the topic of this study. After the increasing usage of uncrewed ships, the most important legal matter to be answered is who will be liable for damages (Sözer 2023). On the other hand, the proliferation of such new ships will contribute positively to the preference of different fuels, such as electricity, towards reducing ship emissions (Dantas et al., 2023).

EU Member States have developed national long-term strategies on how they plan to achieve the greenhouse gas emissions reductions in the light of the latest available science (EU, EUCO 29/19). Other countries might soon develop their own ETS in the lack of a "*global*" scheme. For instance, currently, this issue has been regulated in terms of Turkish ports. Accordingly, “*Emission fees will be collected for greenhouse gas emissions released by commercial ships arriving at or departing from Turkish ports for the purpose of handling cargo or passengers. The European Union Emission Trading System will be determined based on the current carbon price*.” (Off. Gazt. 09.07.2024/32597, Act of Ports no: 618/ Add. Art.2). As an example of regional work, IMO held a meeting for the Caribbean Sea region on 10-11July 2024. At the meeting, it has been discussed challenges and opportunities surrounding decarbonization of the maritime transport sector for Caribbean Small Island Developing States and Least Developed Countries (IMO, Caribbean 2024).

Academic studies and efforts to create clauses for charter parties with maritime organizations will support the emission reduction of the shipping sector. In our study, BIMCO-drafted clauses examined for different types of maritime contracts will provide baseline contract negotiations for future. In practice, parties will amend the charter parties as needed and add rider terms that fit their individual requirements. When drafting a bareboat or a time contract, the shipowner must ensure that they include clauses that will allow for changes to the ship’s structure resulting from the new IMO decarbonisation obligations imposed by EEXI and CII on their ship. The ship might have to enter the shipyard during the charter time, depending on the volume of work at the shipyards. Clauses can be added to ensure that the dry-docking of the ship does not result in a breach of the charter. Under all carriage of cargo by sea contracts, owners are ordinarily obliged to sail their vessels with all convenient speeds (with due despatch or utmost despatch speed). Without taking into account the port's conditions, ships proceed to their destination port at their service speed is usual practice of shipping which calls "*steam fast, then wait*" practice. Without taking into account the port's conditions, ships proceed to their destination port at their service speed. Generally, as a result of this, dry bulk carriers and tankers spend about 8-10% of their entire life at anchorage. According to academic studies, just-in-time practices would result in emissions' savings in the order of 19–25% (JIA H et al. 2017).

Potential points of dispute in time charter contracts are when charterers complain that the ship is proceeding slowly and the shipowner argues that the ship needs to move at a specific speed in order to comply with the new MARPOL regulations. When merely trying to comply with the new MARPOL rules, owners will need to make sure they are not found in breach of their contractual the convenient speeds responsibilities. It's possible that some owners will choose to reduce cargo quantity intake in order to consume less fuel and, therefore, reduce the risk of a lower CII rating. On the other hand, we think that this choice would not be accurate because there may be a breach of contract and low freight will not be preferred by owners. Another issue that owners should pay attention to in complying with the regulations on reducing GHS emissions from ships is the proper renewal of ship ISM Code documents and ensuring their control.

As a result of our review of this paper, it is clear that the new emissions regulations adopt the principle of holding owners directly responsible for the costs of reducing GSH emissions. There is a high probability that owners will make changes to their charter parties to cover these additional costs by increasing the freight or by requesting an addition to the rents on a monthly basis from the charterers. It should be emphasized that it should not be assumed that the traditional maritime trade contract practices will be easily changed by the parties. No matter which *new demurrage* system is approved—the one we have suggested above or another—preventing delays at ports can only be accomplished by incorporating unmanned ship technology and ports into the new system. The maritime sector is a complicated industry with many parties interconnected commercial interests. It is more reasonable to expect the impact of new emissions requirements to be reflected in increases in freight and rental rates in shipping markets. In essence, for a shipping company, emissions management is an operational issue to have targeted profit as well as compliance with new regulations.

In the final conclusion, it can be said that the change of traditional ship types and the transition to uncrewed ship types can accelerate the achievement of zero emissions, which is the target of the IMO and EU.

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NAVIGATING THE WAVES: UNDERSTANDING HUMAN RESPONSE ABOARD MARINE CRAFT THROUGH BIOMECHANICS

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Abstract: This paper demonstrates how methodologies from biomechanical studies can be applied to investigate the interaction between humans and marine craft. Marine environments present unique challenges, including constant motion, varying sea states, and unpredictable weather, which significantly impact crew members' physical and cognitive performance. These stressors can lead to musculoskeletal injuries, fatigue, and diminished cognitive function, affecting overall operational efficiency and safety. By utilizing techniques such as surface electromyography (sEMG) to measure muscle activity levels and fatigue, inertial sensors to analyze human motion, and biodynamic response assessments to understand the impact of vibrations, this research establishes a robust framework for evaluating motion-induced stressors on crew health and performance. The study highlights the importance of transferring knowledge from various biomechanical disciplines to address specific challenges in the maritime domain. A pilot test was conducted to verify and validate the proposed methodologies, providing critical insights into their practical application and effectiveness. The lessons learned from the pilot test underscored the necessity of precise measurement and highlighted areas for further refinement and improvement in future studies. The collaborative efforts of RISE-Research Institutes of Sweden, KTH Royal Institute of Technology, and Dalarna University focus on enhancing human factors integration (HFI) in marine craft design and operation. The aim is to improve the human-machine interface, optimize crew welfare, enhance operational performance, and contribute to the development of safer, more efficient maritime operations by applying interdisciplinary biomechanical insights.

1. Introduction

Marine craft play a pivotal role in a wide array of maritime activities, ranging from transportation and defence to offshore resource extraction and scientific research. These vessels operate in environments characterized by constant motion, varying sea states, and unpredictable weather conditions, which collectively pose significant challenges to the physical and cognitive capabilities of their human occupants. The complex interaction between humans and machines aboard marine craft is critical for operational efficiency and ensuring the safety and well-being of crew members.

The dynamic nature of marine operations necessitates a thorough understanding of how these environments impact human physiology and performance. Crew members aboard the marine craft are exposed to a multitude of stressors, including high levels of vibration, sudden accelerations, and prolonged exposure to motion-induced forces. These stressors can lead to adverse health effects such as musculoskeletal injuries, fatigue, and diminished cognitive function, all of which have implications for operational effectiveness and crew safety (Colwell 2000, de Alwis 2018, de Alwis 2020, de Alwis and Garme 2017, de Alwis and Garme 2021, de Alwis et al. 2017, de Alwis et al. 2020, Dobbins et al. 2016, Ensign et al. 2000, MacLachlan 2017, McCallum et al. 1996, McMorris et al. 2009, Myers et al. 2012, Oldenburg et al. 2010, Pisula et al. 2012, Prusaczyk et al. 1995, Stevens and Parsons 2002, Townsend et al. 2012, Vickers and Hervig 1998, Vickers et al. 1997, Wadsworth et al. 2008, Zigheimat et al. 2013).

Despite advancements in marine technology and ergonomic design, optimizing the human-machine interface remains a formidable challenge. The effectiveness of marine craft is not solely determined by their technical specifications but also by how well they accommodate the physiological and ergonomic needs of their crew. Enhancing the understanding of human responses to marine environments is crucial for developing tailored solutions that improve both operational performance and crew welfare.

This paper aims to delve into the role of biomechanics as a fundamental discipline for elucidating the intricate relationship between marine craft motion and human physiological responses. By integrating biomechanical principles with empirical data from field studies, this research seeks to establish a quantitative framework for assessing the impact of motion-induced stressors on crew health and performance. Such insights are pivotal for informing the design of safer and more efficient marine craft and for optimizing operational protocols to mitigate the risks associated with working at sea.

In collaboration with RISE Research Institutes of Sweden, KTH Royal Institute of Technology, and Dalarna University, this paper presents an experimental design, its pilot implementation, and the lessons learnt to advance knowledge of human factors integration (HFI) in marine craft design and operation by bridging the disciplines of biomechanics and practical maritime applications.

2. Biomechanical Insights for Maritime Environments

The field of biomechanics encompasses a diverse array of methods and technologies aimed at understanding human physiological responses to various environmental and task-related stressors. This section provides an overview of key approaches, including surface electromyography (sEMG), inertial sensors, and studies on biodynamic responses to vibrations. By leveraging these methods, researchers gain insights into the physiological responses of maritime personnel to environmental stressors and task-related demands. Such insights are crucial for enhancing ergonomic designs, refining operational protocols, and ultimately improving safety and efficiency in maritime settings.

2.1 Surface Electromyography in Muscle Fatigue Assessment

Surface electromyography (sEMG) plays a pivotal role in biomechanics and can particularly be useful in assessing muscle fatigue. Cifrek et al. (2009) highlight the versatility of sEMG in quantifying muscle fatigue using various signal-based criteria. These criteria include time domain analysis, which evaluates parameters such as root-mean-square (RMS) and mean power frequency (MPF) to monitor muscle activity over time. Frequency domain analysis assesses spectral changes in sEMG signals, providing insights into muscle fatigue mechanisms across different frequency bands. Moreover, time-frequency and fractal analyses offer additional perspectives by examining the dynamic changes in muscle activity during tasks (Cifrek et al. 2009).

Chang et al. (2016) have focused on the exclusive estimation of sEMG responses to fatigue during sustained static maximum voluntary contractions. Their study demonstrates the well-known pattern that as muscle fatigue intensifies, the root-mean-square (RMS) values derived from sEMG signals increase proportionally, even as muscle force decreases. This indicates that RMS can serve as a reliable indicator of muscle fatigue progression, independent of certain variations in muscle force (Chang et al. 2016).

Yousif et al. (2019) have extended these findings by reviewing machine learning and statistical approaches for assessing muscle fatigue based on sEMG signals. They emphasize the integration of multiple signal processing techniques, such as RMS, mean frequency (MNF), and median frequency (MDF), to enhance the accuracy and reliability of fatigue assessment. These methods enable researchers to extract comprehensive information about muscle activation patterns and fatigue dynamics during both dynamic and static movements (Yousif et al. 2019) although dynamic movements as well as low muscle contraction levels include challenges in terms of reliability (de Luca 1997).

2.2 Inertial Sensors for Human Motion Analysis

Inertial sensors have emerged as valuable tools for studying human motion dynamics due to their portability, affordability, and ability to capture movement data in various environments. Cooper et al. (2009) have introduced a novel method that combines inertial sensors with Kalman filters to estimate knee joint angles during dynamic activities like walking and running. This approach ensures high accuracy in measuring joint angles, essential for biomechanical studies aiming to understand gait patterns and joint kinematics in real-world scenarios (Cooper et al. 2009).

Saber-Sheikh et al. (2010) have validated the feasibility of using inertial sensors for human motion analysis by comparing them with electromagnetic systems. Their study demonstrates strong agreement between inertial sensors and gold-standard methods in measuring hip joint movements during walking. This validation underscores the reliability of inertial sensors in clinical and research settings, highlighting their potential for widespread application in biomechanics and rehabilitation (Saber-Sheikh et al. 2010).

Cuesta-Vargas et al. (2010) have conducted a systematic review to evaluate the accuracy and reliability of inertial sensors across different tasks and anatomical regions. They conclude that inertial sensors offer a portable and cost-effective alternative to traditional motion capture systems, with comparable accuracy in measuring kinematic parameters such as joint angles and accelerations. However, they also note the importance of standardized protocols and calibration procedures to ensure consistent and accurate data acquisition in diverse settings (Cuesta-Vargas et al. 2010).

2.3 Biodynamic Responses to Vibration

Biodynamic responses to whole-body vibration are critical considerations in designing ergonomic interventions to mitigate health risks associated with occupational exposure. Rakheja et al. (2010) have synthesized data on biodynamic responses, highlighting the influence of factors such as posture, vibration direction, and support conditions on the human-body reactions to vibrations. Their analysis identifies specific frequency ranges and response characteristics that inform the development of vibration isolation systems and ergonomic seating designs tailored to minimize vibration-induced discomfort and injuries (Rakheja et al. 2010).

Marcotte et al. (2020) have further explored the biomechanical responses of the human body to whole-body vibration, emphasizing the role of seat geometry and postural variations in modulating vibration transmission. Their review underscores the need for advanced methodologies to accurately quantify vibration exposure and its effects on human health, particularly in occupational settings where prolonged exposure to vibrations poses significant health risks. By elucidating the complex interactions between vibration parameters and biodynamic responses, their work contributes to improving occupational safety standards and ergonomic practices (Marcotte et al. 2020).

2.4 Extreme Environments

Insights from extreme environments provide valuable parallels for understanding and improving biomechanical research in maritime settings.

Gladh et al. (2017) have investigated parachute opening shock (POS) in skydivers, identifying distinct phases and optimal accelerometer placement for accurate measurement of biomechanical loads. Their findings underscore the importance of precise measurement in understanding neck loads and injury risks during POS. Similarly, LoMartire et al. (2016) have focused on neck muscle activity during POS, highlighting high muscle activity levels, especially in the lower posterior neck, and suggesting preventative strategies such as body positioning and neck exercises to reduce neck strain and prevent injuries.

LoMartire et al. (2017) have explored the relationship between electromyography (EMG) and neck muscle force during isometric contractions, offering insights into estimating neck and shoulder loads and the reliability of EMG over time. This study provides a foundation for future research utilizing EMG to estimate upper axial trunk loads, particularly in scenarios requiring isometric contractions.

Äng et al. (2013) and Pousette et al. (2016) have examined neck muscle activity in fighter pilots wearing night vision goggles (NVG) during flight simulations. Their studies reveal increased muscle strain due to NVG, particularly in lower neck muscles at higher G levels, and highlight the implications for neck pain prevention as also suggested by LoMartire et al. (2016). These findings emphasize the need for ergonomic interventions to mitigate the added strain from head-mounted equipment.

3. Biomechanics in Maritime Context

This research project investigates the effects of working conditions aboard marine craft operating at sea on the psychophysical health and performance of its occupants. It aims to understand how the maritime working environment influences the risk to crew members during short-term exposures; from seconds to a few hours, and long-term exposures; over months and years in service. Additionally, the study explores how these environmental conditions impact cognitive abilities, such as concentration and decision-making, thereby affecting health and work performance. The goal is to quantify the relationship between motion-related exposures and biomechanical responses to assess risks of chronic and acute adverse health effects, such as musculoskeletal pain and injuries, development of mental fatigue and degradation of performance as previously shown to be affected in this group (de Alwis 2020). The project has been approved by the Ethics Review Authority (Dnr 2024-00065-01), Sweden.

3.1. Research Collaboration

This interdisciplinary project involves expertise in engineering technology (RISE-Research Institutes of Sweden and KTH Royal Institute of Technology), medicine, physiology and epidemiology (Karolinska Institute Sweden, Dalarna University Sweden, and Norwegian Armed Forces' Occupational Health Service), along with professional insights from the Swedish Coast Guard, the Swedish Defence Material Administration, the Swedish Maritime Administration and industry stakeholders Volvo Penta and Viking Norsafe Life-Saving Equipment.

3.2. Experimental Design

3.2.1. Participant Selection

The study focuses on high-speed craft (HSC) operators from participating organizations, including the Swedish Coast Guard and the Swedish Defence Material Administration. These research persons both male and female, with varying ages and work experiences are randomly and voluntarily selected, ensuring no special interventions or manipulations are involved. The participants are currently operating HSCs in their occupation, particularly drivers and navigators, due to previous findings that these roles perceive vibration exposures differently.

3.2.2. Consent Process

Participants are fully informed about the project well in advance of data collection. They receive comprehensive details about the experiment's nature, methods, duration, and purpose, including potential risks and inconveniences. This information is presented with the ability to ask questions through physical meetings using PowerPoint® slides and distributed in paper format. Participants have three weeks to decide on their participation, and informed consent is obtained through signed consent forms.

3.2.3. Experimental Procedure

Experiments are conducted on four separate occasions with groups of 10 participants each. These are carried out under conditions representative of the participants' usual occupational activities at sea, without provoking extreme conditions. The natural variations in sea state and operational characteristics such as speed and course provide the exposure variations.

3.2.4. Data Collection

Data collection is divided into subjective and objective components.

3.2.4.1. Subjective Data Collection

Two specially developed and validated questionnaire tools for this particular group (de Alwis et al. 2016 and LoMartire et al. 2017) are used to collect subjective data. The first questionnaire, administered at the beginning of the experiment, gathers baseline data on demographics, lifestyle, work exposure, and health. The second questionnaire, completed at the end of each session, focuses on work exposure and health relevant to that session.

3.2.4.2. Objective Data Collection

Objective data collection includes recording craft and human motions as well as human muscle activity.

Motions of the Craft and Humans: Inertial measurement units (IMU) comprising accelerometers, gyroscopes, and magnetometers record linear acceleration, angular velocity, and angular deviation from magnetic north. IMUs are installed on the seat base and cushion to capture craft motion data. Additionally, drivers and navigators are equipped with IMUs on their forehead, neck, lower back, thighs, and calves to measure body segment movements. These IMUs work as stand-alone units with inbuilt memories. Craft and human motions are also filmed using a video camera for further analysis. Table 1 shows the details of measurements and instruments used for the data collection.

Muscle Activity of Humans: Surface electromyography (sEMG) sensors attached to the neck, shoulder, lower back, thigh, and calf muscles of the research participants record muscle activity in volts. These sensors function independently and store data on their internal memories.

3.2.4.3. Data Collection Protocol

One craft with two research persons, a driver and navigator, is used per data collection session. The craft and research persons are instrumented prior to experiments, with calibrated and checked IMUs and sEMGs as illustrated in Figure 1. The craft then performs its usual operations at sea. No special examinations or interventions occur during data collection, and participants continue their regular duties.

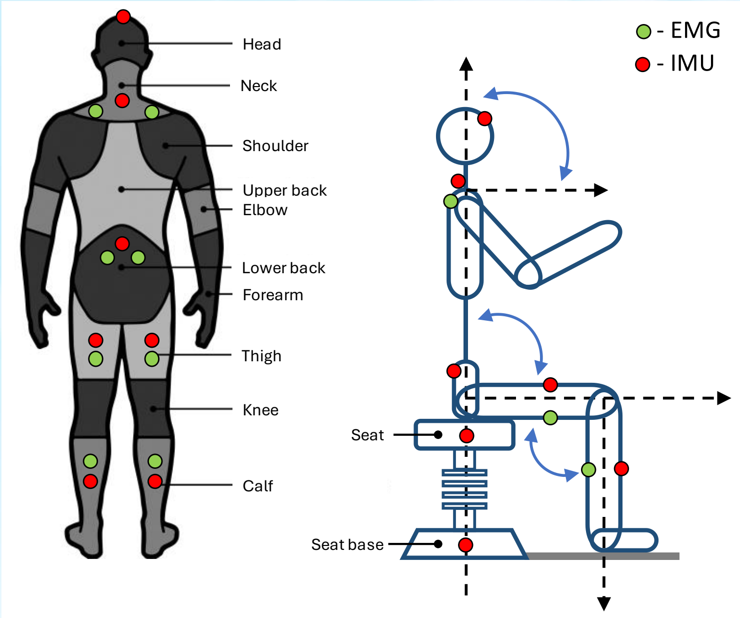

Figure 1. Placement of instruments on the human body and the craft.

Based on previous research (Garme et al. 2011), HSC personnel typically reach the legislated daily vibration dose limit value (Directive 2002 and ISO 2631-1) within an hour at sea. To gather sufficient data efficiently, an experimental cycle is planned over one week. Each day, an instrumented craft completes two 2-hour sea periods with new participants, resulting in a daily measurement flow of 4 persons. Participants may be re-exposed after 48 hours, leading to twice-per-week sea exposure. Successful data collection for four days per week results in 16 exposure sequences, exceeding the EU legislation's vibration dose limit (Directive 2002), although maritime personnel are exempt from this limit.

Table 1. Instrumentation and measurements.

Parameter	Measurement	Instrument	Placement	Per person
Craft motion	6 DoF motion in terms of linear acceleration, angular velocity	IMU	Seat base	1
			Seat cushion/pad	1
Human motion response	Joint angles as kinematic descriptors (neck, torso and knee angles).	IMU	Forehead	1
			Cervical spine – C7	1
			Lumbar spine – L5	1
	Propagation of motion from the lower extremities to the upper extremities		Thigh	2
			Calf	2
	Visual motion response	Camera	Craft	1
Human muscle response	Muscle activity levels (neck and shoulder together, lower back, thigh and calf muscles)	sEMG	Trapezius Descendens	2
			Multifidus	2
			Quadriceps Femoris	2
			Gastrocnemius Medialis	2

3.2.5. Data Analysis

Data quality is checked at the end of each test day. The goal is to characterize the relationship between biomechanical responses and exposure levels/duration, requiring 3-4 weeks of data collection. The data is analyzed after each round of 3-4 weeks of data collection. The data collected from subjective and objective measurements undergoes a rigorous analysis to identify patterns and correlations between motion exposures and their effects on the psychophysical health and performance of marine craft occupants. Figure 2 shows the map of the data analysis and expected outcomes.

3.2.5.1. Data Preprocessing

- Cleaning and synchronization: Raw data from IMUs and sEMGs is filtered to remove noise and synchronize time-stamped data, while questionnaire responses are checked for completeness.
- Segmentation: Data is segmented to represent different phases of sea operations, isolating the effects of various conditions.

3.2.5.2. Statistical Analysis

- Descriptive statistics: Trends and variability are summarized by measures such as mean, median, and standard deviation.
- Correlation and regression analysis: Pearson or Spearman coefficients are used to calculate correlations, and multiple regression models are utilized to predict health risks based on exposure levels.
- Multivariate analysis: Principal component analysis (PCA) is used to identify key factors explaining variance in the dataset.

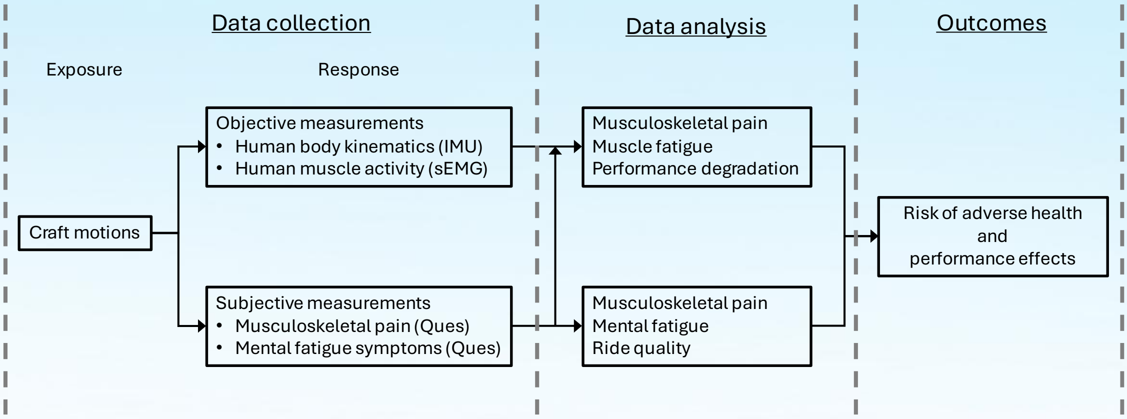

Figure 2. Map of the data analysis and expected outcomes.

3.4.1.1 Biomechanical and Human Response Analysis

- Craft/seat motion (exposure): Craft IMU data is analyzed in terms of root-mean-square (RMS), vibration dose value (VDV), acceleration peak dose, and maximum transient vibration value (MTVV).
- Human motion responses: Human IMU data is analyzed for accumulated joint angle differences, work done against vibration, and time spent in various postures.
- Muscle activity analysis: sEMG data is analyzed for muscle activation levels, activity as a percentage of maximum voluntary contraction (MVC), and delay in muscle response to vibration as well as in terms of spatio-temporal aspects.

3.2.5.4. Health and Cognitive Performance Assessment

- Health outcomes: Musculoskeletal pain (MSP) and mental fatigue data provided by the questionnaire tools are analyzed for prevalence and incidence.
- Cognitive load analysis: Statistical analyses are conducted on cognitive load and mental fatigue patterns related to operational conditions.
- Task performance metrics: Correlation of subjective and objective performance measures with exposure data are examined to assess cognitive impact.

3.2.5.5. Risk Assessment

- Health risk quantification: Risk indices and exposure-response relationships are developed to quantify the likelihood of chronic and acute health issues.

- Safety protocol recommendations: Recommendations are provided for safety protocols and ergonomic interventions, including exposure limits and design modifications for craft seating and control systems.

4. Pilot Test

The pilot test was designed to rigorously evaluate the experimental setup and ensure the reliability of the data collection methods. By simulating the conditions under which the full study will be conducted, potential issues in the instrumentation and procedures were identified and addressed. This test involved detailed preparation, precise alignment of sensors, and a series of controlled movements and measurements. Through this comprehensive approach, the methodology was ensured to be robust and capable of producing high-quality, reproducible results. However, the questionnaires were not administered during the pilot test.

The pilot test was conducted utilizing an advanced wireless EMG and inertial system, WaveX®, developed by Cometa Systems Italy. This system included a comprehensive setup consisting of a receiver, 18 transmitters (14 of which were equipped with both sEMG and IMU sensors, while the remaining 4 were watertight IMUs), and a remote-control unit. Additionally, a GoPro® Hero 11 Black Mini action camera was used to capture the visual motion response of the research participant. One of the research group members, a male, voluntarily participated as the test research participant for this pilot study. The test was carried out using a 6-meter-long research boat owned by KTH Royal Institute of Technology, navigating the waters of the Stockholm archipelago.

The preparation and instrumentation processes were performed in a controlled indoor environment near the sea to ensure optimal conditions. Initially, all IMUs were carefully aligned on a horizontal surface to establish the inertial reference frame, following the precise instructions provided by the manufacturer. The research participant was then outfitted with the sEMG and IMU sensor transmitters according to the guidelines detailed in the objective data collection section (refer to Table 1 and Figure 1). The selection of the sEMG sensor transmitter locations adhered to the protocols set by the SENIAM project (Surface ElectroMyoGraphy for the Non-Invasive Assessment of Muscles), ensuring accurate and reliable measurements. The sensors were attached to the research participant's body using double-sided tape and covered with dressing retention tape.

To verify the functionality of the sEMG sensors, the research participant performed a series of standardized movements, including a torso forward bend, a half squat, a toe stand, and shoulder shrugs. Following these preliminary tests, an isometric mid-thigh pull (IMTP) was conducted to measure the maximum voluntary contraction (MVC) of the muscles. This test was repeated three times, with one-minute intervals between each attempt, and the force exerted during the pull was recorded. Additional tests were carried out to measure MVC for individual muscle groups: seated lateral raises with bent elbows against resistance for the Trapezius Descendens, back extension against resistance while lying on the ground for the Multifidus, seated leg extension against resistance for the Quadriceps Femoris, and calf raises against resistance for the Gastrocnemius Medialis.

Upon completion of the MVC tests, the system was switched to remote data recording mode using the remote control. In this mode, the sensor transmitters disconnected from the data receiver and functioned as stand-alone units, recording data on their internal memories. The research participant then assumed a still posture for one minute to capture the initial IMU orientation within the inertial reference frame. A video camera was mounted on the boat to capture the research participant's motions in the sagittal plane throughout the test. Additionally, one watertight IMU sensor transmitter was affixed to the driver's seat and another to the base of the seat to measure the craft motion data.

To synchronize the video with the sEMG and IMU data, a marker was generated using the pulse generator of the remote control while the research participant nodded his head to make it visible to the video camera. The research participant then proceeded to drive the boat for one hour in the sea. After the boat ride, the research participant returned to the initial instrumentation site. The research participant then maintained a still posture for one minute to capture the final IMU orientation in the inertial reference frame, ensuring consistency and accuracy in the data collected. Following this, the remote data recording mode was deactivated. The research participant then repeated the MVC test using the IMTP at 50% of the maximum force recorded during the initial test to assess submaximal post-fatigue contractions. Finally, the sensor transmitters were carefully detached from the research participant, and the recorded data were extracted from their internal memories for subsequent analysis.

5. Lessons Learnt from the Pilot Test

The pilot test provided critical insights into the practical challenges and technical considerations associated with conducting biomechanical research in maritime environments. Although the results of the analyzed data are not included here due to length restrictions, they will be published later in an extended version of this paper. Several key lessons were learned, informing subsequent experimental designs and methodologies.

Instrumentation and calibration: The initial alignment and calibration of IMUs on a horizontal surface proved essential for obtaining accurate inertial reference frames. Ensuring that all sensors were correctly positioned and calibrated minimized potential errors in motion data. It became clear that careful attention to the setup phase is crucial for the integrity of the collected data. Additionally, capturing the initial and final IMU orientations using a still posture was vital for establishing baseline reference points. This step ensures that any drift or shift in sensor orientation during the experiment can be accounted for, thereby enhancing the accuracy of the motion analysis.

Sensor placement and functionality: The method of attaching sensors using double-sided tape and dressing retention tape was effective in securing the sensors on the research participant's body throughout the test. This approach provided reliable data collection without sensor displacement or detachment, even under dynamic maritime conditions. One of the challenges encountered was adapting the placement of sensors to avoid interference with personal protective equipment and other mandatory gear. Future studies will continue to refine sensor attachment techniques to ensure robustness and durability, particularly in challenging environments.

Participant preparation and comfort: The process of preparing the research participant for testing, including skin preparation before attaching sensors and initial tests for sEMG functionality, underscored the importance of a comfortable and stress-free environment. Proper razor blades and skin cleaners are essential for shaving before attaching the sensors, as irritation to the skin due to shaving can affect the research participant's comfort and potentially bias the data. Any discomfort or distraction can influence the research participant's natural movements and affect data quality. Enhancing the preparation procedures to be more efficient and less intrusive will be a priority in future studies.

Data recording and synchronization: The switch to remote data recording mode and the subsequent synchronization of data from various sensors were successful yet revealed opportunities for improvement. The ability of sensors to act as stand-alone units in remote data recording mode was crucial, as it allowed for uninterrupted data collection without the need for continuous connection to the receiver. This feature ensured the integrity of data collected in a dynamic and remote environment such as the sea. However, a significant issue was encountered with the marker generated to synchronize sEMG and IMU data with the video footage. Due to a technical error, this marker could not be extracted from the remote control. This complication highlighted the need for redundant synchronization methods and regular checks on the functionality of all synchronization tools before initiating the remote recording mode. Future data collections will implement multiple synchronization methods and include careful pre-testing of marker generation and extraction processes to ensure accurate alignment of multimodal data sources. Additionally, the synchronization of time-stamped data from multiple sources, including video recordings, is vital for accurate analysis. Unfortunately, it was discovered post-experiment that the video recording file was corrupted, leading to the loss of visual motion data. This highlights the importance of robust backup measures and continuous monitoring of data recording processes during experiments. Implementing redundant recording systems or automated backup protocols will mitigate the risk of data loss in future studies.

Muscle activity and MVC tests: It was observed that consistent and standardized MVC testing protocols are necessary to ensure comparability across different test sessions and research participants. Future studies will refine these protocols to ensure repeatability and accuracy.

Environmental conditions and real-world application: Conducting the test in the natural maritime environment of the Stockholm archipelago highlighted the importance of considering environmental variables such as sea state, weather conditions, and boat speed. These factors significantly influence motion and biomechanical responses. Incorporating a broader range of environmental conditions in future tests will provide a more comprehensive understanding of their impact on human physiology.

Data quality and analysis: The pilot test emphasized the need for rigorous data quality checks immediately following each test session. This practice ensures that any issues are identified and addressed promptly, preventing data loss or corruption.

Participant feedback: Feedback from the test research participant was invaluable in identifying areas for improvement in the experimental protocol. This feedback highlighted the importance of clear instructions and support throughout the testing process. Future studies will incorporate regular debriefing sessions with participants to gather insights and enhance the overall testing experience.

Acknowledgements

The Swedish Transport Administration (Trafikverket) is acknowledged for funding this research project.

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TURKEY'S MARITIME POLICIES: HORN OF AFRICA (SOMALIA) SPECIMEN

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Abstract: Türkiye has been establishing “humanitarian diplomacy” with African countries since 2002. Turkey's humanitarian diplomacy focuses on establishing schools, hospitals, water supply, student dormitories, elderly care homes, security and other related issues. Political, economic and military relations between Turkey and Somalia have gained momentum since 2011. Türkiye accepted Somalia's request; signed a 10-year agreement to contribute to the development of marine resources, combat pirates and terrorist organizations, combat illegal fishing, toxic waste dumping and any external violations or threats to the country’s coasts. As it is known, a new formation named “Somaliand” emerged in the northern part of Somalia and declared its independence. This formation was not recognized as a “independent state” by Türkiye and the international community. However, like many countries, Türkiye has established healthy relations with this formation. While it supported the stability and development efforts of the region, it also carried out many infrastructure projects, especially health and education. Diplomatic relations between Turkey and Ethiopia, which started in 1925, have developed further especially in recent years. Turkey’s aid in education and health in Ethiopia is appreciated. In addition, the support it provides to agricultural development is very important. The trade volume between the two countries is developing day by day. Economically, Turkey has similar humanitarian diplomacy efforts in Djibouti. Turkey provides support to countries in the Horn of Africa such as Somalia, Ethiopia and Djibouti, especially on security, the fight against terrorists and pirates, military training and similar issues, to contribute to regional and world peace. It is clear that most of the aid and support in question requires special military force. In this article, Turkey's activities in the Horn of Africa, the attitudes of the countries in the region, the efforts of imperialist powers to present Turkey as a “colonial power” will be examined and a perspective for the future will be presented.

Keywords: Horn of Africa, Türkiye, Somalia, Ethiopia, piracy

1. Introduction

Somalia is located in East Africa, bordering the Gulf of Aden and the Indian Ocean, east of Ethiopia. The length of the country's land border with Djibouti is 61 km; The length of the coastline is 3,025 km, with a total of 2,385 km, including 1,640 km with Ethiopia and 684 km with Kenya.

Only 10,320 km² of Somalia's total surface area is 637,657 km² and can be irrigated. In other words, the proportion of land suitable for irrigated agriculture is 1.64% of its surface area.

According to 2020 estimates, Somalia has a population of 13,017,273. Among the ethnic groups in the country, "Somalians" predominate. Among other groups, Arabs and Bantus stand out. Somali and Arabic are official languages in the country. In addition, the use of Italian and English is also important (TWFactbook, 2024).

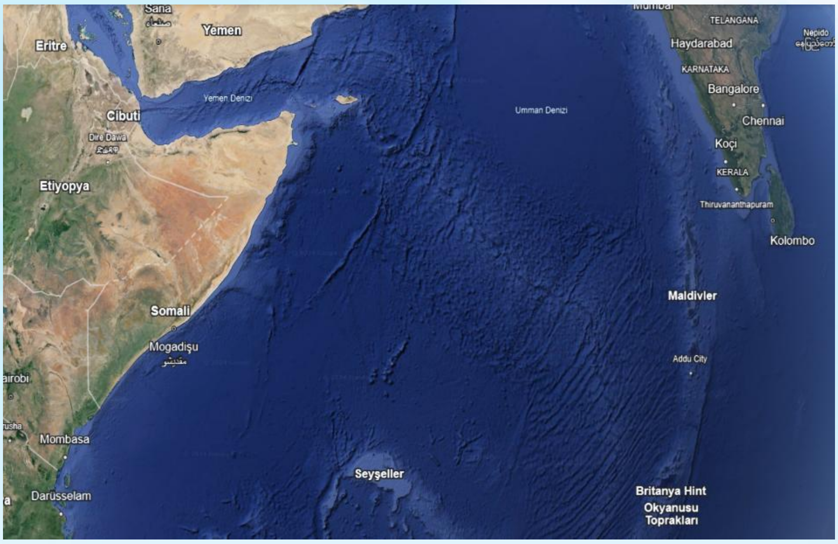
99.9% of Somalia's population is Muslim. Sunni Muslims constitute 98.1% of the population and Shiite Muslims constitute 1.2%.

The country experiences natural dangers such as frequent floods during the rainy season, frequent dust storms in the eastern plains during the summer months, and drought becoming a fate.

2. Strategic Location

Although information about its reserves is not clear, Somalia is thought to have uranium and largely untapped reserves of iron ore, tin, gypsum, bauxite, copper, salt, natural gas and possibly oil reserves.

Located in the Horn of Africa, Somalia has a strategic location on the east coast of Africa, at the junction of the Red Sea (Gulf of Aden) and bordering the Indian Ocean. The country is in a position to control the maritime trade route along the Red Sea, Bab el-Mandeb Strait and the Suez Canal. This region is the shortest route of commercial activities between Europe and East Asian countries, and between Europe and East African countries. It has a position to control the trade of oil, natural gas and other raw materials from the Gulf countries to Europe.



Map 1. Horn of Africa and Somalia

Especially since the start of trade through the Suez Canal, the Red Sea has become even more important in global trade. For this reason, it has become even more important for global powers to have influence in the Horn of Africa. The political geography in the region forces interdependence. For stability in the region, cooperation and coordinated policies should not be abandoned. Located in the Horn of Africa, Somalia has a strategic location on the east coast of Africa, at the junction of the Red Sea (Gulf of Aden) and bordering the Indian Ocean. The country is in a position to control the maritime trade route along the Red Sea, Bab el-Mandeb Strait and the Suez Canal. This region will be able to control the trade of oil, natural gas and other raw materials from the Gulf countries to Europe, and on the other hand, it is the shortest route of commercial activities between Europe and East Asian countries, and between Europe and East African countries.

Especially since the start of trade through the Suez Canal, the Red Sea has become even more important in global trade. For this reason, it has become even more important for global powers to have influence in the Horn of Africa. The political geography in the region not only creates interdependence, but also challenges regional cooperation and coordinated policies.

3. Maritime Policies of Somalia and Horn of Africa Countries

The shaping of Somalia's maritime policies is not new. Somalia published the Territorial Waters and Ports Law No. 37 on 10 September 1972 and forwarded it to the UN with a letter dated 20 December 1973.

Somalia and its neighboring countries Djibouti, Ethiopia, Kenya and Seychelles signed the UN Convention on the Law of the Sea on the same date in 1982. (Table 1) This agreement has been in force worldwide since November 16, 1994 (LOS Bulletin, 2021). Although there are differences in the ratification dates of these countries, they ratified the convention before 1992.

One of the issues that closely affects the relations of neighboring countries in the seas is the sharing and protection of fish stocks living on two or more sides and migratory fish stocks. The agreement on the implementation of the provisions of the contract in this regard was accepted on 11 December 2001, but Somalia did not participate in this agreement. In addition, among the countries of the region, the UN Convention on the Law of the Sea, Article XI. They are hesitant to sign the agreement on the Implementation of Part II. (Table 1)

Kenya and Somalia have long had disagreements over the delimitation of their maritime borders. Ultimately, they decided to take the dispute to the International Court of Justice. The two countries signed a memorandum of understanding on April 7, 2009, not to object to each other regarding the determination of their external borders beyond 200 nautical miles of the continental shelf.

Five years of negotiations yielded no results. Thereupon, Somalia filed a lawsuit against Kenya at the International Court of Justice on 28 August 2014 for the delimitation of maritime areas claimed by both States in the Indian Ocean.

In the dispute between Somalia and Kenya, which has been going on for nearly half a century, Kenya claimed that the maritime border was located east of the point where the two countries meet on the coast. According to Somalia's claim, the sea border in the Indian Ocean should have run in the same direction as the land border. Somalia's complaints were not limited to this. He argued that Kenya had violated its sovereignty by operating in its territorial waters and therefore should pay compensation. The ICJ rejected Kenya's request to pay compensation. In its decision, the court found that "there is no agreed-upon maritime border between the two countries." (ICJ, 2021)

The ICJ largely left to Somalia the disputed portion of a 38,000 square mile (100,000 km²) triangle in the Indian Ocean thought to be rich in oil and gas. Kenya, on the other hand, "completely" refused to recognize the jurisdiction of the International Court of Justice and its decision (BBC, 2021). On the other hand, the USA announced that it did not recognize Somalia's 200-mile Exclusive Zone declaration, although it was in compliance with the International Convention on the Law of the Sea (LOS, 2017).

At this point, it is not known who can implement the ICJ's decision. On the other hand, Kenya stated that it was ready to go to war to defend its territory after the ICJ's decision. It established a fully equipped military base near the disputed territory. Somalia has no navy, but it thinks it has friends.

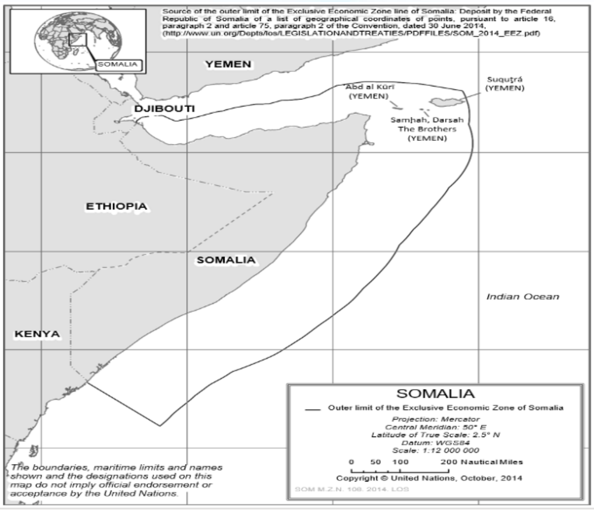
Countries	**Agreement relating to the implementation of Part XI of the Convention** *(in force as from 28/07/1996)*		**Agreement relating to the implementation of Part XI of the Convention** *(in force as from 28/07/1996)*		**Agreement for the implementation of the provisions of the Convention relating to the conservation and management of straddling fish stocks and highly migratory fish stocks** *(in force as from 11/12/2001)*	
	Signature	*Ratification Accession*	*Signature*	*Ratification/ Accession*	*Signature*	*Ratification/ accession*
Somalia	10/12/82	24/07/89	-	-	-	-
Djibouti	10/12/82	08/10/91	-	-	-	-
Ethiopia	10/12/82		-	-	-	-
Kenya	10/12/82	02/03/89	-	29/07/94	-	13/07/04
Seychelles	10/12/82	16/09/91	29/07/94	15/12/94	04/12/96	20/03/98
Madagascar	25/02/83	22/08/01	-	22/08/01	-	-
Maldives	10/12/82	07/09/00	10/10/94	07/09/00	08/10/96	30/12/98
Yemen	10/12/82/	21/07/87	-	-	-	-

4. Turkey's African Initiative and Somalia

Turkey's presence in Somalia emerged as a result of the "Africa initiative" policies that Turkey has implemented since 2005. Since this date, Türkiye has opened many diplomatic representations in African countries. It started direct airline flights from Turkey to African countries. For now, investments have been made in many countries, albeit at a modest level.

The government in Sudan that cooperated with Türkiye was overthrown, but the aid provided to Ethiopia is bearing fruit. Among the countries in the Horn of Africa, the country in which Turkey has invested the most is predominantly Orthodox Christian Ethiopia.

Turkey also has small investments and military cooperation agreements in the small port country of Djibouti. Eritrea, on the other hand, cannot benefit from Turkey's aid because it is under the influence of Saudi Arabia and the UAE.



Map 2. Outer limit of the Exclusive Economic Zone of Somalia (Source: UN (2014). Bulletin No. 85 Law of the Sea).

Turkey appointed a "special envoy" to Somalia for the first time in 2018 and tasked this envoy with increasing the points of agreement between the Somali government and the separatist Somaliland region. Turkey's approach to Somalia is appreciated by Somalis, primarily because it means heeding the "call of Islamic solidarity". Since there are no "conditions" in Turkey's aid and the aid is distributed in accordance with the lists given by local administrators, it is also supported by the political structure.

According to the statements made by the Turkish Ministry of Foreign Affairs, Turkey has provided more than $1 billion in aid to Somalia since 2011 for the health and education sectors, various municipal services and infrastructure projects. It also opened a military training facility in Mogadishu in September 2017, costing $50 million, to train Somali soldiers. Turkey's largest military training facility outside Türkiye is located in Somalia. Meanwhile, a Turkish company purchased 45% of the operating rights of Mogadishu Port for 20 years in 2014 and made serious improvements to the port. Another Turkish initiative purchased the operating rights of the city's airport. These ports have accelerated Turkey's humanitarian aid and investments in Somalia since 2011.

Turkey's largest Turkish military base abroad was opened in Somalia in 2007. This military base includes a military college and some training areas for the training of Somali soldiers. More than 10,000 Somali soldiers received training at this training center between 2007 and 2023.

Türkiye and Somalia relations have been developing rapidly since 2011. The developing political, economic and military relations between the two countries gained a new dimension with the "Defense and Economic Cooperation Framework Agreement" signed on February 8, 2024. According to the statement made by Somalia, the agreement covers cooperation on issues such as terrorism, external threats, piracy, combating illegal fishing, protection of coasts, prevention of illegal trade and development of marine resources. A joint naval force will be formed between Turkey and Somalia, and these forces will protect Somali waters for 10 years and contribute to the development of maritime resources. According to the information provided by the President of Somalia, the agreement does not have a hostile purpose towards Ethiopia or any other country.

5. Balance of Power in the Horn of Africa

The Türkiye-Somalia agreement has military and commercial dimensions as well as a side related to the balance of power in the Horn of Africa. Whoever controls the Horn of Africa can control a significant part of the world economy.

Six foreign countries, including the USA, France, China, Japan, Saudi Arabia and the UAE, have military bases in Djibouti. In addition, Turkey has military bases in Sudan, Turkey, the USA and the UAE in Somalia, and the UAE in Somaliland. With the agreement signed in 2024, the number of US elite bases in Somalia is increased to five.

Somalia's partnership with Türkiye was persistently portrayed as an effort to balance Ethiopia's relationship with Somaliland. Somaliland will gain serious economic resources when Ethiopia begins to access the Somaliland-controlled Berbera Port for commercial maritime operations. Ethiopia, on the other hand, will have launched an alternative port to the Djibouti port. It is obvious that if Ethiopia recognizes Somaliland as an independent state, the stability of the region will be significantly disrupted. Somalia's agreement with Türkiye can also increase the country's effectiveness within the African Union and the East African Community.

China's Belt and Road Initiative, launched in 2013, covers most of Africa, including the Horn of Africa countries. By signing the BRI memorandum with Eritrea in November 2021, China included all the countries in the region in this project (Broke-Holland 2024). China appointed a special envoy for the Horn of Africa in February 2022. According to the official statement, the mission of this ambassador was to "support China's peaceful development plan for the region and help countries achieve long-term stability, development and prosperity (Reuters, 2022)".

Between 2010 and 2012, the Chinese government approved a total of $11.3 billion in concessional loan financing to Horn of Africa countries (Chaisse and Matsushita, 2018).

China transferred $14 billion in investments and loans to Djibouti between 2012 and 2020. In 2017, it established its first military base outside China in Djibouti as "a logistics facility to support naval ships patrolling the coasts of Yemen and Somalia."

The Chinese Navy has increased its security experience in anti-piracy operations off the coast of Somalia. The African Union Mission established in Africa also financially supported AMISOM (Africa News, 2019). He personally organized some peace conferences (VoA, 2022). Many high-level trips were made. All these are evidence that China wants to have a greater role in the region.

6. Somalia's Priority Problems

6.1 Somaliland Problem

Somaliland, internationally recognized as Somali territory, is on the southern coast of the Gulf of Aden in the Horn of Africa. Somaliland, the world's largest unrecognized country, borders Djibouti to the northwest, Ethiopia to the south and west, and Somalia to the east. The area it controls is 176,120 square kilometers (68,000 square miles) and its population is approximately 6.2 million as of 2024.

Somaliland is strategically located in the center of the Horn of Africa and along the Gulf of Aden, near the entrance to Bab al-Mandab. Somaliland is in a position to affect traffic between the Red Sea and the Suez Canal, a major maritime route through which one-third of the world's shipping passes.

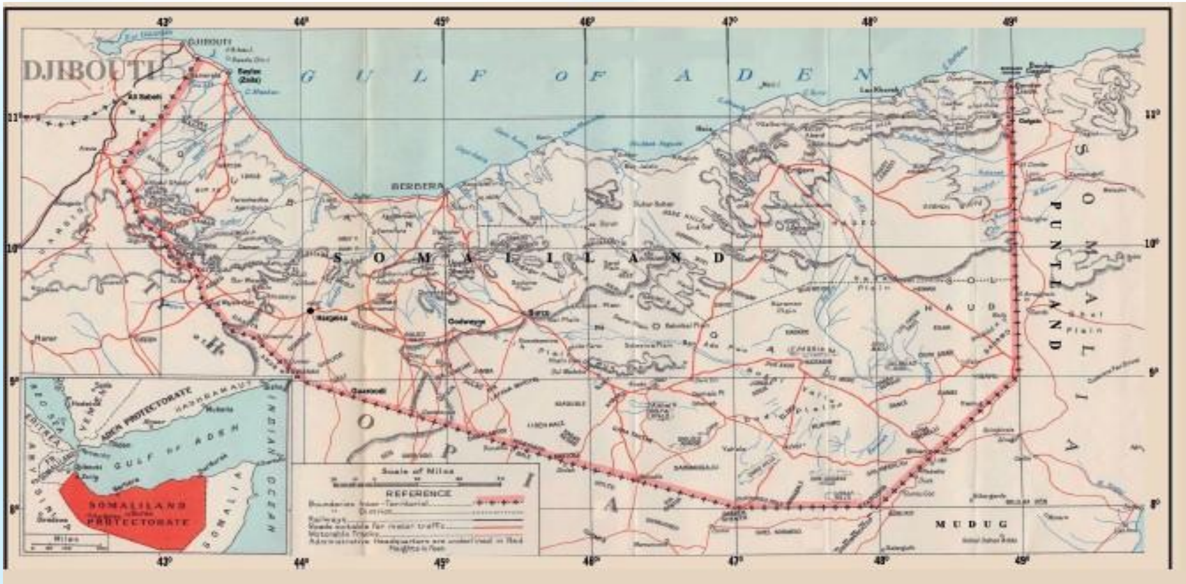
Due to its location at the crossroads between Europe, the Middle East and Asia, Somaliland has emerged as a trading country. Somaliland imports basic foodstuffs such as wheat, wheat flour, rice, sugar, edible oils and legumes, pasta, dates and biscuits. Other than food, the products it imports include cement, construction materials, steel, clothing, fuel, vehicles and vehicle spare parts.

The main exports of the Somaliland region are live animals, gum, hides and leather, which are sold to Saudi Arabia and other Gulf countries. UAE, Ethiopia, Yemen, China, Saudi Arabia, EU countries, America and Japan stand out in imports. Türkiye ranks 15th in Somaliland's imports.

The territory of Somaliland is thought to be rich in oil deposits. The first test well was drilled by Exxon Mobil and Shell in 1958. In early 2015, Western oil companies stated that they had identified three wells with estimated reserves of 1 billion barrels of oil each.

Somaliland has political connections with its neighbors Ethiopia and Djibouti, as well as South Africa, Sweden and non-UN member Taiwan.

Somaliland announced in January 2024 that it had leased the strategic Berbera port to Ethiopia, a landlocked state (The Economist, 2024). When Eritrea declared its independence in 1993, Africa's second most populous country, Ethiopia, was cut off from its Red Sea ports and became a landlocked state. The Somaliland region, which wanted to separate from Somalia and formed a separate administration, gave Addis Ababa access to the Red Sea again. According to the agreement signed between Ethiopia and Somaliland, Somaliland leased 20 kilometers (12 miles) of its coast to landlocked Ethiopia to use as a military base and for commercial purposes. In return, it is thought that Ethiopia will recognize Somaliland as an independent state.



Map 3. Map of Somaliland

The UN recognizes the territory of Somaliland as Somali territory. Many countries reacted harshly to this agreement, as Ethiopia making such an agreement could pave the way for recognizing Somaliland as an independent state. Türkiye said, “We reaffirm our commitment to the unity, sovereignty and territorial integrity of the Federal Republic of Somalia. We emphasize that this situation is a requirement of international law. "As in the past, today we wish that the disputes between Somalia and Somaliland will be resolved through direct negotiations and among Somalis, and we reiterate our support for initiatives in this direction," he said. Along with Turkey, the USA, China and some leading European countries stated that they support the solution of the problem between Ethiopia and Somalia through diplomatic means.

Ethiopia did not make an official statement about the ratification of the Türkiye-Somalia agreement. The biggest reaction to the agreement was shown by Al-Shabab, which is also on Turkey's list of "terrorist organizations". The terrorist organization Al-Shabab tried to present this agreement as "a new reflection of Turkey's hegemonic ambitions in the region (BBC Turkish, 2024).”

It does not seem possible for the United Arab Emirates, which has been conducting diplomacy for years to sign such an agreement with Somalia, not to be disturbed by this agreement. It cannot be said that Ethiopia is happy with this agreement. It does not seem reasonable for Ethiopia, which provides unmanned aerial vehicles and other military equipment from Turkey in its fight against the Tigray region, to react to Turkey. To this, we also need to add Turkey's humanitarian and military aid to Ethiopia and the modern schools and hospitals it opened there.

Türkiye is the only country that has been carrying out the mediation process between Somalia and Somaliland for a long time. Even though Somaliland sees its territory as Somali territory, it continues to provide humanitarian aid and open modern schools in Somaliland. Turkey has established modern schools in Hargeisa, Djibouti, Mogadishu, Harar, Mekelle and Addis Ababa, and has won the hearts of the people of the region with its humanitarian aid.

As in the USA State Department Report (USA Department of State, 2024), actors operating in the country are taking actions that amount to interference in Somalia's internal affairs. The most important reason why Turkey was invited to the country is that it takes care not to interfere in the internal affairs of the countries that invite it.

6.2 Terrorism Problem

11 large and effective terrorist organizations operate in and around the Horn of Africa. (Table 2). Even though Somalia and its partners in the Horn of Africa carried out successful operations against the Al-Qaeda-linked terrorist organization Al-Shabaab, this organization still maintains its power.

Al-Shabaab has retained the ability to launch sophisticated and often coordinated attacks against civilians, government personnel and facilities, and security forces, including Somali and African Union peace support operations (Country Report of Terrorism, 2022:11)."

Table 4 U.S. Government-Designated Foreign Terrorist Organizations in 2022 Source: Country Reports on Terrorism 2022

Ansar al-Dine	AAD
Boko Haram	BH
ISIS-Democratic Republic of the Congo	ISIS-DRC
ISIS in the Greater Sahara	ISIS-GS
ISIS-Mozambique	ISIS-M
ISIS-West Africa	ISIS-WA
Jama'at Nasr al-Islam wal-Muslimin	JNIM
Jama'atu Ansarul Muslimina Fi Biladis-Sudan	Ansaru
al-Murabitoun	
al-Shabaab	AS
al-Qa'ida in the Islamic Maghreb	AQIM

One of the most critical partners for the United States and the region in the fight against terrorism is Djibouti. The only permanent US military installation in Africa is in this country. Additionally, AFRICOM Combined Joint Task Force-Horn of Africa's headquarters is in Djibouti. Djibouti is also geographically close to the areas of activity of leading terrorist organizations such as Al-Shabaab, which controls regions in neighboring Somalia. Djibouti provided two battalions of support to the African Union Transitional Mission (ATMIS) in Somalia (Country Report of Terrorism, 2022:23).

Despite the joint efforts of the Federal Government of Somalia (FGS), neighboring countries and the African Union, Al-Shabaab continues to pose a significant terrorist threat in Somalia and the region. Al-Shabaab generates millions of dollars in revenue from residents and businesses in Somalia. The organization carries out very lethal operations such as targeted assassinations, suicide attacks, complex attacks, ambushing along transportation routes and using firearms. Al-Shabaab's attacks are damaging for all countries in the region, as well as for those trading and investing in the region.

ISIS-Somalia, on the other hand, remained isolated in Puntland in northern Somalia due to the pressure of Al-Shabaab. ISIS Somalia is trying to generate income through extortion.

The reality of Somalia cannot be analyzed correctly without separating Turkey from other powers operating in Somalia. Because Türkiye is not a "player country" in Somalia, but a "supporting country". Türkiye is one of the most prominent partners of the extremely weak and fragile Somali economy. Additionally, Türkiye has trained thousands of Somali security guards without achieving anything. It contributed to ensuring security and overcoming the problem of famine in regions where terrorists are active. It has established a military base to ensure the security of its forces fighting against terrorists in the country.

While Turkey's influence in Somalia is increasing, "player countries", which feed on the instability in Somalia, are unfortunately not happy with the stability achieved in Somalia thanks to Turkey's aid.

The "military base" established by Turkey in Somalia, unlike the military bases of other countries, is the "backbone of the Somali defense capacity in the fight against the terrorist organization al-Shabaab (Takambou, 2024)." In other words, the military base established by Turkey has brought stability to Somalia (USA Department of State, 2024).

6.3 Other Problems

For decades, millions of people in Somalia have been struggling with hunger, poverty, disease, locust invasions, floods, dust storms, conflict and displacement. Minimum human needs should be provided in the country, epidemics should be prevented, and a social structure resistant to natural and man-made disasters should be established. Possibly as a result of climate changes, severe dust storms, periodic floods and severe droughts pose a serious threat. Reaching a more resilient economic structure will help Somalia manage its own problems more effectively.

Widespread corruption, weak financial institutions, lack of an appropriate regulatory environment, and limited access to international finance due to concerns about money laundering and terrorist financing continue to rob Somalia of critical resources and deter private investment.

7. Common Interests of Türkiye and Somalia

The United States decided that a physical presence in Mogadishu was no longer worth the cost or security risks. Despite this, Türkiye focused on the following objectives in its Somalia mission:

Improved security coordination between Somali forces and international partners to reduce the risk of global terrorism centered in Somalia. To reduce terrorism, terrorist financing, insurgency and violent crime by increasing the effectiveness of Somali forces. Responding to recurring humanitarian needs while supporting inclusive and resilient economic growth. Enabling marginalized Somalis to more effectively withstand shocks and stresses. Supporting reforms that ensure full debt cancellation, promote private sector-led growth, and reduce financial crime. Promoting peace through stable, effective governance.

Somalia has the second longest coastline of all African countries. Therefore, it has a large exclusive economic zone that hosts significant amounts of marine life and may contain significant hydrocarbon resources. Somalia is a country of focus for many countries and companies hoping to sign lucrative deals for exploration and research.

For this reason, the details of the agreement made between Türkiye and Somalia are extremely important.

1. If the revenue sharing arrangement can be made fair, Turkish oil and natural gas exploration companies can gain access at a lower cost than the costs of standard license agreements. It will reduce some of Turkey's upfront financial risks and burdens associated with the acquisition of foreign offshore exploration and extraction rights. This means that Turkey's activities under the agreement are partially covered by revenues from maritime activities.

2. The Turkey-Somalia Agreement gives Ankara the authority to guarantee the protection of Somalia's 3,333-kilometer coastline and maritime borders against all kinds of threats. One of these is illegal and unregulated fishing and piracy off the coast, costing the Somali economy at least 500 million dollars a year (Abdolgader, 2024). An annual savings of $500 million is not a rate that can be ignored, especially in regions affected by piracy, kidnapping and kidnapping for ransom.

3. It is a profitable deal for Somalia to obtain 30% less tax revenue from license fees in exchange for Somalia's development of advanced maritime security capabilities. Because accessing and using maritime technologies is an expensive business.

4. If Turkey can participate not only in exploration and extraction activities in Somalia's exclusive economic zone, but also in the activities of licensed third parties, this could be a profitable step for Turkey.

Since the agreement reached by Turkey is development-oriented, it needs to be compatible with Somalia's broader goals of developing its communities and the country. The Somali government must ensure that local communities are not marginalized and that maritime benefits are shared. Historically, Somali piracy was primarily driven by coastal communities' complaints about illegal fishing and environmental degradation by foreign vessels.

Although the security and defense agreement signed between Turkey and Somalia in February 2024 only covered a 10-year period, it was frequently criticized by the global colonial states with military bases in the region, and Turkey's settlement, especially in the Horn of Africa, was opened to discussion. However, since Turkey started training the Somali army, the Somali army has gained psychological superiority against the terrorist organization Al-Shabaab. Just as it quickly helped Qatar when there was a crisis between the Gulf countries in 2017, it quickly responded to Somalia's request for help.

This agreement is important for Türkiye in at least five ways. First, Turkey's military presence in Somalia was at a symbolic level before this agreement. However, now it will increase its military power. Secondly, it will put on its agenda to have a military airport to meet the logistical needs of the military presence it sends to Somalia. Thirdly, the Turkish navy will have a base in the Horn of Africa. Fourthly, new job opportunities will be created for the drilling ships that Turkey has recently acquired to search for oil and natural gas. Fifth, while the Turkish navy protects the Somali coast, it will also provide security to Turkish drilling ships.

8. Conclusions

Delay in cargo delivery due to piracy, ransom payments to pirates, dangers to ship crews and similar problems cause cost increases in many areas. Somalia requested support from Turkey in the field of "fighting terrorism" and "maritime security". By responding positively to this request, Turkey will help Somalia improve its capacity and capabilities to combat illegal and irregular activities in its territorial waters, such as terrorism, piracy, illegal fishing, toxic waste dumping and any external violations or threats to the country's coasts.

Turkey focuses on assisting the Somali state's efforts to ensure the security of its people and reducing the capacity of these groups to cause harm. In these efforts, Turkey aims to protect civilians and emphasize respect for human rights, to hold those responsible for all kinds of rights violations accountable, and to create a more operationally effective and professional Somali security force.

With the policies of the UN Security Council and the deployment of naval forces of more than twenty countries to the region to protect merchant marine vessels, there has been a significant decrease in maritime piracy off the East Coast of Africa and the Gulf of Aden. There are no significant incidents of piracy off the coast of Somalia in 2022 and 2023 by the ICC International Maritime Bureau (ICC, 2024).

In this troubled region, no uniform and reliable standard has been produced to catch pirates, adjudicate their guilt, and impose punishment. International support for solving the problem has generally been limited to arrest and deterrence. Implementing these is left to regional states that cannot fulfill their responsibilities effectively (Hallwood & Miceli, 2013).

Cheuk Yui Kwong said, “Turkey's influence is growing eastward. In his article titled "This is a nice thing", he wrote: "Turkey's recently strengthened relations with Somalia raise the possibility of Ankara becoming more involved in Indian Ocean issues; This probably benefits the West. On the contrary, China cannot welcome this development at all. It is part of a larger shift in Turkish foreign policy. In the past, Turkey focused on nearby places such as the Middle East, the South Caucasus and the Mediterranean, but the latest agreement today extends much more assertively to the Horn of Africa and beyond. Türkiye competes with China generally in Africa. Now the agreement between Turkey and Somalia must be troubling China, which has sought influence in the Horn of Africa beyond Djibouti but has been thwarted by its geographical and cultural distance from the region. Türkiye will of course look after its own interests while developing new relations. "But the West must recognize and approve the eastward movement in its influence, which is definitely to the detriment of China," he says (Kwong, 2024).

Somali piracy has emerged mainly due to three interrelated factors: the prolongation of the internal conflict in Somalia, Somalia's proximity to major shipping lanes, foreign fishing vessels fishing in Somali waters, and the decline in fish stocks due to merchant vessels polluting Somali territorial waters.

Partnership with Turkey for Somalia aims to strengthen Somalia's sovereignty and development, build maritime security capacity, and produce new alternatives among complex power dynamics. Türkiye seems to be the best partner for Somalia, a state without a navy, to build a navy.

Fierce competition for Somalia's underground and surface resources has led to serious divisions among clans. Türkiye can mediate a fair solution to power and revenue sharing with the government and other important political stakeholders in Somalia.

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EVALUATION OF SEAFARERS' ANNUAL PAID LEAVE RIGHTS WITHIN THE SCOPE OF MARITIME LABOUR LAW NO. 854 AND MARITIME LABOUR CONVENTION (MLC-2006)

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Abstract: The right to paid annual leave, guaranteed by Article 50 of the Constitution, is a universal right that aims to ensure that workers can rest without working and worrying about income. Work in the maritime profession consists of intensive physical strength, labour-intensive and long working hours. In addition, the maritime profession, by its very nature, involves many risks in terms of occupational health and safety. Due to all these concrete facts, it is of great importance that seafarers can properly exercise their constitutional and universal right to rest. However, the fact that the ships are mostly a living space for seafarers leads to the intertwining of working and rest periods and there are difficulties in distinguishing these periods from each other. Since the seafarer does not have the opportunity to go ashore, it is difficult to determine how much of the periods that the seafarer stays on board the ship will be accepted as work time and how much of them will be accepted as rest time because the Maritime Labour Law does not contain a regulation on the work periods that are accepted as worked. Adopted by the ILO in February 2006, the "Maritime Labour Convention 2006" is a legal text that aims to unify all the conventions previously adopted by the ILO in the maritime sector under a single roof and to guarantee the rights of maritime workers in the widest scope. MLC 2006 contains comprehensive provisions to protect the physical and mental health of seafarers, such as determining the minimum rest and maximum working hours of seafarers, ensuring that seafarers take sufficient leave, and ensuring that their annual leave is used as much as possible without interruption. Countries that are parties to the Convention are obliged to make regulations in their domestic law texts that are compatible with the content of the Convention. Although the MLC 2006 was ratified by the TGNA with the Law No. 6898 dated 2017, the enforcement procedure in terms of our domestic law has not been finalised until today. In this study, the amendments and innovations that need to be made in the national legislation within the scope of the regulations of MLC 2006 on annual paid leave will be discussed and solution suggestions will be tried to be given in this regard.

Keywords: Seafarer, annual paid leave, Maritime Labour Law, Maritime Labour Convention

1. Introduction

The right to annual paid leave is a constitutional right that aims to provide workers with the opportunity to rest without engaging in any work-related activities and without concern for their income. The right to annual paid leave is enshrined in Article 40 of the Maritime Labour Law No. 854 (Akyiğit 2012; Tulukçu 2023). Furthermore, the right to annual paid leave is also included as a fundamental right of employees. It is also enshrined in the legal texts of numerous international organisations, including the Universal Declaration of Human Rights of 1948, the International Covenant on Economic, Social and Cultural Rights of 1966, the European Social Charter of 1961 and the International Labour Organization (ILO).

The Maritime Labour Convention 2006 (MLC 2006), which was adopted by the 94th Conference of the International Labour Organization in Genoa in February 2006, represents the latest iteration of a series of conventions that have sought to consolidate and revise the existing legislative framework governing the maritime sector. At the Conference of the International Labour Organization held in Genoa in February 2006, the "Maritime Labour Convention 2006" (MLC 2006) was adopted as the latest convention to revise and unify all those previously adopted by the organisation in the maritime sector. Additionally, the MLC 2006, which entered into force in 2013, encompasses regulations pertaining to the right to rest and annual paid leave of seafarers (Algantürk 2006).

The Law dated 2 March 2017 and numbered 6898, which ratifies the Maritime Labour Convention 2006, was published in the Official Gazette on 25 March 2017 (No. 30018). With regard to Turkish law, the procedure for implementing the Convention has not yet been completed (Halatçı Ulusoy 2020). Nevertheless, the fact that the enforcement procedure of the Convention has not yet been completed does not absolve ship operators flying the Turkish flag from liability. Firstly, the preamble of the Convention, entitled "General Obligations", commits the parties to the Convention to transpose the provisions of the Convention into domestic law upon the conclusion of the ratification process. Furthermore, in accordance with Article A5.4 of the Convention, when a ship subject to the Convention is in the ports of a member state, the compliance of this ship with the provisions of the Convention may be inspected by the member port state, and the ship may be sanctioned. Therefore, it is of the utmost importance to complete the ratification process and to implement the necessary arrangements in our domestic law without delay (Baskan 2024).

It is essential to assess the concept of annual paid leave for seafarers, while taking into account the distinctive characteristics of maritime work. In general, maritime work is characterised by long working hours, demanding physical strength and psychological endurance, and a high prevalence of occupational health and safety hazards. Another significant aspect of work at sea is that seafarers frequently remain on board for extended periods without leaving the ship. This dual role of the ship as both workplace and residence for seafarers is a defining feature of their work environment. During these extended periods, seafarers are separated from their families and social circles (Güner 2001; Taşdelen 2015; Ağartan 2006; Düğenci 2018). Research indicates that seafarers are unable to obtain sufficient rest in the face of these challenging working conditions, which often results in the development of "burnout syndrome" (Zorba 2016; Aydın 2015; Kurt 2010; Kınalı 2020; Büber 2017). In light of these considerations, it is of paramount importance that seafarers are able to exercise their right to rest in accordance with the stipulations set forth in relevant legislation.

This study will examine the concept of annual paid leave, which is of great importance for the creation of a physically and mentally healthy working environment for seafarers. It is the intention of this study to examine the manner in which the Maritime Labour Law and the MLC 2006, the ratification of which is still pending in Turkey, regulate the annual paid leave. In this context, an attempt will be made to include an analysis of the differences between the two legal texts on issues such as entitlement to and use of annual paid leave, conversion of unused annual leave into wages, problems experienced in practice and solution suggestions.

2. Annual Paid Leave in Terms of Maritime Labour Law No. 854

2.1. Conditions of Entitlement to Annual Paid Leave

The regulation of annual paid leave is outlined in Article 40 of the Maritime Labour Law. In accordance with Article 40/1 of the Maritime Labour Law, the fundamental prerequisite for seafarers to be eligible for annual leave is that they have been employed by the same entity for a minimum of six months under one or more contracts of employment within a one-year period (Karaman 2018; Tulukçu 2023).

In accordance with the stipulations set forth in the pertinent legislation, the waiting period is required to comprise a minimum of six months within a calendar year. Consequently, it is not feasible for individuals employed under contracts that conclude prior to the expiration of the aforementioned six-month period or the subsequent one-year period to be eligible for annual paid leave commensurate with the length of their working tenure. Similarly, entitlement to annual paid leave in proportion to the duration of employment will not be possible for periods of employment that commence at a point other than six months or one year.

Article 40/3 of the Maritime Labour Law prohibits the employee from waiving their right to annual paid leave. This article aims to protect the right to rest against the transactions that the employee may take against themselves (Karaman 2018; Bedük 2012; Tunca 2013). In addition to this mandatory stipulation, it is evident that the majority of legal regulations pertaining to the protection of the right to annual paid leave exhibit a relative mandatory nature. In this context, it can be argued that seafarers may be entitled to rights in addition to those provided for in the legislation on annual paid leave rights (Dündar 2010; Karaman 2012).

2.2. Annual Paid Leave Periods

In accordance with Article 40/2 of the Maritime Labour Law, the minimum annual leave period for seafarers with six months to one year of seniority is 15 days, while those with one year or more seniority are entitled to one month of annual leave per year. The aforementioned provisions pertaining to these periods are considered to be relative mandatory provisions. However, it is possible to agree on longer annual leave periods between the parties involved (Kar 2021; Tuncay 2008). The age of seafarers is not a factor in the calculation of the annual leave periods set out in the Maritime Labour Law (Akyiğit, 2012).

The Maritime Labour Law does not include a stipulation indicating that national holidays, weekdays, and general holidays that coincide with the annual paid leave period should not be included in the annual leave period. Consequently, the prevailing view in the academic literature is that the holiday days that overlap with the annual paid leave periods of seafarers should be counted within the annual leave period (Kar 2021).

2.3. Use of Annual Paid Leave

In accordance with Article 40/3 of the Maritime Labour Law, the seafarer is entitled to take their annual leave during the period deemed appropriate by the employer. The Maritime Labour Law does not include a provision for the seafarer's opinion in determining the time of leave. In accordance with Article 40/4 of the Maritime Labour Law, one month's leave may be divided into two parts, to be used within the same year, if the parties involved agree.

In accordance with Article 40/5 of the Maritime Labour Law, a seafarer is not obliged to take their annual paid leave in a foreign port or in a location other than the place where the employment contract was concluded.

2.4. Annual Leave Wage Under Maritime Labour Law

A wage claim does not arise in the event that an employee does not take their annual leave prior to the termination of their employment contract. Nevertheless, in the event of the employee's employment contract being terminated prior to the utilisation of the accrued annual leave, the remuneration for the unutilised leave periods shall be paid to the employee or their designated beneficiaries (Özdemir 2013; Tunca 2013).

In accordance with the stipulations set forth in Article 40/7 of the Maritime Labour Law, in the event that the employment contract is terminated by the employer through a justified termination in accordance with Article 14/I of the Maritime Labour Law, the employer is not bound by law to remunerate the seafarer for the unused annual leave periods (Kar 2021; Tulukçu 2023).

Recently, upon the application of the 9th Civil Chamber of the Court of Cassation, the Constitutional Court has decided to cancel paragraph 40/7 of the Maritime Labour Law. In its decision, the Constitutional Court concluded that the condition that the payment of annual leave wages to seafarers is subject to a condition related to the reason for the termination of the contract violates the right to paid annual leave, and therefore Article 40/7 of the Maritime Labour Law is contrary to Article 50 of the Constitution.

3. Annual Paid Leave in Accordance with the Maritime Labour Convention 2006 (MLC 2006)

3.1 The Purpose of the Right to Annual Leave under the MLC 2006

The purpose of the right to annual leave is explained in regulation 2.4 as ensuring that seafarers take adequate leave. Accordingly, it is the duty of each Member State to ensure that seafarers take adequate leave at reasonable times. The MLC 2006 also recognises the right to annual leave as a universal right of workers. According to Standard A2.4, the right to annual leave may not be waived except in cases prescribed by the competent authorities.

3.2 Obligation to Regulate Annual Leave under the MLC 2006

Firstly, it should be noted that the provisions on annual leave in the MLC 2006 are also relatively binding. This is because many of the Convention's provisions allow seafarers to be granted more favourable rights under national law than those provided for in the Convention. The obligation of Member States to make arrangements for the use of annual leave is contained in Standard A2.4. Accordingly, each Member State is required to adopt national legislation laying down minimum standards for annual leave, taking into account the special leave needs of seafarers.

3.3 Calculation and Utilisation of Annual Leave in accordance with MLC 2006

In accordance with Standard A2.4, leave entitlement is calculated on the basis of a minimum of 2.5 days for each month worked, without prejudice to the provisions of collective agreements and legislation which are more favourable to seafarers.

The rules to be followed by Member States in calculating periods of annual leave are set out in Directive B2.4.1. In accordance with the relevant provisions of the Convention, seafarers are entitled to annual leave in proportion to their length of service. Seafarers employed for less than one year or whose employment is terminated should be granted annual leave or annual leave allowance in proportion to their length of service. In addition, the seafarer's service performed outside the service contract should be considered as part of the seniority period for the purpose of entitlement to annual leave. Again, in accordance with regulation B2.4.1, the seafarer's holidays and other leave days which are intertwined with the annual leave period shall not be counted in the annual leave period.

In the MLC 2006, there is no requirement for payment of wages for unused annual leave to the seafarer, irrespective of the reason for termination of the contract. It follows from Directive B2.4.1 that, in all cases of termination of the seafarer's employment, wages for unused annual leave must be paid to the seafarer or his beneficiaries.

In accordance with regulation B2.4.2, seafarers should not be compelled to take their annual leave elsewhere than where they are required to take it. However, if seafarers are required to take their annual leave elsewhere, the employer should bear the transport and other costs involved.

Again, in accordance with Directive B2.4.2, the time for taking annual leave cannot be determined unilaterally by the employer. Unless otherwise determined in accordance with national law, the time for taking annual leave should be determined in consultation with the seafarer and by agreement with the seafarer or his representative.

3.4 Splitting and consolidating annual leave under the MLC 2006

The Convention emphasises that annual leave should be taken as undivided as possible in order to ensure that it is a period of complete rest in accordance with its purpose. Guideline B2.4.3 states that annual leave must be taken undivided unless otherwise provided for in another agreement binding on the employer.

3.5 Periods of leave for young seafarers in accordance with the MLC, 2006

Directive B2.4.4 requires Member States to ensure that young seafarers under the age of 18 take longer periods of annual leave. Member States should also ensure that young seafarers have free transport to their place of residence when taking leave (Baskan 2024).

4. Conclusion

It is noted that Turkish national legislation is inadequate with regard to seafarers' annual leave rights, as is the case with many issues related to maritime labour law. The root of the problem lies in the fact that the Maritime Labour Law No. 854 of 1967 has hardly been amended and revised since its enactment. In the meantime, there have been rapid changes and developments in the maritime labour sector worldwide, but Turkish national legislation has lagged far behind. The MLC 2006, as in many other areas, contains rights and provisions that are far ahead of the MLC in relation to seafarers' rights to paid annual leave, which is the subject of our study.

Although Law No. 6898 on the ratification of the MLC 2006 in terms of Turkish law has been published in the Official Gazette, the process of implementing the Convention in terms of our domestic law has not yet been completed. Another problem in this regard is that Law No. 6898 ratified the first version of the MLC 2006. However, since its entry into force in 2013, the Convention has been amended three times, in 2014, 2016 and 2018. Therefore, the Convention is now referred to as the "Maritime Labour Convention, 2006, as amended". The 2020 amendment is expected to enter into force in December 2024. Article 15/12 of the Convention states that "After the entry into force of an amendment, the Convention may be ratified only in its amended form". Based on this provision, in order to complete the ratification process of the MLC 2006 for Turkey, the ratification law needs to be revised. However, the fact that the ratification process of the Convention has not yet been completed does not relieve the operators of ships flying the Turkish flag of their liability.

It is important to complete as soon as possible the ratification process of the MLC 2006, which provides much more favourable rights for seafarers than the Maritime Labour Law. Immediately thereafter, the provisions of the Convention should be transposed into national law and Turkish national legislation harmonised with the Convention. As a first step, the Maritime Labour Law No. 854 should be revised in line with the MLC 2006 as soon as possible.

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A COMPARATIVE EVALUATION OF AIS-DATA DRIVEN SEQ2SEQ LSTM WITH LUONG ATTENTIONS FOR SHIP TRAJECTORY PREDICTION

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Abstract: Ship trajectory prediction plays a crucial role in maritime applications, enabling effective route planning, collision avoidance, and operational decision-making. On the last decade, the growing availability of Automatic Identification System (AIS) data has opened new opportunities for accurate vessel trajectory prediction. The main aim of this study is to present AIS-based Seq2Seq LSTM models developed with attention mechanisms for ship trajectory prediction and to compare their predictive performance across varying numbers of timestamped points of AIS time series data. Experimental results show that the model with three historical time points achieved the lowest mean distance error, with an average distance error on the test dataset of 0.1357 nautical miles.

Keywords: ship trajectory prediction; automatic identification system data; long-short term memory

1. Introduction

The increase in maritime transportation increases the risk of collisions at sea and environmental threats, making the need for an effective vessel traffic management system (VTS) critical. A VTS aims to monitor and manage vessels in ports, in harbors or in waterways, beside optimizing the flow of maritime traffic as a vital part of the global supply chain [1]. A real-time monitoring of vessel movement requires both hardware and software components to be included in a VTS, where the software and hardware components of a VTS determine the quality and amount of the data is transmitted and processed, respectively. While advancements in the field of communication technologies increase data bandwidth, the advancement in the field of information and artificial intelligence technologies make VTSs more than just an environment to share, store and visualize the data, they become data-driven analysis tool, paving the way for self-driving vessels [2].

With promising results from recent studies in the literature that use artificial intelligent techniques in ship trajectory prediction research, AI-based methods have demonstrated superiority over traditional kinematic equation-based prediction methods, which had to take into account a large number of external random and uncertain environmental factors, such as water flow, wind, etc.

Several machine learning and deep learning methods have been employed in the field of AI-based ship trajectory prediction. Recent research compared the long-short term memory (LSTM) algorithm with back-propagation algorithm [3-6]. A proposed Seq2Seq-based real-time ship AIS trajectory prediction model has been tested against the LSTM-RNN and Gated Recurrent Unit (GRU)-RNN [7]. Gao et al proposed a multi-step prediction model based on LSTM algorithm with a high prediction accuracy [8]. Wang et al. attempt to combine GAT and LSTM to obtain the spatio-temporal features of ship sequence data in terms of ship trajectory prediction [9]. No matter which AI algorithm is used, AI-based solutions need a large amount of historical trajectory data thanks to the increased accessibility of Automatic Identification System (AIS) data over the past decade, which provides both information about the vessels like Maritime Mobile Service Identity (MMSI), ship type and its dimensions; and time-point dynamic information like location, speed over ground (SOG) and course over ground (COG).

When developing systems based on historical data for predictive modeling, it is necessary to mention about the trade-off between the length of historical data needed for accurate predictions and the ability to make real-time predictions on new data. Longer historical data trajectory sequences provide more comprehensive data and patterns, on the other hand, it increases computational complexity in training phase of the model development, and it may cause delay in real-time predictions on new data. It is a challenging era in AI-based ship trajectory prediction that less sacrifice in predictive accuracy with given higher priority to satisfy real-time condition. This balance is critical to ensuring operational efficiency and safety while leveraging the insights gained from historical data to inform timely decision-making.

This research project aimed to investigate the impact of the length of historical trajectories on the accuracy of an LSTM with Luong Attentions based ship trajectory prediction model. To evaluate this, a series of experiments was conducted using prediction models with identical configurations and training parameters, differing only in the number of time points in the historical trajectory training data.

The rest of the article is organized as follows: the dataset used in the presented study is described in the following section, then data preprocessing data techniques and experimental setup of the study is detailed in third section. Experimental results have been given in results and discussion section and final remarks have been denoted in the last section.

2. Dataset

This section introduces the dataset used in the presented study, consisting historical trajectories collected from various vessels, encompassing information such as timestamps, geographical coordinates, speed, and heading. The following subsections describe the data collection process, preprocessing steps, and the characteristics of the dataset that make it suitable for the presented research work

2.1. AIS Data Sources and Raw AIS Dataset

Marine Cadastre is known for its comprehensive repository of marine data, providing access to AIS messages from ships transiting global waterways. These AIS messages provide valuable insight into maritime activities by containing important information. The dataset is obtained in CSV (Comma-Separated Values) format. Data for each day is provided as a separate CSV file, where each record is a comma-separated list of attributes such as the ship's identity, location, speed, course and timestamp. In this study, the freely accessible historical real-world Automatic Identification System (AIS) raw messages are obtained from international data provider Marine Cadastre.

As it is widely known that vessel traffic in rivers and offshore areas differs due to factors like narrow channels in rivers and varied conditions offshore. Rivers require precise navigation due to tight spaces, currents, and changing water levels, accommodating diverse vessel types and high traffic density, especially in urban areas. International regulations and safety standards for both river and offshore traffic emphasize the importance of effective navigation and safety management, including autonomous navigation.

The Mississippi River, one of North America's longest and most economically significant waterways, presents a unique set of vessel traffic properties. In this study, a historical raw AIS time-stamped dataset was obtained from the international data provider Marine Cadastre, limited to the Mississippi River area during January 2020, within specific geographical coordinates (-91.7 to -91.2 degrees longitude and 30.5 to 31.5 degrees latitude). The data selection process involves applying exclusion criteria, which include filtering out vessels not categorized as "Under way using its engine" (status value zero) and excluding entries with invalid heading and Course Over Ground (COG) properties in degrees.

2.2. Transforming Raw AIS Dataset for Time Series Forecasting

The transformation procedure begins by grouping raw AIS data entries with the same vessel number together and sorting them in ascending order based on their timestamp. Each of these grouped sequences is referred to as a 'ship trajectory'. Further steps are applied to eliminate incomplete or invalid vessel trajectories. The nautical distances between each neighboring time points of a trajectory were calculated in nautical miles based on their longitude and latitude coordinates using 'distance' and 'deg2nm' functions of MATLAB®. Then, any trajectory with a total navigation distance of less than 10 nautical miles or any trajectory having at least one pair of neighboring time points with a sea distance of more than 5 nautical miles are eliminated from the ship trajectory dataset. A total of 460 ship trajectories was extracted from the raw AIS data with a mean distance and standard deviation of 34 nm and 20 nm, respectively. The collection of these '*Ship Trajectories (T)*' called in this paper as '*Ship Trajectory Dataset (TD)*'. A single ship trajectory is a sequence of '*Timestamped Points (P)*'. A particular time point (P_i^k) is indicated by two parameters, *k* and *i*, where the *k-value* specifies the ship trajectory to which it belongs, and the *i-value* indicates the time point of the relevant ship trajectory, stated in the following equation:

$$P_i^k = (lon_i^k, lat_i^k, cog_i^k, sog_i^k, t_i^k)\ , \tag{1}$$

where *lon*, *lat*, *cog*, *sog* and *t* stands for longitude, latitude, speed over ground, heading over ground and time, respectively. Then, a particular ship trajectory (T^k) is denoted in terms of time points as:

$$T^k = \{P_i^k \mid i = 1,2,..,m\}\ , \tag{2}$$

where *m* is the number of timestamped points in the trajectory. Finally, a dataset containing *n* number of trajectory is a set denoted as:

$$TD = \{T^k \mid k = 1,2,..,n\}\ , \tag{3}$$

Figure 1 shows some of the sampled ship trajectories (*n* = 460) overlaid on the relevant map region, with each trajectory represented by a distinct color.

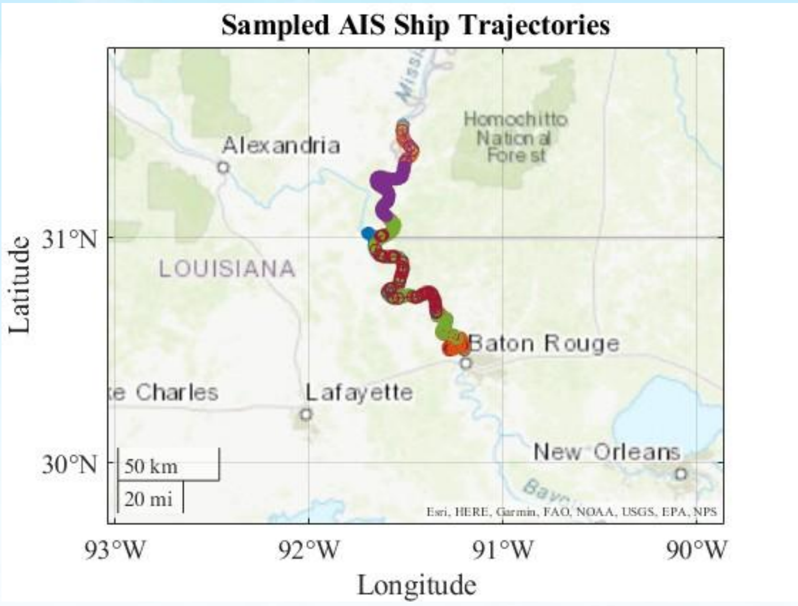

Figure 1. Ship trajectories sampled for the dataset.

After extracting AIS ship trajectories from the raw dataset, a sliding window technique was applied to each trajectory to transform it into a set of supervised trajectory segments consisting of six historical time points. When extracting trajectory segments from a single AIS ship trajectory, the following criteria have been taken into account: the time difference between adjacent time points must be within the range of 0.8 to 1.2 minutes, and any two trajectory segments of the same AIS ship trajectory must not overlap. Thus, a total of 10,757 trajectory segments were extracted for the training and test phases of the prediction model development. In this study, a supervised trajectory segment is referred to as a 'tuple', and the collection of those tuples is referred to as 'the dataset'.

Figure 2 illustrates a single tuple in the transformed dataset. The illustrated tuple belongs to the kth AIS ship trajectory, which starts from the i^{th} time point of the trajectory. In this study, the last time point was reserved as the target, and the first time point has been used in normalization procedure, which is explained in the following section of this document. The remaining four time points have been used to feed the LSTM model as input in the training phase, where the last time point is the output of the model.

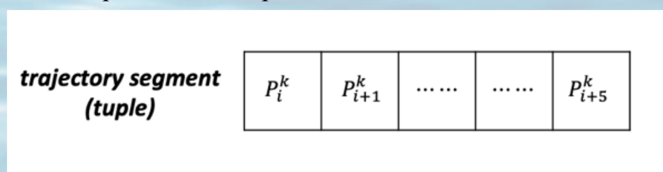

Figure 2. Illustration to a tuple belongs to the k^{th} AIS ship trajectory.

Further, the historical and target time points of a tuple are overlaid on a map that are marked with green and red lines respectively, where green line represent past tense and red line represent future tense (Figure 3).

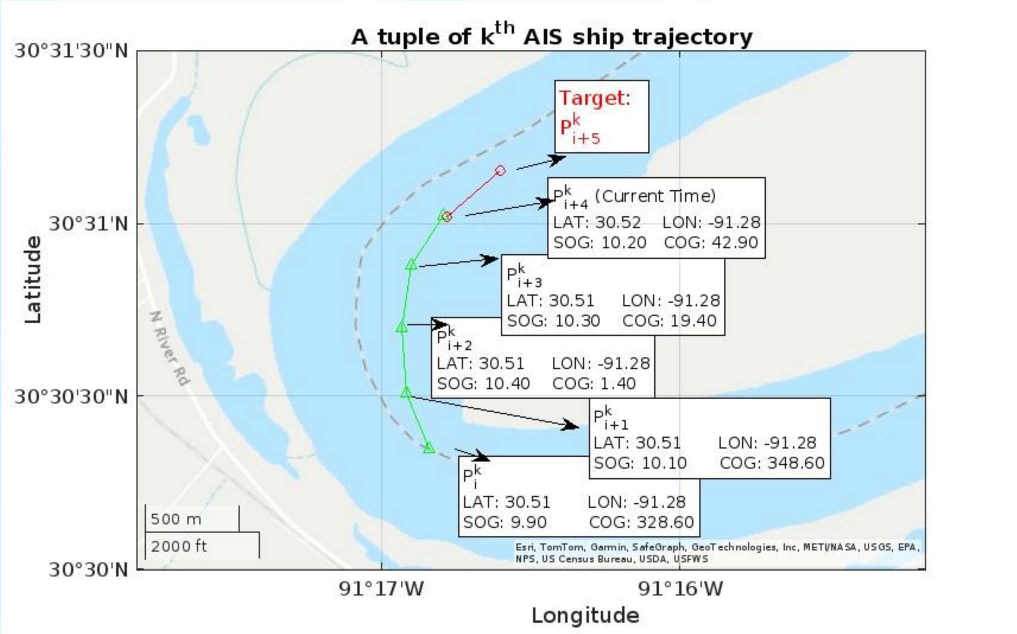

Figure 3. A tuple of the k^{th} AIS ship trajectory, starting from the i^{th} time point, overlaid on a map.

Finally, the dataset has been prepared for the training phase of the predictive model. The normalization procedure is applied on all four features of the dataset to ensure consistent feature scales, aid faster convergence in training, and improve the model's ability to generalize. The speed over ground and heading over ground data were normalized using max-min normalization method as:

$$X_{norm} = \frac{X - X_{min}}{X_{max} - X_{min}}, \quad (4)$$

where X denotes the original data to be normalized (SOG or COG), X_{max} and X_{min} denotes the maximum and the minimum value found in the trajectory segment dataset respectively. Then X_{norm} stands for the normalized data that replace the original data X in the dataset. The X_{max} and X_{min} values were kept for denormalization in order to calculate the exact longitude and latitude that are predicted by the model.

In time series data, the displacement (changes in position over time) is often more crucial than the absolute numerical values of longitude and latitude. Therefore, the normalization procedure for such data involves replacing the original longitude and latitude values with the changes in longitude and latitude between consecutive time points within the same tuple. The original longitude and latitude values of the first time points have been kept for denormalization to calculate the exact locations in the test phase of the predictive model.

3. Experimental Design and Assessment Methods

This research project aimed to investigate the impact of the length of historical time points on the accuracy of an LSTM-based ship trajectory prediction model. To evaluate this, an experiment was conducted by training three different prediction models with identical configurations and training parameters, but differing only in the number of historical time points (n_t) included from the historical segment used for training the models. For a fair comparison, the historical trajectory has been determined by going back different numbers of time points, with the current time being the last time point of the historical segment, as illustrated in Figure 4. The main goal of the prediction model is to predict the last time point of the tuple, where the time difference between the target tie point and the current time is within the range of 0.8 to 1.2 minutes. In other words, the experiment is conducted to answer the question of how much historical information is needed for better prediction of where the ship will be after 1±0.2 minutes.

The assessment procedure in this study involves the calculation and analysis of quantitative metrics. First, the dataset has been divided into train set and test set according to the ratio of 8:2 to compare the performances of the models based on the same test dataset. Thus, of 2151 tuples have been reserved for the test, while the remaining 8606 tuples were used to train the models. The predictions made by models trained on the same training data for the same test set were recorded, resulting in a paired dataset that allows for the application of paired statistical methods. The great-circle distance for each pair of actual and predicted geographical locations is calculated in nautical miles with the haversine method as:

$$a = \sin^2\left(\frac{\Delta lat}{2}\right) + \cos(lat_1).\cos(lat_2).\sin^2\left(\frac{\Delta lon}{2}\right), \quad (4)$$

$$c = 2.\operatorname{atan2}\left(\sqrt{a}, \sqrt{1-a}\right), \quad (5)$$

$$d = R.c.k, \quad (6)$$

where lat_1 and lat_2 are the latitudes of two points, lon_1 and lon_2 are the longitudes of two points, R is the radius of the Earth and *atan2* is a function that computes the arctangent of the ratio of its two arguments, taking into account the signs of both to determine the correct quadrant of the angle. Finally, d denotes the distance in nautical miles, where k is a constant used to convert miles into nautical miles. The absolute value of this distance (d) is called Distance Error (DE), which is the main quantitative metric used in this study.

The quantitative analysis based on DE consists of generating histograms for each predictive model based on DE, applying a repeated measures ANOVA and pairwise t-tests to assess differences in model predictive performance.

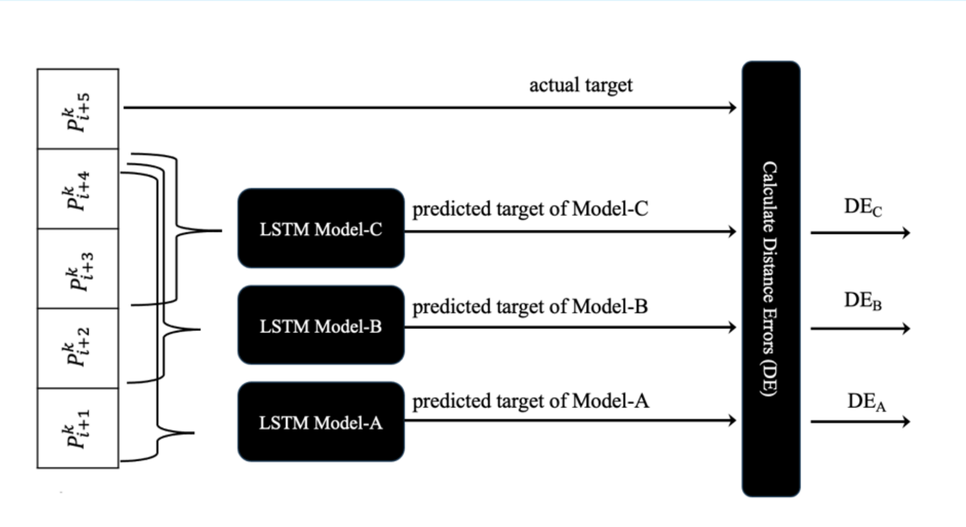

Figure 4. Illustration to the use of a tuple in training and testing the models.

The three LSTM models were implemented in MATLAB, utilizing a custom learning loop that employed MATLAB®'s implementation of the adaptive moment estimation (Adam) algorithm via the 'adamupdate' function. The hyperparameters are listed in Table 1.

Table 1. Hyperparameter settings in training of LSTM models.

Parameter	Value
Epoch	30
Batch size	500
Initial learning rate	10^{-3}
Gradient decay factor	$9\text{x}10^{-4}$
Dropout	0.01
Number of hidden units	128

3. Results and Discussion

The dataset contains 10757 tuples extracted from 460 AIS ship trajectories. Approximately, 23.38 numbers of tuples extracted per AIS ship trajectory. Each trajectory consists of an average of 4,523.15 time points, with a standard deviation of 2,059.51 time points. The following table summarizes various descriptive statistics of the AIS ship trajectories and the tuples (Table 2).

Table 2. Statistics of the AIS ship trajectories.

	avg±std[min-max]
The length of the trajectories (in nm)	35.7±20.78[10.12-105.14]
The length of the trajectories (in minutes)	545.31±214.27[79.5-1,439.52]
The average SOG of the tuples	5.32±2.25[0.13-14.3]
The average COG of the tuples	183.55±41.44[4.8-328.18]
The SOG over all tuples	5.53±2.72[0.1-15.6]
The COG over all tuples	186.10±110.01[0-359]
The number of tuples per trajectory	23.38±15.71[1-74]
The number of time points per trajectory	4,523.15±2,059.51[510-10,948]

Figure 4 shows histograms of distance errors on the test dataset produced by the predictive models with experimental parameter (n_t) set to four, three and two, separately. The descriptive statistics of the distance errors are calculated for each predictive model and presented in Table 3.

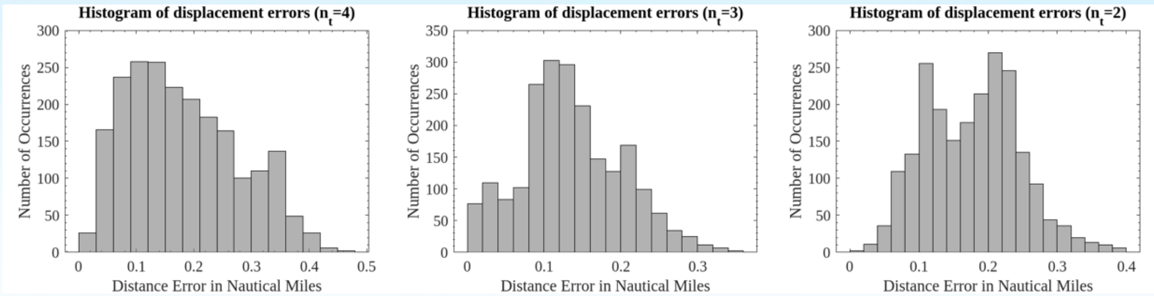

Figure 1. Ship trajectories sampled for the dataset.

Table 3. Distance errors on the test dataset (n=2151).

Statistical metrics of DE	Model-A (n_t=4)	Model-B (n_t=3)	Model-C (n_t=2)
Mean	0.1815	0.1357	0.1771
Standard Deviation	0.0970	0.0658	0.0680
Range in [Min-Max]	[0.0051-0.4651]	[0.00073567-0.3505]	[0.0177-0.3999]

The repeated measures ANOVA test results revealed a statistically significant difference in the mean distance error across the three types of predictive models. The results were highly significant, F(2, 4300) = 554,63, p<0.0001. Since the model with the lowest mean distance error is favored, indicating it provides the most accurate predictions among the three types of predictive models, further pairwise comparisons using paired t-tests were conducted. Specifically, two pairwise comparisons between the favored Model B and the other two models were performed with a Bonferroni correction (α = 0.001/2). Extremely statistically significant differences were reported in the mean difference between Model-A and Model-B (t=-30.91, df=2150) and in the mean difference between Model-C and Model-B (t=-32.45, df=2150).

Figure 5 shows the training curve of Model B. The 'loss' represents the numerical difference between the normalized values of the longitude and latitudes. A total of 540 iterations across 30 epochs took 5 minutes and 41 seconds. The gradually decreasing learning rate was finalized at approximately 0.00067. The gradually decreasing with a few peaks learning curve indicates a healthy training process and suggests that the model is converging. The peaks in the learning curve gradually disappeared, indicating that the learning rate and other hyperparameters are well-tuned.

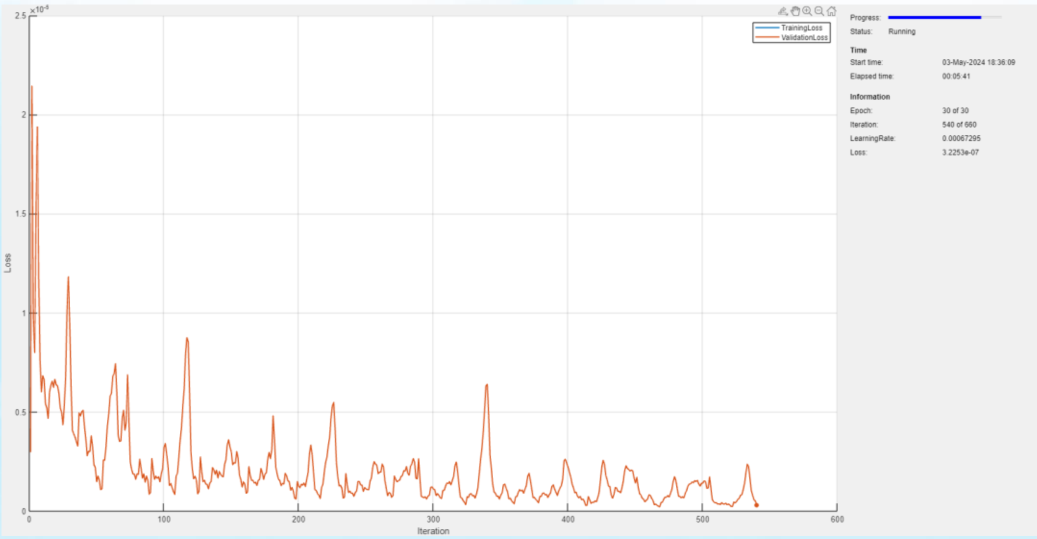

Figure 5. Training curve of Model-B

5. Conclusion

In this study, the efficacy of AIS-based LSTM models for ship trajectory prediction was investigated. A series of experiments with varying numbers of historical time points was conducted to determine an optimal number of historical time points that improves the predictive accuracy of LSTM models. Presented results show that the model with three historical time points achieved the lowest mean distance error, indicating its superior performance compared to other configurations. This research highlights the importance of selecting the optimal length of historical data in enhancing the predictive capabilities of LSTM models for maritime applications. Future work may explore the integration of additional contextual information and the application of these models to other maritime regions and conditions to further validate and enhance their robustness and generalizability.

Acknowledgements

This study is part of the project entitled as ‘Evaluation of Recurrent Neural Network Architectures Containing Attention Mechanism for Ship Navigation Prediction’ (STB Project Code: 089300), supported by Piri Reis University.

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QUANTITATIVE ANALYSIS OF OIL RECORD BOOK DEFICIENCIES: INSIGHTS FROM THE PARIS MOU DATABASE VIA THE ANALYTIC HIERARCHY PROCESS

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Abstract: The Oil Record Book (ORB) is a mandatory document to be filled in accordance with MARPOL 73/78 regulations, which records the activities related to the machinery space and cargo/ballast operations carried out on board ships. This document addresses critical operational processes such as the collection, transfer, and disposal of oil residues, as well as ballasting or the cleaning of oil fuel tanks, which are essential for marine safety and the environment. Furthermore, the Oil Record Book plays a vital part in regular ship inspections conducted by different maritime entities, such as flag states, port states, classification societies, and vetting or insurance companies. Examination of the Port State Control (PSC) deficiency statistics spanning from 2020 to February 2024 in the Paris Memorandum of Understanding (Paris MoU) database indicated that issues linked to the Oil Record Book are included in the top 20 deficiencies. Based on this observation, the objective of this paper is to identify the factors that result in deficiencies related to the Oil Record Book using the Analytic Hierarchy Process (AHP), a widely used multi-criteria decision-making method for determining the weights of criteria and priorities of alternatives in a structured manner. The paper concludes with findings, suggestions, and countermeasures to reduce the number of Oil Record Book deficiencies in PSC inspections.

Keywords: Oil Record Book; PSC; Paris MoU; AHP

1. Introduction

Maritime transportation is a vital component of the global economy and trade. It provides a secure, environmentally sustainable, energy-efficient, and cost-effective mode of transportation, making it a preferred choice over other commercial transportation options (Yan et al. 2022, Jiang and Lu 2020). However, the complexity of the maritime industry renders it challenging to analyze, understand and predict its functions, behavior and performance (Stopford 2008). One of the most significant concerns within this industry is the concept of safety, which encompasses the measures, regulations and practices designed to ensure the safety of lives, vessels and cargoes at sea. In order to enhance maritime safety, the International Maritime Organization (IMO) has implemented a set of rules and regulations such as the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL). It is a fact that these regulations are essential for the prevention of marine incidents, which can result in significant loss of life and environmental damage (Akyuz 2017). A ship is deemed substandard if its hull, machinery, crew, equipment, or operational safety and the protection of the environment are found to be significantly below the standards set forth in these conventions and regulations (IMO 2023).

Port State Control (PSC) represents a crucial element in the effort to ensure maritime safety. The current framework for PSC can be traced back to a memorandum of understanding signed in The Hague between eight North Sea states in 1978 (Cariou et al. 2008). The main function of the PSC authority is to monitor the safety and environmental compliance of foreign vessels within the boundaries of national ports. Rigorous inspections are carried out to ensure that each vessel complies with the standards and regulations set by the international maritime authorities. In the event of an identified deficiency, the vessel may be detained until the necessary corrections are rectified (Heij et al. 2011). In order to conduct efficient and uniform PSC inspection procedures, regional Memoranda of Understanding (MoU) are established, which require the members to cooperate with one another and to harmonise their activities. Currently, ten MoU regimes regulate the identification of substandard ships in 116 countries and regions globally (Xiao et al. 2021).

The Paris Memorandum of Understanding (Paris MoU), which was adopted in January 1982, constituted the inaugural instance of regionally-based, regular and systematic ship inspections. Consequently, the Paris MoU has served as a model for the establishment of memorandum of understanding structures on PSC in other parts of the world (Ozcayır, 2008).

In accordance with the Annex I of MARPOL 73/78, the Oil Record Book (ORB) is a mandatory document that must be provided and clearly and accurately recorded for every oil tanker of 150 gross tonnage and above, as well as for every ship of 400 gross tonnage and above that is not an oil tanker. The ORB is divided into two distinct sections: Part I, which is dedicated to machinery space operations, and Part II, which is allocated to cargo and ballast operations for oil tankers. The ORB plays an important role in environmental protection by ensuring that ships comply with appropriate procedures for the handling of oil and oily residues. It serves as a tool for monitoring compliance with anti-pollution regulations, the deterrence of illegal discharges, and the facilitation of inspections by Port State Control Officers (PSCO) (INTERTANKO 2021). A review of PSC deficiency statistics from 2020 to February 2024 in the Paris MoU database revealed that issues related to the Oil Record Book are among the top 20 deficiencies (Paris MoU 2023).

In the light of above, this study aims to identify and weigh the factors that lead to ORB violations in PSC inspections and to narrow the literature gap by adopting the Analytic Hierarchy Process (AHP), a widely used multi-criteria decision-making method. This paper is divided into four chapters. The motivation of study and a brief introduction regarding maritime safety, PSC regime and ORB are presented in this chapter. The second chapter introduces the methodology. The application of the methodology and the results are provided in chapter three. The final section gives a conclusion and contribution of the study.

2. Methodology

This section presents a step-by-step explanation of the AHP method for evaluating the ORB deficiencies.

2.1. Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a widely utilized tool in the field of multi-criteria decision making (MCDM) (Saaty 1994). This approach, developed initially for military applications by Thomas L. Saaty (1980), enables the decision-maker to structure problems in a hierarchical manner, with the aim, criteria, sub-criteria and alternatives.

In general, AHP consists of three basic elements: decomposition, comparative judgment and synthesis (Kibria et al. 2024). It provides the prioritization of alternatives by decomposing a decision into a hierarchical structure of criteria and sub-criteria, and then employing a systematic comparison of alternatives against these criteria. AHP is a widely used method due to its straightforward implementation of multiple objective programming formulations through an interactive solution process. The method is founded upon the pairwise comparison of criteria and alternatives by experts (Yu et al. 2021).

The Analytic Hierarchy Process (AHP) is a technique for organizing and analyzing complex decisions, based on pairwise comparison matrices and expert opinions. The main steps of the AHP method are listed below (Kibria et al. 2024, Saaty 2008, Velmurugan et al. 2011)

Step 1. Define the problem and determine the goal

It is essential to clearly articulate the problem and to determine the overall goal of the decision-making process.

Step 2. Develop hierarchical framework

The problem should be decomposed into a hierarchy of sub-problems, each of which can be analyzed independently. The hierarchy typically has three levels:

- The top level represents the overall goal.
- The middle level(s) represent criteria or sub-criteria.
- The bottom level consists of the alternatives to be evaluated.

Step 3. Generate pairwise comparison matrices and perform pairwise comparisons to determine the relative priority of each element

In the pairwise comparison matrix (Eq. 1), rows indicate ratios of weights for each factor with respect to all other factors. Consequently, the pairwise comparison value a_{ij} represents the ratio of the weights w_i and w_j of the two alternatives, i and j

$$A = (a_{ij}) = \begin{bmatrix} 1 & w1/w2 & \dots & w1/wn \\ w2/w1 & 1 & \dots & w2/wn \\ \vdots & \vdots & \vdots & \vdots \\ wn/w1 & w & \dots & 1 \end{bmatrix} \quad (1)$$

In the context of the matrix, when the indices i and j are equal, the element aij is equal to 1, which represents the main diagonal elements of matrix A. As indicated in Table 1., the wi value can vary between 1 and 9 (Saaty 1980).

Table 1. Saaty's scale for pairwise comparisons.

Relative Intensity	Definition	Explanation
1	Equal important	Two requirements are of equal value for the expert.
3	Moderately important	The expert has a slight preference for one requirement over another.
5	Strongly important	The expert strongly prefers one requirement over another.
7	Very strongly important	A requirement is strongly favored, and its dominance is evident in practice.
9	Extremely important	The evidence favoring one over another is of the highest possible order of affirmation.
2, 4, 6, 8	Intermediate values between the preferences	In instances where a compromise is required.

Step 4. Calculate eigenvectors (priority vectors) / weights

The relative weights (priority vector) for each element should be derived by normalizing the eigenvector corresponding to the largest eigenvalue of each pairwise comparison matrix.

Step 5. Ensure the consistency of the judgments by calculating the Consistency Ratio (CR).

In the final stage of the process, the data received from the experts must be subjected to a series of checks including the values of the Consistency Index (CI) (Eq. 2), Consistency Ratio (CR) (Eq. 3) and Random Index (RI) (Table 2.) (Saaty and Vargas 2012).

$$CI = \frac{\lambda_{max.} - n}{n-1} \quad (2)$$

$$CR = \frac{CI}{RI} \quad (3)$$

Table 2. Random index values.

Size of matrix (n)	1	2	3	4	5	6	7	8	9	10	11	12
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.58

2.2. Data Acquisition and Determination of Criteria

The present study employs the AHP method to identify the principal factors influencing ORB deficiencies and to devise novel strategies to diminish the prevalence of these deficiencies in PSC inspections. AHP recommends that, in order to make pairwise comparisons, it is first necessary to identify the experts involved. This will enable us to gain a clear understanding of the current state of knowledge regarding the criteria. In this study, eight experts were selected to evaluate the criteria according to the AHP technique. The expert profiles include six port state control officers and two flag state surveyors who have extensive experience in ship inspections in accordance with national and international conventions.

Secondly, six criteria are identified through a process of expert consultation, an extensive literature review on the subject, and the analysis of Paris MoU reports and case studies. Table 3. presents the criteria associated with ORB deficiencies.

Table 3. Criteria for ORB deficiencies.

No	Evaluation Criteria	Definition
C1	Negligence	Crew members may neglect to properly record oil-related operations or discharges in the oil logbook due to lack of oversight or lack of awareness of the importance of accurate documentation.
C2	Misunderstanding Regulations	Crew members may misunderstand the regulations regarding what should be recorded in the oil record book, leading to incomplete or inaccurate entries.
C3	Intentional Non-Compliance	In some cases, crew members may intentionally omit or falsify entries in the oil record book to conceal illegal or unauthorized activities, either to save time or to avoid penalties.
C4	Lack of Training	Crew members who are not adequately trained in proper record-keeping procedures may inadvertently make errors or omissions in the oil record book.
C5	Language Barriers & Miscommunication	On international vessels, language barriers and miscommunication between crew members may result in inaccuracies or omissions in the oil record book.
C6	Pressure to Meet Deadlines / High Workload	Crew members may not carry out operational processes and proper record-keeping in the same time period due to mental and physical factors triggered by workload and deadline pressures leading to incomplete or rushed entries in the oil record book.

3. Application of AHP Method for ORB Deficiencies

This section presents a systematic analysis of the factors that cause ORB deficiencies, employing the AHP method.

Step 1. Define the problem and determine the goal

The research question or the problem of this study is to identify the factors leading to PSC deficiencies related to the ORB. As previously stated in the introduction, ORB deficiencies are consistently included in the top 20 deficiencies list in the Paris MoU database. However, there is no comprehensive study in the literature describing these deficiencies. Accordingly, the objective of this study is to identify the primary factors contributing to ORB deficiencies in PSC inspections and to develop strategies to mitigate the prevalence of these factors.

Step 2. Develop hierarchical framework

The most significant factors contributing to ORB deficiencies are presented in Table 3. The study does not include any sub-criteria. The criteria are identified through a process of consultation with experts, an extensive review of the relevant literature, and the analysis of reports and case studies produced by the Paris MoU.

Step 3. Generate pairwise comparison matrices and perform pairwise comparisons to determine the relative priority of each element

Eight experts, comprising port state control officers and flag state control surveyors, employed a nine-point comparison scale to evaluate the relative priority of each criterion. The results of the pair-wise comparisons of the criteria conducted by the eight experts are presented in Table 4. and Table 5.

Table 4. Pairwise comparison matrix and data from experts.

Compared Criteria	EXP 1	EXP 2	EXP 3	EXP 4	EXP 5	EXP 6	EXP 7	EXP 8	Average
C1/C2	0.33	0.25	0.50	0.20	0.33	0.25	0.33	1.00	0.40
C1/C3	0.17	0.14	0.17	0.13	1.00	0.20	0.25	0.50	0.32
C1/C4	0.50	0.25	0.33	0.25	0.50	0.20	0.33	0.33	0.34
C1/C5	6.00	5.00	5.00	7.00	5.00	4.00	5.00	3.00	5.00
C1/C6	4.00	5.00	4.00	6.00	3.00	3.00	4.00	3.00	4.00
C2/C3	0.33	0.20	0.33	0.25	0.50	0.33	1.00	2.00	0.62

Table 4. Pairwise comparison matrix and data from experts. (cont')

Compared Criteria	**EXP 1**	**EXP 2**	**EXP 3**	**EXP 4**	**EXP 5**	**EXP 6**	**EXP 7**	**EXP 8**	**Average**
C2/C4	0.50	0.33	0.50	0.33	0.50	1.00	0.33	2.00	0.69
C2/C5	6.00	8.00	7.00	7.00	6.00	4.00	5.00	6.00	6.13
C2/C6	5.00	6.00	5.00	7.00	4.00	3.00	3.00	6.00	4.88
C3/C4	4.00	4.00	2.00	5.00	4.00	3.00	5.00	1.00	3.50
C3/C5	7.00	8.00	6.00	8.00	6.00	4.00	6.00	4.00	6.13
C3/C6	6.00	7.00	5.00	7.00	5.00	4.00	4.00	3.00	5.13
C4/C5	4.00	7.00	5.00	7.00	5.00	4.00	6.00	7.00	5.63
C4/C6	3.00	4.00	4.00	5.00	3.00	3.00	5.00	7.00	4.25
C5/C6	0.33	0.25	0.50	0.33	0.17	1.00	0.33	0.25	0.40

The results of the pairwise comparison of the criteria, which are averaged arithmetically to ascertain the collective opinion of the experts, are presented in Table 5. The values in the same column are aggregated and displayed in the bottom row in preparation for the normalization and weighting process, which will be conducted in step 4.

Table 5. Pairwise comparison of criteria.

Criteria	C1	C2	C3	C4	C5	C6
C1	1.00	0.40	0.32	0.34	5.00	4.00
C2	2.50	1.00	0.62	0.69	6.13	4.88
C3	3.14	1.62	1.00	3.50	6.13	5.13
C4	2.96	1.45	0.29	1.00	5.63	4.25
C5	0.20	0.16	0.16	0.18	1.00	0.40
C6	0.25	0.21	0.20	0.24	2.53	1.00
SUM	10.05	4.84	2.58	5.94	26.40	19.65

Step 4. Calculate eigenvectors (priority vectors) / weights

In order to obtain the weights of the criteria, it is first necessary to normalize all values in the pairwise comparison matrix belonging to the criteria. This is achieved by dividing each value in the same column by the sum of the values in that column. The relative weights (priority vectors) for each criterion are derived by normalizing the eigenvector corresponding to the largest eigenvalue of each pairwise comparison matrix. The results of the normalized pairwise comparisons and the criteria weights are presented in Table 6.

Table 6. Normalized pairwise comparisons and criteria weights.

Criteria	C1	C2	C3	C4	C5	C6	Eigenvector (w)	Criteria Weights %
C1	0.10	0.08	0.12	0.06	0.19	0.20	0.13	13%
C2	0.25	0.21	0.24	0.12	0.23	0.25	0.22	22%
C3	0.31	0.33	0.39	0.59	0.23	0.26	0.35	35%
C4	0.29	0.30	0.11	0.17	0.21	0.22	0.22	22%
C5	0.02	0.03	0.06	0.03	0.04	0.02	0.03	3%
C6	0.02	0.04	0.08	0.04	0.10	0.05	0.05	5%
SUM	1.00	1.00	1.00	1.00	1.00	1.00	1.00	100%

Step 5. Ensure the consistency of the judgments by calculating the Consistency Ratio (CR).

In the final stage, the consistency ratio (CR) of a matrix is identified by first calculating the matrix consistency index (CI) using eq. 2. The Random Index (RI) is calculated using the values provided in Table 2. If the consistency ratio (CR) is less than 0.10, the results of the analysis are considered consistent (Saaty and Vargas 2012). Results of consistency analysis are shown in Table 7. The consistency analysis indicates that the results of all pairwise comparisons in our study are consistent, thereby providing evidence that it is valid to determine the order of importance of criteria for ORB deficiencies.

Table 7. Results of consistency analysis.

Criteria	Eigenvalue (w')	Eigenvector (w)	w' / w	Largest Eigenvalue (λmax)	Consistency Index (CI)	Random Index (RI)	Consistency Ratio (CR)
C1	0.79	0.13	6.26	6.372	0.074	1.24	0.05998
C2	1.37	0.22	6.39				
C3	2.35	0.35	6.65				
C4	1.43	0.22	6.58				
C5	0.21	0.03	6.22				
C6	0.34	0.05	6.14				

3.1. Findings

A detailed examination of Table 6. reveals that the most significant factor (35%) leading to ORB deficiencies is the Intentional Non-Compliance (C3) defined as in certain instances, crew members may intentionally omit or falsify entries in the oil record book to conceal illegal or unauthorized activities, either to save time or to avoid penalties.

On the other hand, the study identified two additional significant factors influencing ORB-related deficiencies: Misunderstanding Regulations (C2) and Lack of Training (C4). The former refers to the potential for crew members to misunderstand the regulations to be recorded in the oil record book. The latter is defined as the possibility that crew members who have not received sufficient training in the correct procedures for maintaining records may also contribute to these deficiencies. The two criteria are in second place as two factors represent equally significant influences (22%) on ORB deficiencies.

Furthermore, the results indicate that factors such as Negligence (C1) (13%), Pressure to Meet Deadlines and High Workload (C6) (5%), and Language Barriers / Miscommunication (C5) (3%) have a comparatively minor impact on ORB deficiencies. The results of the weighting of the criteria for ORB deficiencies are presented in Figure 1.

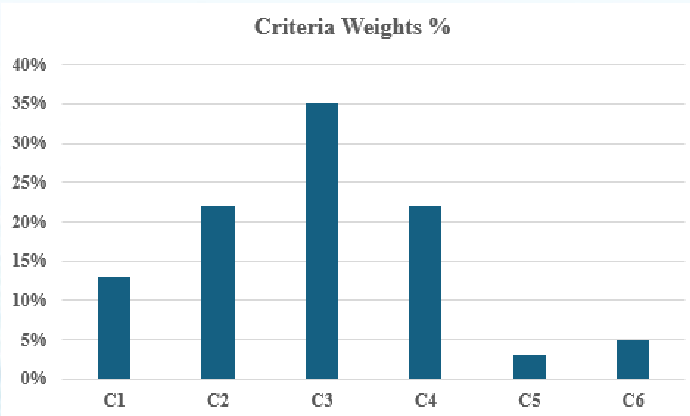

Figure 1. Weights of the criteria for ORB deficiencies.

4. Conclusion

The main objective of this study is to identify the factors that result in ORB deficiencies in PSC inspections from the perspective of port state control officers and flag state surveyors. For this purpose, the criteria identified through expert consultation, a comprehensive literature review on the subject and analysis of Paris MoU reports and case studies were weighted using the AHP method. The results of the AHP indicate that, the primary factors contributing to ORB violations in PSC inspections are identified as Intentional Non-Compliance (C3), Misunderstanding Regulations (C2) and Lack of Training (C4). Conversely, factors exerting relatively lesser influence comprise Negligence (C1), Pressure to Meet Deadlines and High Workload (C6), and Language Barriers/Miscommunication (C5).

In light of the findings, it is proposed that the outputs of this study be linked with the following strategies in order to effectively reduce the prevalence of ORB deficiencies in PSC inspections.

- Developing monitoring systems to support a zero-tolerance policy against deliberate falsification or omission of records and promoting a transparent and ethical working environment that encourage a culture of accountability and responsibility.

- Providing comprehensive training programs focused on regulatory requirements for ORB entries.

- Optimizing operational schedules to allocate adequate time for record-keeping tasks and clarifying responsibilities.

Additionally, this study contributes to the limited academic literature on this subject by determining the importance weights of the factors that cause ORB deficiencies. Future studies may be conducted by associating with other inspection results from the Paris MoU database, thus providing a more comprehensive and detailed safety outputs.

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MODELING CAVITATION IN A VENTURI NOZZLE OF DIFFERENT SIZES: A STUDY IN THE CONTEXT OF SHIP BALLAST WATER TREATMENT

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Abstract: In the present study, a real numerical experiment has been carried out to generate cavitation flow in a Venturi nozzle for three different cases, i.e. for three different Venturi tube constriction sizes. The numerical experiment has been carried out to verify the experimentally obtained results of velocity, pressure, vapor volume fraction characteristics of the cavitation process through a Venturi tube as part of a thesis on "Methods for treating ship ballast water to achieve international standards and requirements for water purity". The motive for carrying out this research study is to validate the experimental data obtained for cavitation with Venturi tubes to contribute to the dual purpose of the above-mentioned thesis, namely: to study, analyses and propose effective methods for the treatment of ship ballast water to meet international standards and requirements for water purity. The project aims to contribute to the improvement of ship ballast water management in line with high standards of marine environmental protection. The numerical experiments presented in this thesis were carried out using the ANSYS solver CFX software package. The Venturi tube geometries were made on SolidWorks numerical software, the dimensions for all three cases of Venturi tubes were selected according to the fabricated such Venturi tubes used for the field experiment conducted using a rig specially designed for the purpose of the above-mentioned analysis. The cavitation modelling was carried out using the CFX solver part of ANSYS. The inlet and outlet pressures obtained from the in-situ experiment were used as boundary conditions at the beginning of each simulation for the thesis. Six simulations are presented in this work for each of the three venturi tubes with different sizes and angles, strong and weak cavitation through the venturi tubes is modelled. On the basis of the numerical results obtained for total pressure, water velocity and steam volume fraction and their comparison with the experimental data, curves describing the convergence of the results and validating the experimental ones with very good accuracy have been produced and the percentage error given by the numerical models with respect to the field experiment carried out has also been calculated for the purpose of the thesis. The numerical results obtained and their comparison with the experimental data contribute to the understanding and optimization of ship ballast water treatment processes by providing accurate tools to measure the error and improve the treatment efficiency.

Keywords: cavitation, simulation, Venturi nozzle, Bernoulli principle, Continuity Equation, mass flow rate

1. Numerical modeling through a venturi tube with different constriction diameters

For the purposes of the dissertation, the numerical studies were carried out using the ANSYS CFX software package and uses the finite element method is used to solve the flow equations of motion. The geometry of the modeled system is divided into small cells (discrete), i.e. a computational grid is created. For each of these cells, the Navier-Stokes partial differential equations can be rewritten in the form of algebraic equations that relate various physical quantities such as temperature, velocity, pressure, mass flow and other variables to the values of the same parameters in neighboring cells. The solution variables (pressure, velocity, flow rate) stop changing significantly between successive iterations (repetitions of the numerical solutions) i.e. reach a stable state (become convergent) during the numerical solution of the equations. ANSYS CFX also allows modeling of transient flows, when the processes in the system change with time, i.e. processes are transient. Such processes involve variable inlet and outlet conditions. Several model tests have been carried out considering different venturi geometries, under different variable inlet and outlet conditions. (Z hou et al. 2022), (Zohaib et a l. 2022), (Vijay, Subrahmanyam 2 014), (Sanghani et al. 2016), (Tamhankar et al. 2014), (Bylar et al. 2009), (Nouri et al 2015).

For venturi tubes, model a is suitable model for use is the " k-ε ", which uses the hypothesis of the dissipation rate due to Reynolds stresses and their effect on the rate of change of the mean velocity and the dissipation rate of the turbulent eddies. Parameter " k " is the turbulent kinetic energy and it is defined as extent of change of velocity fluctuations in dimension m²/s², while "ε" is the dissipation rate of turbulent eddies and is of dimension of "k" per unit time i.e. m²/s³. The model introduces two new variables into the calculation system. Thus, the continuity equation takes the form (Ansys CFX Solver Theory Guide):

continuity equation:

$$\partial p / \partial t + \partial / \partial x_j * (\rho U_j) = 0 \qquad (1)$$

and the momentum equation:

$$\partial \rho U_i / \partial t + \partial / \partial x_j (\rho * U_j * U_i) = -\partial p' / \partial x_j + \partial / \partial x_i * [\mu_{eff} * (\partial U_i / \partial x_j + \partial U_j / \partial x_i)] + W_m \qquad (2)$$

Where: ρ. density of fluid
U_j, U_i vectors of speed along the axes i, j respectively
W_m is the sum of the weight forces.
μ_{eff} is an effective viscosity that accounts for turbulence
p' is the modified pressure and is equal to:

$$p' = p + 2/3 * \rho * \kappa + 2/3 * \mu_{eff} * \partial U_k / \partial x_k \qquad (3)$$

Where: κ is the turbulent kinetic energy per unit mass

The last member $2/3 * \mu_{eff} * \partial U_k / \partial x_k$ the velocity variation (divergence) is determined and for incompressible flows is neglected. For the numerical simulation, a single-phase flow was used - water with the following characteristics, which are assumed to be constant.

Table 1. Parameters of the modeled flow

Size	Value	Measuring units
Temperature	22	°C
Density of water	998	kg/m³
Kinematic viscosity of water	9.10 -7	m²/s
Vapor fraction density	0.02308	kg/m³
Kinematic viscosity of the vapor fraction	4,273.10 -4	m²/s
Saturation pressure	2300	Ra

2. Geometry and computational grid of the objects

The 3D object geometry was prepared in SolidWorks and Ansys for 8 mm Venturi size –diameter of the throat (here in after abbreviated as "8mm"). (Fig. 1, 2). Because of the volume limits of this scientific paper, only two Venturi tube cases are presented (6mm and 8 mm). An 8mm Venturi geometry is shown for convenience.

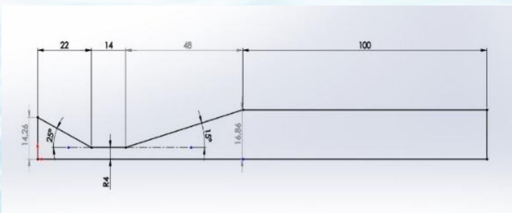


Figure 1. Symmetrical sketch of 8mm. Venturi nozzle SolidWorks

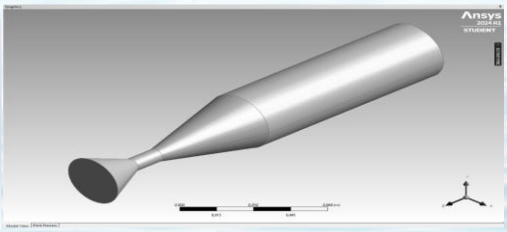


Figure 2. Geometry of 8mm Venturi nozzle in ANSYS

When preparing the mesh, it is used a " MultiZone " meshing method. The mesh interior is made of 146276 hex cells. The number of nodes is 156585. For the mesh quality, the maximum aspect ratio is 2.5236, the orthogonal mesh quality is 0.96221, which is less than 1, i.e. the mesh quality is very good. (Figure 3).

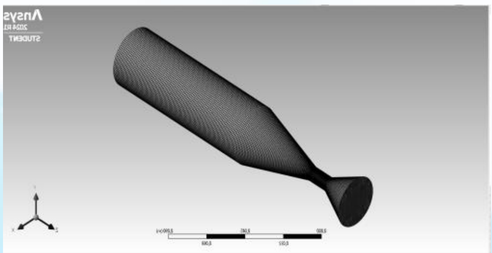


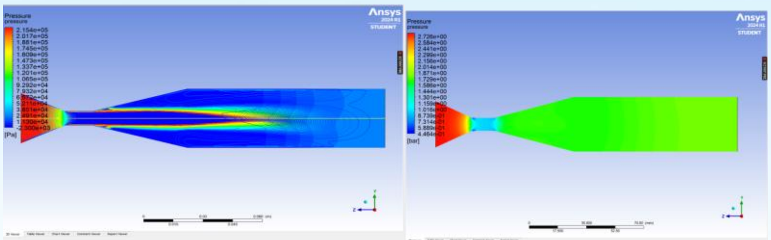
Figure 3. Computational mesh of 8mm Venturi nozzle in ANSYS

3. Results obtained in the modeling

For each Venturi nozzle two simulations were performed - for strong and boundary (weak, vanishing) cavitation. The boundary conditions are chosen so that the inlet pressures remain almost constant, and the outlet pressures change. The profiles of the pressures and the velocities of the flow along the size of the venturi tubes are shown below.

Selection of boundary conditions for a venturi nozzle with a constriction diameter of 8 mm: *first case-strong cavitation:*inlet pressure Pu –220000Pa; outlet pressure Pd –40000Pa; *second case-weak cavitation:* inlet pressure Pu –280000Pa; outlet pressure Pd –180000Pa

The results are shown in pictures and graphs as follows:



a b

Figure 4. Distribution of the pressure field at strong (a) and weak (b) cavitation for 8 mm Venturi

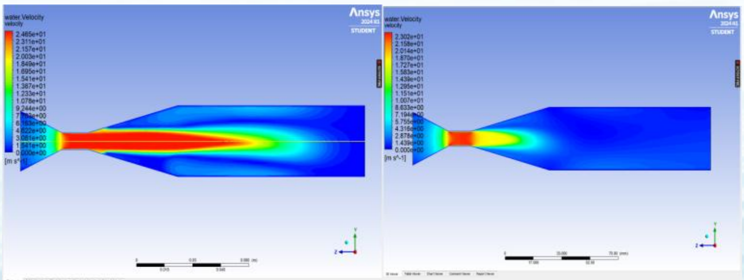


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Figure 5. Distribution of the velocity field at strong (a) and weak (b) cavitation for 8mm Venturi

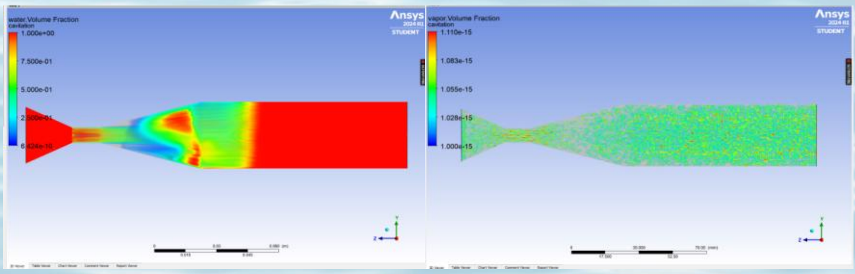

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Figure 6. Distribution of the vapor fraction at strong (a) and weak (b) cavitation for 8mm Venturi

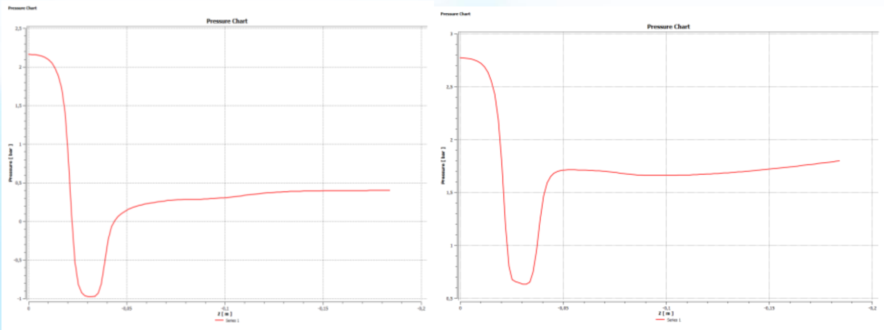

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Figure 7. Plot of the pressure distribution in strong (a) and weak (b) cavitation for 8mm Venturi

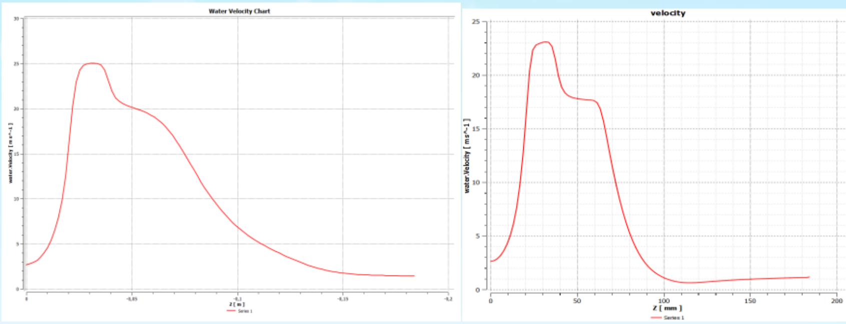

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Figure 8. Plot of the velocity distribution in strong (a) and weak (b) cavitation for 8mm Venturi

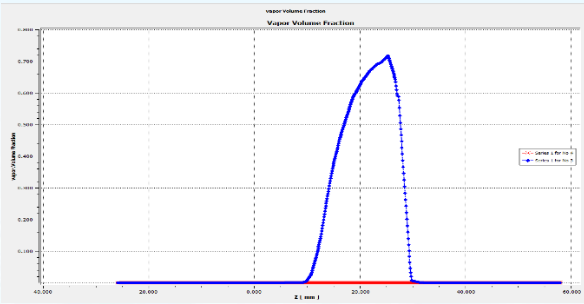

Figure 9. Plot of the vapor fraction distribution in strong and weak cavitation for 8mm Venturi

4. Conclusions from the obtained results

4.1. Fluid pressure distribution under strong and weak cavitation: from the plots and pictures obtained for the pressure distribution under strong cavitation, the characteristic profile of the pressure drops in the constriction below the saturation pressure, which causes the appearance of steam bubbles (cavitation) and after that it recovers in the expanding section. (Fig. 6a, 6b, 7a, 7b) The inlet pressure in both cases (a, b) remains almost unchanged. The outlet pressure in the case of strong cavitation(s) is significantly less than that at with weak (b) cavitation, which shows its importance for the strength of the cavitation by means of its participation in the equation "pressure ratio P_r", (Manzano et al. 2016). The pressure in the throat of the Venturi nozzle is the clearest indicator of cavitation, as when it drops below the saturation pressure of the fluid, the phenomenon of cavitation begins, (fig. 6a and 7a)

4.2. Speed distribution of the fluid at strong and weak cavitation - from the graphs and photos obtained for the distribution of the velocity of the fluid at strong and weak cavitation, the mirror profile shows that the speed increases in the narrowing and drops in the inlet and outlet sections of the venturi tube. Velocity is an important factor in HC flow in venturi tubes. At the high velocities in the constriction, the flow becomes turbulent, and the conditions for the initiation of cavitation phenomena are present. The visualization of Fig. 8a shows that the maximum flow speed is after the narrowing in the so-called "vena contracta".

4.3. Distribution of the vapor fraction - from the photos and graphs of the distribution of the vapor fraction (the ratio of the volume of the vapor fraction to the volume of the mixture of vapor plus liquid fraction) with strong and weak cavitation can be seen that the formation of steam bubbles begins shortly after the narrowing (in the so-called vena contracta), and the length of the zone of formation of steam bubbles depends on the pressure ratio - the more it decreases, the more the zone increases i.e. the cavitation becomes stronger.

5. Validation of the data from the natural and model experiments

The measurement of parameters such as pressures, velocities and mass flow along the entire length of the experimental venturi model as a basis for comparison with the model test requires specialized and expensive equipment. For this reason, *the comparison is made at three characteristic points along the length of the pipe - at the entrance, in the constriction and at the exit* which are decisive for the nature of the cavitation phenomena and can serve with a high degree of accuracy for a comparative analysis, bearing in mind the purpose of the dissertation work - use of cavitation in venturi tubes as a method for cleaning ship ballast water .

The pressure and velocity distribution graphs in the experiment were constructed by dividing the Venturi tubes into 10 points along the length. For each point, the area of the sections, the velocities and pressures in each section were calculated according to the following formulas (Fig. 10, 11).

$$S_i = \pi * D^2 / 4 \quad (4)$$

$$V_i = \dot{m} / \rho_{water} * S_i \quad (5)$$

$$p_i = 1/2 * (V_u^2 - V_i^2) * \rho + p_u \quad (6)$$

D_i – diameter of the corresponding section

p_i – pressure in the corresponding section,

p_u - pressure ascending section, ρ density

$\dot{m}$ – mass flow rate

V_i – velocity in the corresponding section

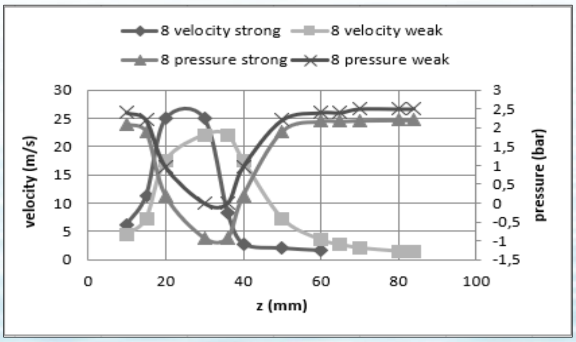

Figure 10. Velocity and Pressure Profile Plots for 8mm Venturi - Experiment (Test)

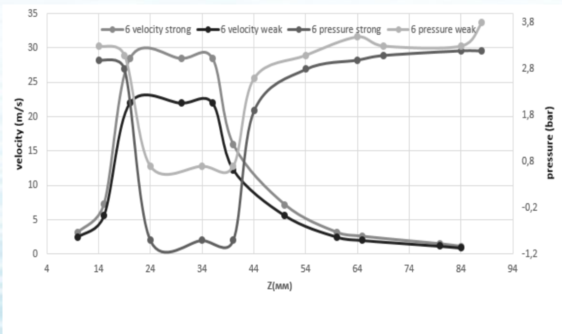

Figure 11.Velocity and Pressure Profile Plots for Venturi 6mm – Experiment (Test)

The following comparative Tables 2, 3 were obtained:

The graphs obtained from the results of the experiment are marked with " *8 Test speed/pressure, strong/weak"* , which means the graph of speed/pressure at a Venturi with a constriction diameter of 8 mm, obtained during the experiment (Test) with strong and weak cavitation, respectively.

The pressure and velocity plots from the model test were obtained from the corresponding results achieved with ANSYS CFX . They are marked similarly to the notations of the experimental graphs with *"8 CFX velocity/pressure, strong weak",* which similarly means graph of velocity/pressure at Venturi with a constriction diameter of 8 mm, obtained during modeling (CFX), with strong and weak cavitation, respectively. (Fig., 10, 11)

Table 2. Comparison of the speed and pressure in model test (CFX) and from the experiment in Venturi tube 8 mm

situation	SPEED (m/s)						PRESSURE (bar)					
	CFX strong	Experiment strong	Percent Error %	CFX weak	Experiment weak	Percent Error %	CFX strong	Experiment strong	Percent Error %	CFX weak	Experiment weak	Percent Error %
3 narrow. section	1.4	1.7	18	1.3	1.6	19	2.2	2.2	0	2.5	2.5	0
constriction	25	23	8	23	21.5	6	-0.85	-0.8	6	0.8	0.6	25
distr. section	3.2	2.9	10	2.6	2.7	3	0.5	0.45	10	2.5	2.0	20

Table 3. Comparison of the speed and pressure in model test (CFX) and the experiment in Venturi tube 6 mm

situation	SPEED (m/s)						PRESSURE (bar)					
	CFX strong	Experiment strong	Percent Error %	CFX weak	Experiment weak	Percent Error %	CFX strong	Experiment strong	Percent Error %	CFX weak	Experiment weak	Percent Error %
narrow section	1.6	1.15	28	1.4	1,2	14	3,4	3,4	0	3.7	3.8	3
constriction	28.8	28.5	1	23	25	8	-0.9	-0.92	2	1.0	0.8	20
distr. section	1.0	1.14	10	1.0	1.1	9	0.18	0.2	10	2.1	2.2	5

The following graph (Fig.12) and table show the comparison of *the mass flow rates* in the experiment (Test) and the simulation (CFX).

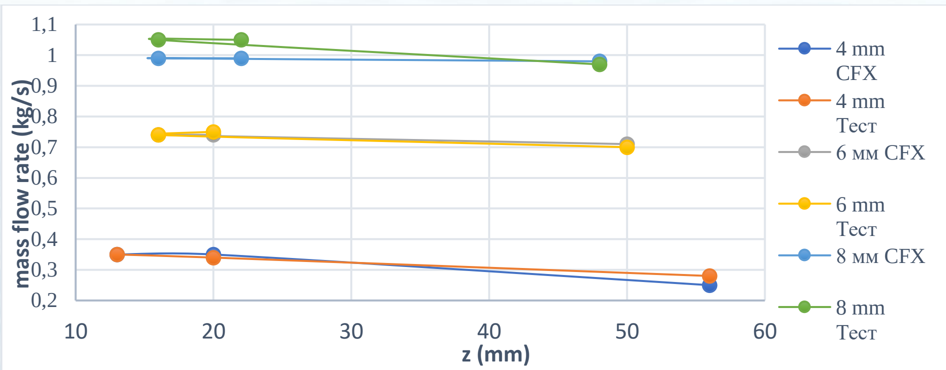

Figure 12. Comparison of mass flow rates in simulation (CFX) and experiment (Test)

Table 4. Comparison of mass flow rates in simulation (CFX) and experiment (Test)

Constriction Diameter(mm)	CFX mass flow rate (kg/s)	Mass flow rate experiment (kg/s)	% Error
4	0.355 – 0.25	0.35 – 0.30	4
6	0.70 – 0.744	0.79 – 0.74	8
8	0.99	1.05 -1.00	1

Conclusions from the obtained results and the validation:

Mathematical models can be used as useful tools to better understand how the devices work under cavitation conditions. The model tests in CFX modeling can serve as a basis for future research to include precision measurement with specialized instrumentation of variable geometry mass flow rates, velocities and pressures along the entire length of the venturi tubes.

From all the computer simulations done and from the results obtained using ANSYS CFX, the main conclusion can be drawn – these are a good basis for finding quick solutions and researching cavitating flows. Predictive results of numerical studies can serve successfully to find a high-precision design of the experimental setup and to optimize it.

As can be seen from Table 4 and Fig.12, the mass flow rate in the computer simulation and in the experiment remains almost constant, which follows from the continuity equation. The difference between the results obtained in the experiment and the computer simulations is less than 5%.

Tables 2, 3 show that the percentage of error is small – on average in the range of up to 10%. The larger percentage - up to 25% is due to the difference that is obtained from the methodology of obtaining the results. Obtaining more precise results can be achieved by installing specialized and expensive equipment when conducting the experiment.

From the obtained graphs for the comparison of the speeds and pressures in the mathematical model and those obtained from the experiment, one can see the same nature of the curves with the specific pressure drop in the constriction and its recovery in the expanding section of the Venturi tube, which is a characteristic of the cavitation processes.

From the same graphs, the mirror profile of the velocity curves can be observed with the specific peak in the narrowing of the tubes – one of the characteristic features of cavitation.

Performance Of A Natural Experiment With Sea Water. Evaluation Of The Method For Microbiological Disinfection Of Ship Ballast Waters

5.1. Aspects of microbiological disinfection of seawater used for ship BW by the HC method achieved with venturi tubes

Hydrodynamic cavitation (HC) has long been used for wastewater disinfection and has found application in many areas of technology. The use of HC in systems for the microbiological disinfection of marine ballast water is a relatively new method. In the recent years , there has been an increased interest in cavitation, including a possible method for cleaning ship ballast water (Gregg 2009). The method is described in quite modern scientific publications (Dular et al. 2014), (Save et al. 1994), (Sawant et al. 2008), (Badve et al. 2015), (Cvetcovietal et al. 2015), (Dindar 2016), (Ozonek 2012), (Yuoti, Pandit 2001), (Joshi, Gogate 2012), (Huang et al. 2024), (Lee at al. 2001).

There are different methods of treating BW, each with its own advantages and disadvantages. This necessitates the use of hybrid methods – combinations of chemical and physical methods. HC is often compared to acoustic cavitation (AC) achieved with ultrasound. AC has been successfully used for microbiological disinfection of ship systems by disrupting the cell membranes of microorganisms through shock waves, high temperatures and mechanical stress.

Recent studies have indicated that HC achieved with venturi tubes is a more efficient technology compared to AC due to its ability to form high concentrations of bio-oxidants, such as hydroxyl radicals and hydrogen peroxide. The HC parameters include upstream pressure, downstream pressure, and constriction velocity. Research shows that HC can replace AC and has a greater application for disinfection, providing environmental and economic advantages. HC systems operate at around 50-65% efficiency, while AC systems range from 4-40%.

5.2. Research methodology

Experiments have been conducted to study HC with venturi tubes using seawater from Varna Bay. The experiment was carried out using a set-up of 100 samples of treated water and venturi tubes of 4, 6 and 8 mm diameter. The inlet and outlet taps are fully open to achieve maximum cavitation. Samples were taken at regular intervals and analyzed for the effectiveness of microbiological disinfection.

5.3. Results obtained in the experiments.

The results were processed in the "Laboratory for Research and Control of Ballast Water at the "N.Vaptsarov" State Medical University, Varna. To establish deviations from the standard of rule D-2 of the International Convention for the Control and Management of Ship Ballast Water and Sediments, the number of viable organisms of the two size groups was determined:

Viable organisms with a minimum size ≥ 50 μm

Viable organisms with a minimum size < 50 μm and ≥10 μm

To determine the number of organisms with a size ≥50 μm, the samples were filtered through a filter device of the appropriate size, a receiving flask and counted under a stereo microscope "Euromex DZ.5040" (Fig. 13). The filter unit circulation pump is Millipore, model WP 6122050 (Fig. 14).

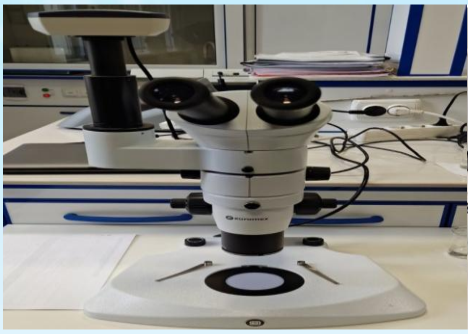

Figure 13. Stereo microscope Euromex DZ 50.40"

Figure 14. Millipore pump

To determine the number of organisms with a size of 10÷50 μm, the samples were concentrated and counted under a "Euromex i Series" microscope with an appropriate magnification (Fig. 15).

Fig. 15 Microscope "Euromex i Series "

For all of them, an equal number of circulations were performed for different times depending on the mass flow rate – one-time, ten-fold, thirty-fold, fifty-fold, hundred-fold. The disinfection percentage was calculated for each circulation by the formula:

% Disinfection = $\frac{C-Di}{C}$.100 % where:

C – number of viable organisms from a sample taken before cavitation disinfection (null sample)

D_i - number of viable organisms from the respective sample after cavitation disinfection after the respective number of circulations.

The results of field experiments are shown in Tables 5, 6.

Table 5. Experiment results of natural disinfection for Venturi 8 mm

Multiple circulations	Flow rate (l/min0	Time (min)	Number of viable organisms	% Disinfection
0	60	0	554	-
1	60	1.5	181	67
5	60	8	8	95
10	60	16	4	97
30	60	48	2	99
50	60	80	0	100

Table 6. Experiment results of natural disinfection for Venturi 6 mm

Multiple circulations	Flow rate (l/min0	Time (min)	Number of viable organisms	% Disinfection
0	50	0	350	–
1	50	2	158	55
5	50	10	17	93
10	50	20	0	100
30	50	60	0	100
50	50	100	0	100

In graphical form, the results are shown in Fig.16

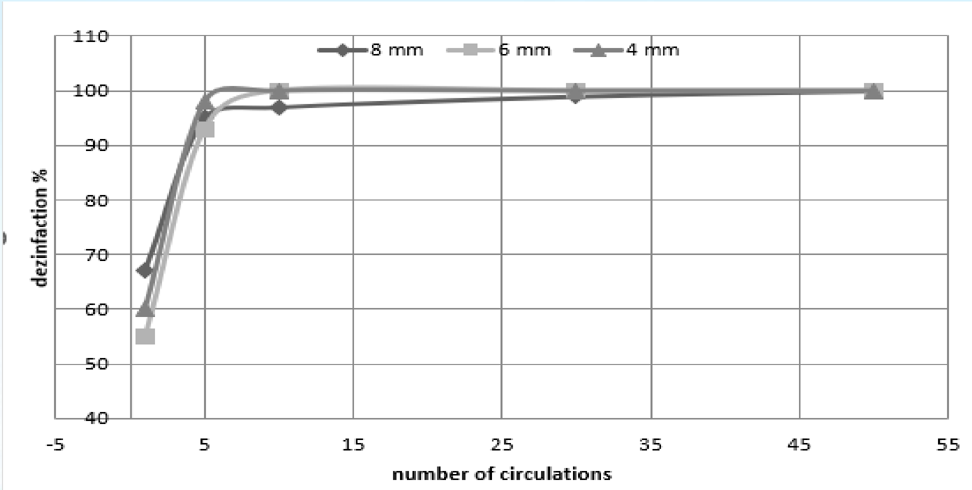

Figure 16. Dependence of % disinfection on the multiplicity of circulation for the different Venturis

The results of seawater disinfection show that it happens relatively quickly. The large number of destroyed species takes place already during the one-time circulation (Fig. 16). Further circulation loses practical meaning. This is confirmed in a number of publications (Xun et al. 2020), (Cerecedo et al. 2018), (Milly et al. 2007), (Sun et al. 2017) , (Chand et al. 2007) .

During the tests carried out in a specialized microbiological laboratory (VIK Varna), it turned out that HC is weakly effective in terms of the destruction of disease-causing microbes dangerous to human health - Escherichia coli, enterococci and cholera strains. For now, this requires that this method be combined with another disinfection method - most often chlorination

6. Conclusion

The goal of the dissertation work was achieved - analysis of methods for treating ship ballast water and results of experiments with three types of Venturi, confirming the effectiveness of HC for the destruction of marine organisms without the addition of chemicals. HC is an environmentally friendly and waste-free technology that can play an important role in the future of ballast water treatment. Combining HC with chlorination results in a higher degree of disinfection.

Hydrodynamic cavitation is an easy-to-implement, safe and effective technology for cleaning ballast water. Installing precision measuring equipment can optimize the process. Although HC is weakly effective against disease-causing microbes, the combination with chlorination shows high effectiveness. HC can play an important role in ballast water treatment systems and as a stand-alone system, which can be the subject of future research.

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THE CURRENT CRUCIAL MARITIME CONFLICTS AND THEIR IMPACTS ON THE MARITIME AREAS

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Abstract: To dominate over the seas is historically one of the states' targets by constituting sea power. They are known that the Phoenicians captured the trade to establish dominance in the Mediterranean, Athens became a regional power by using the sea, the Romans expanded the empire by sea and the Ottoman Empire also expanded its territory during the possession of a strong fleet. Moreover, Great Britain established a grand empire via hegemony in the maritime domains in the nineteenth century. Russia, Portugal, Spain, Japan, the Netherlands and France have existed with sea power throughout history. The U.S. has become a global actor with the support of sea power in the 20. and 21. centuries. Today, China's rising economic power has to the phase of an effective fleet creation. The study targeted to explore aspects of states and how they are getting their regions de-securitization and instability rather than securitization. State activities aiming at power struggle indicate state-by-state or proxy war as well as international engagement of defensive collaboration. In this venue, specifically, reflecting on the maritime areas of three conflicts (Special Operation between Russia and Ukraine, spread of the Gaza-Israel War to the Red Sea and escalating activities of tensions in the Asia-Pacific Region) and the international community's response to them shall be analyzed as case studies as depicted below with their underlying reasons by referring realist theory based on power and maximization of national interest s in the anarchical environment and security dilemmas as well.

Keywords: maritime conflicts, naval strategies of states, navigating troubled waters.

1. Introduction

The seas, which communities have also confronted since ancient times, are becoming more important for maritime sovereignty and security. Therefore, various naval battles have played into the world until today. For instance, the beginning of power struggle is the Peloponnese Wars (431-404 BC), the Battles of Preveza Naval Victory (1538), the Djerba Naval Battle (1560), the Lepanto Sea Battle (1571), the English Channel Battles (1588-1589), Crimean War (1853-1856), Battle of the Taku Forts (1900), Great Britain's annexation of Cyprus to control Indian trade routes (1914), Dardanelles Naval Operation (1915), Battle of Jutland (1916), Third Reich's invasion of Poland to open to sail (1939), Atlantic and Pacific Wars during the World War II, Taiwan Issue, Bay of Pigs Invasion (1961), Soviet's gain access to the warm waters (Tartus Port is Russian only naval base in the Mediterranean with agreement dated 1971 between Soviet and Syria), Falkland Sea Warfare (1982). We may explain the conflicts that occurred in the various periods of history by Albert Thayer Mahan's Sea Power Theory (Whoever rules the waves rules the world - but before him, Ottoman Chief Admiral Barbaros Hayrettin Pasha said the same word approximately three hundred years ago).

This paper examines the intricate dynamics of maritime conflicts from the perspective of states that operate in an anarchical international system driven by the imperative to maximize their interests, and aims to contribute to a better understanding of maritime conflicts and strategies of states referring to the international theories, emphasizing the continuous relevance of naval power and international alliances in the pursuit of national interests and global security as well as how states are further getting insecurity and instability rather than the securitization of navigating troubled waters. The study analyses multifaceted dimensions of maritime conflicts through the lens of realist theory. It discusses the reasons for state-based conflicts in the maritime domains and aspects of states to expand their spheres of influence and interests by looking at Mahan's "The Sea Power Theory" in the context of the strategic importance and existence of naval forces in affecting across the world's seas and oceans. State activities aiming at regional sovereignty has revealed state-by-state or proxy wars as well as international engagements such as defensive collaborations.

In this venue, specifically, three pivotal maritime conflicts and the international community's response to them shall delve into as case studies as depicted below in light of realist theory based on power struggle and anarchy in the international community: Firstly, the Russia-Ukraine Conflict surfaced geopolitical consequences by not only the British Government's will to donate mine-hunter ship for mines in the Black Sea but also blockade of Ukrainian ports to cause food crisis around the world. Secondly, the Last Gaza-Israel War reflecting on the Red Sea examines the destabilizing role of both state and non-state actors and proxy warfare in maritime domains, particularly through the mentioned conflict spills over into the Red Sea, affecting global trade routes and prompting international military actions toward the significance of maritime security for freedom of navigation in the modern geopolitical landscape. Lastly, the tensions in the Asia-Pacific Region highlight that Chinese ideological and territorial disputes in this area have caused aggressive actions by driving militia fishing vessels into gray-zone, China's infrastructure developments and regional security architectures demonstrate the backdrop of its assertive maritime claims in the context of the global balance of power.

2. Sample Cases

2.1 The Russia-Ukraine War

Russia resists NATO's enlargement strategy on ex-Soviet territories with the Near Abroad Doctrine dated 1993. The war has historically reached the Russian desire which has been to gain access to warm waters but its sea connection was cut off due to the disintegration of the Soviet Union. The Black Sea Basin is now a place where the West and Russia stand off against each other. This situation reflects on the region as an escalation in which the bulk cargo vessels have been sunk. The Black Sea Region has become more unstable because of the Georgian War in 2008, the invasion of Crimea in 2014 and lastly Russian occupation of Ukraine over the years per contra the new NATO concept containing memberships of Georgia and Ukraine.

Türkiye, which has implemented the Montreux Convention impartially and diligently since 1936, maintained unwavering determination and a moral stance throughout this war to prevent the escalation of tension in the Black Sea. So, Türkiye closed the Straits to warships of belligerent parties by Article 19 of the Montreux Convention Regarding the Regime of the Straits. The Sandown Class Mine-Hunter Ship donated to Ukraine by the United Kingdom, was not allowed to pass through the Turkish Straits to the Black Sea as well. Türkiye, Bulgaria and Romania signed the Black Sea Mine Countermeasure Task Group (MCM Black Sea) Agreement on 01/11,2024 to jointly tackle the mine threat in the region during the Russia-Ukraine War. However, the Agreement was activated on 07/01,2024 when Maritime and Cabotage Day was important for Turkish marines. A large of mines washed up from off-Black Sea on littoral beaches until this date endangering the security of navigation and people's security of life there.

Another point is that the most important incident in the sea domain lying behind the energy crisis in Europe is the use of the Nord Stream-1 Pipeline as a sabotage tool in contravention of Article 2 of the 1958 Geneva Convention of the High Seas. The Russia-Ukraine War also assessed Türkiye's strategic move to block the passage of a mine-hunter ship through the Turkish Straits, reflecting on the delicate balance of power in the Black Sea Region and Türkiye's role in mitigating conflict escalation. This section delves into the geopolitical ramifications of the Nord Stream-1 Pipeline sabotage within the context of the Russia-Ukraine War by illustrating how energy security and maritime strategy play into broader regional stability and international energy markets.

Furthermore, the Aegean Area is a continuation of the Black Sea from the perspective of U.S. naval strategy. So, the armament of the Aegean Islands is important to cut off Russian maritime trade routes as Turkish Straits sovereignty is lost against NATO that's why Alexandropolis and Crete pose an importance for this strategy. But these actions of Western Alliances violated the 1923 Lausanne Treaty including demilitarization and disarmament of Eastern Aegean Islands by arming them and they fell into as same error as condemning Russia for violation of international rules.

The U.S. is planning to build the largest NATO base in Romania to contain Russia in the Black Sea Region. Moreover, the probability of the exercise zone of Sea Guardian Operation expanded to the Baltic escalates the tensions in this region and propagates the conflict zone to the Arctic Basin due to conclusions of climate change. So, High North becomes a new center of gravity with the hoist of GIUK Gap where Russian submarines are taken under pressure.

2.2 Conflicts in the Red Sea

The war has particularly shown that maritime security is at stake in the Red Sea connecting the Indian Ocean to the Mediterranean. We saw that in the Modern capitalist world at different times, for example in the 1941 Atlantic Charter between Roosevelt and Churchill. Today, non-state organized armed groups fed by some states through proxy wars (such as Houthi) have increased instability in the maritime domain. As trade routes were obstructed in the Gulf of Aden due to the spreading impact of the attack on October 7th across the Red Sea, many ships had to circumnavigate Cape Hope of Africa. At least 12 percent of global trade volume is handled through the Suez Channel linking the Red Sea to the Mediterranean. Merchant vessels detour around Cape of Good Hope in Africa by turning to the old route due to Houthi's attacks towards Israel-related ships (commercial, Israel, military and no identified) which 124 attacks were launched from 19/10/23 to 28/06/24 because of Israel's attacks to Gaza. That's why this has caused to extend 10-12 days more of sailing time.

America-led military actions vie for sea control by launching Operation Prosperity Guardian contrary to Houthi's sea denial policies which used anti-ship ballistic missiles (ASBM) to fire against shipping as the first entity in the history of the world. However, this operation has indicated a lack of cooperation between allied nations on pro-Israel approaches. In addition, the U.S., Israel, UAE and Bahrain launched an exercise in charge of CENTCOM (United States Central Command) in the Red Sea on 12 November 2021 for the containment of Russia and China who are candidates for global power and Iran who is a regional power.

Not only Houthi attacks but also other state-supported proxy powers pose an obstacle to freedom of navigation via drone strikes and anti-ship ballistic missiles as well as the results led to by wrong policies of the U.S. and the U.K. in the Red Sea. In the meanwhile, in the middle of Somalian regions piracy activities to cause low-level combat at sea started appearing, in addition to the Agreement on access to port facilities between Ethiopia and Somaliland violating the territorial integrity of Somalia and might provoke inter-state warfare. Ships have been obligated to detour around South Africa in that all of them infringe the principle of *mare liberum*.

Lastly, it expresses that proxy powers are supported in Yemen, violating fundamental principles of international law which are respect for state sovereignty and non-interference in internal affairs. What kind of path to follow for ASBM used by Houthis regarding great power or official authorities in Yemen? The transition from maritime safety to maritime defense was brought to the agenda with the Active Endeavour Operation Plan formed by the North Atlantic Council after the 09/11 Attacks, but it is probable to continue these cases during both Saudi Arabia which is the Istanbul Cooperation Initiative country and Iran support their proxies in Yemen Civil War and insurgencies which undermine the capacity of country to police its maritime territories and contribute to the rise of blue crime to keep maritime interdiction hanging in midair.

2.3 Escalation of Tensions in the Asia-Pacific Region

Disputed enclaves became apparent after the exploration of rich hydrocarbon deposits and the increasing global trade volume in the region which has belonging questions of Socotra Rock (between China and South Korea) in the Yellow Sea, of Senkaku Islands (between China and Japan) as well as Taiwan is *sui generis* dispute in East China Sea, of Paracel Islands (between China and Vietnam), Spratly Islands (between China and Vietnam, Malaysia, Brunei and the Philippines) and Pratas Islands (between China and Taiwan) in South China Sea.

In the lens of liberal ideology and considering offensive neorealism theory in terms of power maximization and expansionism, the Chinese Concept of Four Seas, of its salami strategy, declares to get together four groups of micro–islands at this maritime domain and belong each of them to its territory based on UNCLOS (United Nations Convention on Law of the Sea) Article 121: "Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf," China establishes artificial islands and military installations through land reclamation and floating platforms to expand its influence at this area by going back to historical claims to sovereignty within series of maritime boundary markers known as the "nine-dash line". Hence, China aims to escalate its efforts under gray area warships by carrying out a gray area strategy whose China conducts exercises on the brink of war, such as economic strains, espionage (information retrieval from submarine cables), and sabotage activities. On the other hand, the Chinese Cabbage Strategy responds to fishing activities of the Philippines with firstly militia fishing vessels, then coastal safety vehicles, and finally naval ships to lay claims to the region. Therefore, the U.S. perceives a threat to Asia-Pacific. While it targeted cutting Chinese connection to the ocean, China eliminated American efforts via an agreement with the Salomon Islands.

China-U.S. competition occurs in the South China Sea, East China Sea and Taiwan Strait. As Spykman's Rimland Theory suggested containment of the Soviet Union to block access to warm waters via NATO (North Atlantic Treaty Organization), ANZUS (Australia, New Zealand, United States Security Treaty), SEATO (Southeast Asia Treaty Organization) and CENTO (Central Treaty Organization) during the Cold War. Likewise, the U.S. restrains China in the Asia-Pacific via international collaboration such as QUAD (Quadrilateral Security Dialogue) and AUKUS (Australia, United Kingdom, United States). Therefore, the other challenge is sea lift including logistic support and steady flow of supply chain in the Asia-Pacific. On the one hand, the U.S. established the biggest naval and air bases abroad in Japan, on the other hand, China strengthened its existence in the South China Sea using the establishment of bases and installations in the first and second chains, deployment of DF-21/DF-26 medium-range ballistic missiles and fighter bombing aircraft, and placement of cables and mines among them, as well as formation of artificial islands (such as Spratly Islands and Paracel Islands) which are reefs being filled with sand, populated, and planted trees on them for acquirement of exclusive economic zone in contravention of Article 121/3 of UNCLOS. Therefore, the Japanese Navy having an Aegis ballistic missile defense system is the only navy outside the U.S. because of the North Korean threat and containment of China. Additionally, conflicts originating from the Strait of Malacca, where two-thirds of the produced goods are marketed, have been multilateral and extra-regional actors involved in it. China diversifies energy transportation, using the Gwadar Sea Port with the China-Pakistan Economic Corridor (CPEC) to access oil towards the closing of this choke point.

China has just passed the level of sea control by aircraft carriers and hypersonic missiles while doing sea denial at the beginning. It procures logistic support on forward naval bases chains in Bangladesh, Myanmar, Sri Lanka, the Seychelles, Pakistan, and Djibouti known as String of Pearls on the Maritime Silk Road to widen the theater of navy and has managed to access to Gulf of Bengal through these countries without Malacca Strait. However, the U.S. tries to maneuver sea control response to these Chinese escalations in tensions through both hard power such as the fifth fleet and naval exercises around this territory and AUKUS (both hard and soft power due to including of building of nuclear attack submarines with supports of the U.K. and the U.S.) and soft power such as QUAD by considering in the lens of defensive. But two nuclear actors -China and Australia- will be confronted when Australia has possessed nuclear power in the Asia-Pacific region. However, to be exact, these Anglo-Saxon countries were prejudiced against the Rules-Based International Order, especially the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) entering into force in 1970. Nuclear submarines hamper detection and extermination due to acoustics energy. So, submarines will form an important ground with emerging technologies in this region upcoming period.

The U.S. shifted sixty percent of its fleet to the Pacific for deterrence without warfare by pursuing the Forward Presence Policy and making bilateral security agreements with states in the region. Although the U.S. may not possibly gain a quantitative edge over China which uses fishing boats being the third biggest naval force after fleet and coast guards for counteraction to Western naval component, it conducts naval power projections by sending aircraft carriers and overseas fleet to the region as well as establishing forward operational base replacements in the region. China carries out cabbage tactics and salami slicing strategy as a response to the Atlantic strategy. Nonetheless, it is viewed that China has succeeded in integrated deterrence which uses power elements separately with the Belt and Road Initiative, technological developments, economic relationships and military leaps, especially deep seabed warfare.

China declared that all ships carrying hazardous cargo must report to Chinese authorities before entering Chinese territorial waters with effect from 1 September 2021. Commercial and warships can use the right of innocent passage in the crossing of territorial waters. But China is now under control. Because it perceives USN passing almost monthly though Chinese territorial waters so-called freedom of navigation as geopolitical provocations in the South China Sea.

Eurasian Heartland including China and Russia has been contained by westerly NATO and easterly American bases in Japan, South Korea and the Philippines. Considering history, the West who pried into Chinese ports for a "liberal economy" with the Opium Wars in the 19th century tried to feed China back into the mainland. It falls over backyards to forget the Century Humiliation and not to go back mainland. Nonetheless, the U.S. maintains its existence by power projection with succinct sources. In brief, there is the China Navy which is ready to steer for not only San Hai (Yellow Sea, South China Sea, East China Sea) but also the whole of the Pacific and the Indian Ocean.

3. Conclusion

The Cold War has seemingly even finished as Francis Fukuyama said "The End of History" after the disintegration of the Soviet Union. It continues with the enlargement of NATO, the Belt and Road Initiative, regional alliances, China's emphasis on fleet rapidly, gunboat diplomacy, naval diplomacy, flag shows, arms investment of states because of the *Thucydides Trap* etc. Consequently, states avoid neither rising ongoing escalations nor violating international treaties to seek their benefits through revisionist policies. On the other hand, the identification of states as friends or foes has shown up in these maritime conflicts. America plays the role of global gendarmerie through naval exercises at different zones and strategic competition with China for influence in the Asia-Pacific as well as keeps its bases and military strength in the key areas (fifth fleet in the Middle East, sixth fleet in the Mediterranean, seventh fleet in the Asia-Pacific region) for maintaining of global trade without a hitch to control sea lines of communications. Thus, we have reached that these escalation activities and polarization among states threatened international shipping lanes.

Alfred Thayer Mahan advocated that the U.S. which had a small navy initially, should later come to a globally effective position by improving its naval power in his "The Influence of Sea Power upon History" book. Starting from this, we predict that Türkiye may help to overcome the crises by expanding its impact areas to interest areas (such as the naval base in Somalia) due to its strong navy with an "effective, deterrent and confidential" motto and getting conflicting parties together as such in the Grain Corridor Agreement.

When considered from constructivist aspects, U.S.-led Western powers have been identified as "foes" and even "devils" in the three reviewed cases by China, Russia, and Yemeni proxy power promoted by Iran. It is important that Türkiye contacting all parties maintains its existence around the field as well as is diplomatically active on the table.

AI, cyber/network-centric intelligence, prevention of jamming and spoofing activities, electronic warfare, emerging and disruptive technologies, autonomous/unmanned naval vessels and pre-emptive strikes instead of preventive actions shall play a great role in conflict zones. Stakeholders ought to provide benefits in the maritime domain. They support exercise scenarios of multi-dimension operation, planning, supporting maritime situational/domain awareness, operational level of CPX (Command Post-Exercise), inter-agency operational framework, command-control procedure, foster information sharing between institutions, high-intensity maritime security operations, enhancing of collaboration and coordination in the area of interest, increasing of capacity-building, providing knowledge on the patterns of activities at sea, regarding co-ordination of interagency rather than collaboration, switch from mutual exercises to integrated, establishment of confidence between regional states. It is important to fix simulated exercises and specifically respond to them. Besides, UNCLOS should be revised to be agreed on by everyone on the disputed issues and amended due to new requirements as well as active and collaborating policies should be sought to mitigate conflicting cases in the maritime domains.

According to the sanction power of the 1949 Geneva Convention of War, two belligerent parts of the Russia-Ukraine War skirt around international law, saying "special military operation". The Court shall not conduct an ex-officio investigation due to ground on the application of states. Unfortunately, states do not respect the principles of *pacta sunt servanda* and good faith being a basis for international contract law and post-WWII order formed no destructive wars again.

Finally, states have to abide by Article 2 of the United Nations Charter saying that all members shall settle their international disputes by peaceful means in such a manner that international peace and security, and justice, are not endangered. They should primarily use diplomatic means and then should go to arbitration unless selected methods respond. It is crucial to state that Russian and Ukrainian authorities say even through the war is a military operation, but it is an interstate war in practice. Therefore, the International Tribunal for the Law f the Sea/International Court of Justice ought to take precautions to guarantee the safety of life and property. Even if UN Naval Peacekeeping is constituted to reestablish international maritime order if any efforts do not result, taking lessons from previous unsuccessful operations, the international system will not be able to provide a solution to inter-state wars and armed conflicts around the world related to the need for the UNSC (United Nations Security Council) Resolutions to interfere them because of votes of Russia and China who are permanent members and possess a right of veto in the Council.

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SYSTEM DYNAMICS MODELING OF MARITIME GREENHOUSE GAS EMISSION MEASURES AND THEIR EFFECTS

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Abstract: Carbon emissions have become a major problem for the world. Many institutions and organisations are encouraged to initiate various projects aimed at minimising or eliminating their ecological footprint. Although global maritime trade does not make a significant contribution to emission pollution in today's conditions, considering the growth rate of the maritime sector, it is an indication that we may face serious problems in the coming years. In order to address this problem, the International Maritime Organisation (IMO) has established a road map and action plan and the implementations have started. IMO is striving to encourage the use of innovative technologies and business practices to reduce pollution from the maritime sector and has set targets to reduce greenhouse gas emissions by 2050. Due to both the complexity of these changes (such as the introduction of new regulations, energy-efficient technologies and alternative fuels) and the uncertainty of the situation in field applications for sector stakeholders, the need for a systematic management of the problem has emerged. In order to completely eliminate these pollutants from the maritime sector, we need innovative tools and strategic decisions on operational and long-term actions. This study is a comprehensive research that uses system dynamics methodology to explain the complex and interdependencies of emissions from ships in the maritime sector. Simulations can be performed over many scenarios, including how new technologies that reduce emissions will affect fuel consumption, operational costs and the required fleet size. For legislators and other stakeholders, long-term results can be obtained by simulating the interactions between variables. Modelling and scenario-based management of this process increases the efficiency and adaptability of the decarbonisation process. It shows that cooperation on innovative technologies and practical applications, together with legislative changes when determining carbon emission reduction strategies, can save the environment while ensuring the sustainability of maritime operations.

Keywords: Carbon Emissions, Maritime Industry, IMO Regulations, Alternative Fuels, Decarbonization, Emission Reduction Strategies, Technological Innovation, System Dynamics Modeling

1. Introduction

The share of the maritime sector in all emissions in the world is approximately 2.7%. The sector is under increasing scrutiny due to international environmental restrictions and regulations, including the Paris Agreement. The International Maritime Organisation (IMO) has set a high target of 40% reduction in carbon intensity by 2030, which is a stop on the roadmap for carbon reductions (Herceg et al., 2021). Although there are different approaches to be taken in achieving these targets, it is important to promote the use of hydrogen and LNG fuels, integrate shore power systems in ports and encourage the advancement of innovative technologies such as just-in-time arrivals (Qin et al., 2017). Regulations and inspections such as EEDI, SEEMP and CII are also legal initiatives to achieve these goals, but also aim to establish sustainability in the sector (Psaraftis, 2019).

Given the interrelated network of stakeholders, including regulatory bodies, for the production, operation and transport of resources, achieving significant decarbonisation of maritime logistics involves highly interdependent and interconnected tasks. This complexity requires sophisticated techniques such as system dynamics modelling to study the interactions between variables such as ship design, fuel use and regulatory compliance (Geng et al., 2017). Research shows that system dynamics modelling effectively expresses carbon reduction scenarios and mentally and mathematically models the impact of alternative fuels, energy-saving technologies and port operations on emissions (Wang et al., 2020). Moreover, these models have demonstrated the ability to spread the effects of disruptions such as port congestion and vessel waits across the system to assess how this part affects the whole and overall emissions (Xu et al., 2021).

This study uses system dynamics modelling as a tool to evaluate GHG mitigation strategies in the roadmap established by the International Maritime Organisation, with a particular focus on container ships. By integrating technical measurements and practices such as EEDI and SEEMP with operational strategies such as CII and speed optimisation, it aims to provide a holistic analysis of emission reductions. This modelling method provides insights into feasible strategies to achieve decarbonisation targets by integrating cause and effect feedback loops and their long-term effects in a mathematically clear way. The results help policy makers and industry stakeholders to formulate and implement effective strategies, while also providing insights for different ship types and different cargo carriers.

2. Methodology

In this paper, System Dynamic Modeling was implemented in six steps. These steps are categorised as follows:

I. Literature Review and Identification of Dynamics Affecting Greenhouse Gas Emissions

II. Data collection

III. System Dynamics Modelling Design of greenhouse gas emissions from ships

IV. Testing and Validation of the System Dynamics Model

V. Development and Implementation of Scenarios Based on System Dynamics Model

VI. Developing Strategies and Policies on Greenhouse Gas Emissions in the Maritime Sector

The research began with a comprehensive review of the literature on GHG emissions and climate change in the maritime sector, considering national and international legislation to develop a core understanding of the industry's characteristics. Subsequently, relevant data were collected from technical journals and publications to accurately illustrate historical patterns and enable more model simulations. The system dynamics model was created to incorporate cause-and-effect interactions among variables using mathematical formulations to predict the system's behavior over time. The model was tested and validated by comparing its output with established reports, thereby verifying its reliability. Employing the validated model, various scenarios have been developed to examine reduction strategies in alignment with IMO standards. Ultimately, it formulated plans and regulations aimed at achieving net-zero emissions by 2050, including interim goals and pathways based on the IMO's updated 2023 GHG reduction strategy.

3. System Dynamic Modeling Approach (SDMA)- Base Scenario

A fundamental scenario employing System Dynamic Modeling is created to understand and assess the initial conditions of the model's present state. The accuracy of the initial conditions is assessed in this context. A model is provided as a benchmark for formulating diverse scenarios. The supplementary resources comprise the tool type, variable names, equations, variable units, definitions, and dynamic references.

The foundational scenario for the System Dynamic Modeling Approach is predicated on the assumption of "CO2 emissions from container ships employing current applications devoid of any emission reduction strategies." Figure 1 illustrates the SD model framework for the baseline scenario.

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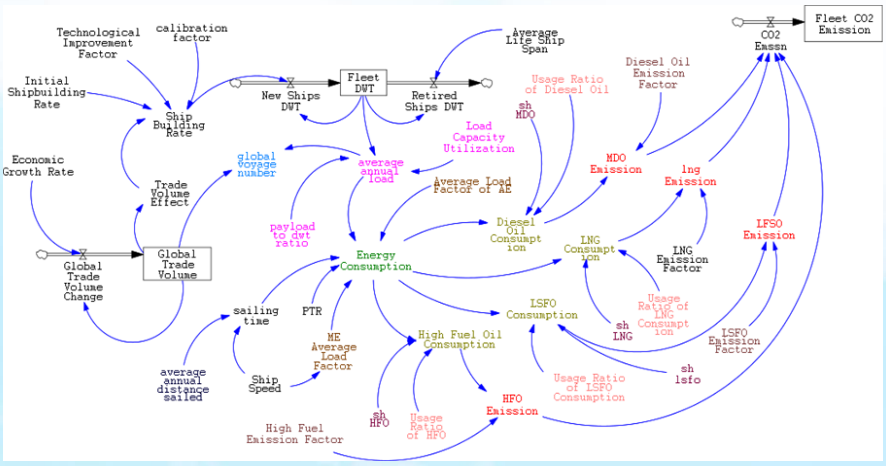

Figure 1. SD model framework of base scenario

4. Conclusion

This study evaluates a system dynamics model aimed at identifying methods to mitigate GHG emissions in the marine sector, namely in container transportation. The principal findings reveal that existing initiatives like EEDI, SEEMP, and CII establish a crucial basis yet fall short of fulfilling the decarbonization targets for 2050. Current predictions suggest a substantial increase in CO_2 emissions under business-as-usual scenarios, highlighting the urgent need for intervention. Fuel-switching scenarios suggest that transitioning to LNG, methanol, or hydrogen might significantly reduce emissions; however, this requires substantial investments in infrastructure and technology. Short-term strategies, such as reducing vessel speed to about 15 knots, yield cost-effective emission reductions, demonstrating the potential for operational improvements like speed optimization. Economic measures, such as increased costs for HFO compared to LNG, can create incentives for cleaner fuels, but must be bolstered by stringent legislation and continuous technological progress.

This paper emphasizes the need of system dynamics modeling for examining the complex interconnections of technology, operations, economics, and regulations, thereby enabling scenario-based strategic planning and policymaking. The model's parameters are limited to container vessels, and its dependence on existing data and assumptions may be influenced by impending technological and regulatory changes. The model's expansion may encompass additional vessel types and current data to improve applicability and precision. Realizing the IMO's decarbonization goals requires a multifaceted strategy that integrates various operational, technological, economic, and regulatory methods, alongside continuous monitoring and cooperation among industry participants.

Acknowledment

The project discussed within the scope of this study is a project funded by The IAMU as All Academic Staff in FY2023's System Dynamics Modelling of Maritime GHG Emission Measures Impact Assessment (GEMIMA-MOD) (Project Number: :20230307).This study is presented in the 29th International Maritime Lecturers Association (IMLA29) Conference.

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SHIP COLLISION AVOIDANCE USING AI APPROACHES

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Abstract: The maritime industry faces major issues in ensuring safe navigation, with collisions being an important issue that can have a disastrous effect. This project addresses the development of an advanced AI-based ship detection system intending to reduce the risk of collisions at sea. The technology is effectively deployed in important places close to the ship, enabling real-time detection of nearby vessels. It utilizes innovative artificial intelligence algorithms that assess data from various sensors and precisely detect potential collision risks. When discovered, the innovation signals pilots via the ship's bridge or other integrated communication systems, allowing for timely and informed decision-making. In this research, the AI-based deep learning model YOLOv8 is applied to implement the model. The model object detection accuracy is achieved by 99.06% for real-time collision avoidance. Thus, this technique aims to enhance maritime safety by raising situational awareness and producing early warnings.

Keywords: Real-Time Detection and Tracking, Collision Risk Assessment, Artificial Intelligence, deep learning, Automated Alerts.

1.Introduction

The maritime sector faces significant difficulties in maintaining safe navigation, with collisions being a major concern that can have catastrophic effects. This work addresses the development of an advanced AI-based ship detection system to minimize the risk of collisions at sea. The technology is successfully deployed in important places near the ship, permitting real-time detection of nearby vessels. It utilizes cutting-edge artificial intelligence algorithms that assess data from various sensors and precisely detect potential collision risks. When discovered, the innovation signals pilots via the ship's bridge or other integrated communication systems, allowing for timely and informed decision-making. This technique aims to enhance maritime safety by raising situational awareness and producing early warnings. This project introduces a state-of-the-art AI-based ship detection system specifically designed to improve collision avoidance at sea. The system leverages advanced artificial intelligence and machine learning algorithms to automatically detect nearby vessels, even in challenging environmental conditions such as low visibility or rough seas. By processing data from multiple sensors, the system can accurately assess the proximity and movement of neighbouring ships. The ship detection system is strategically installed at key locations on the vessel, ensuring comprehensive coverage of potential collision zones. Upon detecting a nearby ship, the system immediately alerts the bridge duty officers through the ship's bridge or other integrated communication systems, enabling them to take prompt and appropriate action. This proactive approach to collision avoidance not only enhances the safety of individual vessels but also contributes to overall maritime safety.

The initiative intends to establish a new benchmark in marine navigation by developing and deploying this AI-based ship identification system, thereby lowering the risk of collisions and fostering safer waters. Even with improvements in navigational technology and shipbuilding, collisions are still a constant risk, particularly in places with heavy traffic, such as ports, straits, and major trade lanes. These dangers are made worse by elements like mechanical malfunctions, human mistakes, and unfavourable weather, which calls for the creation of increasingly complex collision avoidance systems. The Figure 1 represents the overall flow of the proposed model.

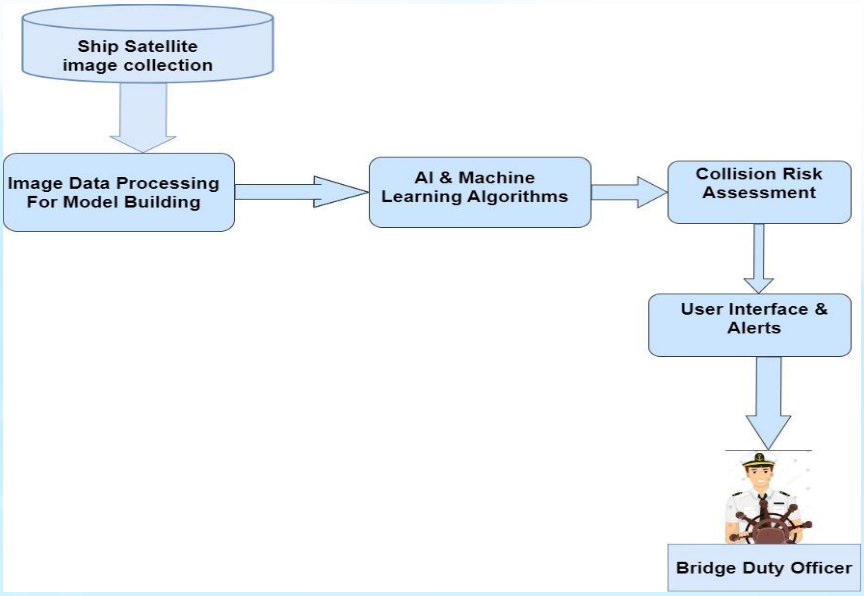

Figure 1. Workflow model for the collision avoidance system for ships using AI

2. Literature Review

The literature on Ship Collision Avoidance emphasizes the expanding role of digital technology in improving marine safety, especially with the rise of intelligent ships [1]. A thorough study of 851 publications from 2004 to 2023 demonstrates considerable global collaboration between academics and institutions, focusing on crucial areas such as research subjects, technological approaches, and sophisticated AI algorithms like machine learning and deep learning. The literature on Ship Collision Avoidance highlights the growing complexity of maritime traffic due to the increasing number of vessels, making it important to improve the effectiveness and efficiency of collision avoidance tactics for both two-ship and multi-ship encounters[2].The research on autonomous ship collision avoidance highlights difficulties with deep reinforcement learning, particularly in feature extraction and compound errors. To solve these challenges, this paper proposes using rule-guided vision supervised learning. The study emphasizes the limits of DRL by comparing deep feature extraction networks to Nature CNNs in DQN. RGVSL is proposed as a method to increase adaptability and lower learning costs[3]. Deep feature extraction networks' limitations in deep reinforcement learning have an impact on performance in complex settings, which is exacerbated by errors and poor sample quality. To overcome these issues, this work presents rule-guided vision supervised learning (RGVSL), which enhances collision avoidance decision-making in autonomous ships. When deep feature extraction networks are compared to Nature CNN in DQN, the inadequacies of DRL become clear. RGVSL demonstrates increased adaptability and lower learning costs[4]. The study of collision avoidance decision-making (CADM) for autonomous ships is complex and difficult. Reinforcement learning has received attention for optimizing actions based on interactions with the environment to maximize rewards. This paper presents an enhanced RL technique that employs knowledge transfer to improve ship collision avoidance algorithms. The study efficiently transfers information from source tasks to related target tasks by developing a reward function that is linked with COLREGs and categorizing collision avoidance tasks. Experiments demonstrate high success rates for head-on, overtaking, and crossing encounters—90%, 95%, and 82.5%, respectively. The suggested solution enhances algorithmic efficiency while also ensuring safety and rule compliance, with potential benefits for other autonomous systems in dynamic situations [5]. Accurate timing for collision avoidance is critical to avoiding maritime collisions, but traditional methods based on indications such as Distance to the Closest Point of Approach and Time to the Closest Point of Approach (TCPA) are constrained by environmental variables and human factors. This paper tackles these concerns by introducing a machine learning method for learning collision avoidance behaviour from empirical ship data, with a focus on cross-encounter scenarios [6]. As maritime traffic becomes more complex, technical advancements and new rules require the installation of advanced navigational equipment on bridges. This complexity makes it difficult for police on duty to make decisions. To reduce human error and improve sea transport safety, this study uses the concept of e-navigation, with a focus on collision avoidance path planning. It uses an Ant Colony Algorithm from artificial intelligence to build a model that mimics real-world optimization behaviours. The model uses navigational practices, marine rules, and real-time AIS data to develop safe and cost-effective collision avoidance routes. Recommendations for collision avoidance and course correction are made, with a Geographic Information System serving as the decision support platform. This system integrates navigation information, collision avoidance models, and electronic charts to provide valuable references for vessel traffic [7]. Autonomous surface vehicles are increasingly being recognized for their potential to improve maritime safety and efficiency, resulting in a substantial interest in creating effective path-planning systems. This study examines various path-planning algorithms for autonomous surface vehicles, emphasizing their classification and application. It investigates critical issues such as vessel autonomy, regulatory frameworks, guiding, navigation, and control components, and industry improvements. The review also discusses terminological difficulties in the literature on path planning. Finally, the study summarizes its findings and highlights the need for updated rules to facilitate the development and integration of autonomous surface vehicles [8]. When dealing with complex marine traffic, an officer of the watch (OOW) can benefit from a decision assistance tool to help avoid collisions while balancing safety and economic factors. This study uses a genetic algorithm influenced by biological evolution models to offer the safest and most cost-effective collision avoidance strategy. The algorithm uses international regulations (COLREGS) and safety domains to deliver the best suggestions for avoidance turning angles, navigation restoration time, and angles. The system is developed on a Geographic Information System (GIS) platform, which allows Vessel Traffic Services (VTS) operators and OOWs to use it for real-time collision assessment and planning [9]. Ship collision avoidance is crucial in marine systems, especially when traffic density and vessel speeds rise, lowering decision-making time and increasing the danger of human mistakes. A particle swarm optimization (PSO) technique is presented to address these hazards for ship path planning and collision avoidance. This approach uses an improved dynamic ship domain model to evaluate collision hazards during close-range encounters. Simulations based on conventional marine traffic scenarios evaluate the PSO algorithm's compatibility, consistency, and execution efficiency. This strategy tries to eliminate human factors while increasing collision avoidance efficiency in open water with good sight [10].

3.Maritime Safety Challenges

Maritime safety is a vital problem because of the potential repercussions of maritime crashes, which include fatalities, severe environmental contamination, and significant economic expenses. Despite advances in shipbuilding and navigation systems, collisions remain a constant concern, particularly in high-traffic locations such as ports, straits, and congested shipping lanes. Human mistakes, mechanical problems, and severe weather conditions all increase these hazards, prompting the development of increasingly complex collision avoidance technologies.

4.The Role of AI in Enhancing Maritime Safety

Artificial intelligence (AI) has transformed the marine industry by offering novel solutions to long-standing security challenges. AI's ability to evaluate huge amounts of data from numerous sensors and systems on a ship enables it to detect potential threats more effectively than traditional methods. Machine learning algorithms, particularly deep learning models, can analyse complex patterns in data to predict and avoid collisions. These models change over time, using past accidents and near-misses to improve future forecasts and responses.

5.System Architecture and Components

5.1 Sensor Integration

The system incorporates data from several sensors, including radar and cameras, to identify adjacent vessels. These sensors are strategically positioned around the ship, covering all potential blind spots and collision zones.

5.2 Data Processing Unit

A central processing unit with high-performance computing capability performs real-time data analysis. The CPU implements AI and machine learning techniques to determine the proximity, speed, and trajectory of adjacent vessels.

5.3 User Interface

The system's interface, which appears on the ship's bridge, gives real-time alerts and visualizations of adjacent vessels. It is intended to be intuitive, allowing pilots to swiftly interpret information and make sound decisions.

5.4 Communication System

The device is incorporated into the ship's current communication network, allowing alarms to be sent to all necessary individuals, including the captain, bridge crew, and any neighbouring vessels.

6.Key Features and Capabilities

6.1Real-Time Detection and Tracking

The system continuously monitors its surroundings, tracking and identifying the movements of neighbouring ships in real time. This skill is critical in congested maritime routes where swift decision-making is required.

6.2Environmental Adaptability

The AI algorithms are developed to function successfully in a variety of environments, including fog, heavy rain, and high waves. This versatility ensures that the system stays reliable even in situations where traditional navigation tools may fail.

6.3 Collision Risk Assessment

The technology utilizes modelling techniques to determine the risk of a collision based on the identified ship's trajectory and speed. It gives pilots an estimated time-to-collision and suggests evasive manoeuvres if necessary.

6.4 Automated Alerts

When the system detects a probable collision, it promptly warns the pilot and other essential staff via visual, audio, and tactile signals. These notifications are prioritized based on the seriousness of the threat, so crucial warnings receive prompt attention.

7.Benefits of the AI-Based Ship Detection System

7.1Enhanced Safety

By providing early warnings and actionable insights, the system reduces the likelihood of crashes, protecting people, the environment, and assets.

7.2Reduced Human Error

The automated operation of detection and warning systems reduces the influence of human mistakes, which is a major cause of marine accidents.

7.3Cost Savings

Reducing collapses can save shipping businesses millions of dollars in potential damages, legal fees, and environmental penalties. Additionally, the system's predictive capabilities help optimize routes, lowering fuel consumption and operational costs.

8.Methodology

The development of the AI-based ship detection system follows a structured approach, integrating advanced technologies and systematic testing which is represented in Figure 2.

8.1 System Design and Architecture

The first process is to develop the overall architecture of the ship-detecting system. This includes selecting appropriate sensors (such as radar, LiDAR, and cameras) to collect information about the surrounding maritime environment. The system is modular, enabling sensor integration to be tailored to the ship's individual needs and operating conditions.

8.2 Data Collection and Preprocessing

Comprehensive data collection is carried out to capture numerous scenarios of ship interactions under a variety of climatic conditions, including clear skies, fog, rain, and night-time operations. The obtained data is then pre-processed to reduce noise, improve image quality, and standardize input formats for the AI model.

8.3 Model Development

Machine learning and deep learning models are being developed to effectively identify and classify nearby vessels. Convolutional Neural Networks are used for image recognition, while real-time object detection is achieved using approaches such as YOLOv8. The models are trained using a large collection of maritime pictures and videos, which include annotations showing ship positions.

8.4 Sensor Fusion and Data Integration

To improve detection accuracy, data from multiple sensors are fused, providing a comprehensive view of the surrounding environment. Sensor fusion techniques combine inputs from radar, cameras, and LiDAR to enhance the detection of ships, even in challenging conditions. The integrated data is processed in real-time to ensure timely alerts.

8.5 System Integration and Testing

The developed AI model is integrated into the ship's control system, with the detection outputs being linked to the bridge's alert mechanisms. The system undergoes extensive testing in simulated environments, including maritime simulators and controlled sea trials, to evaluate its performance in real-world scenarios. Adjustments are made based on test results to optimize system responsiveness and reliability.

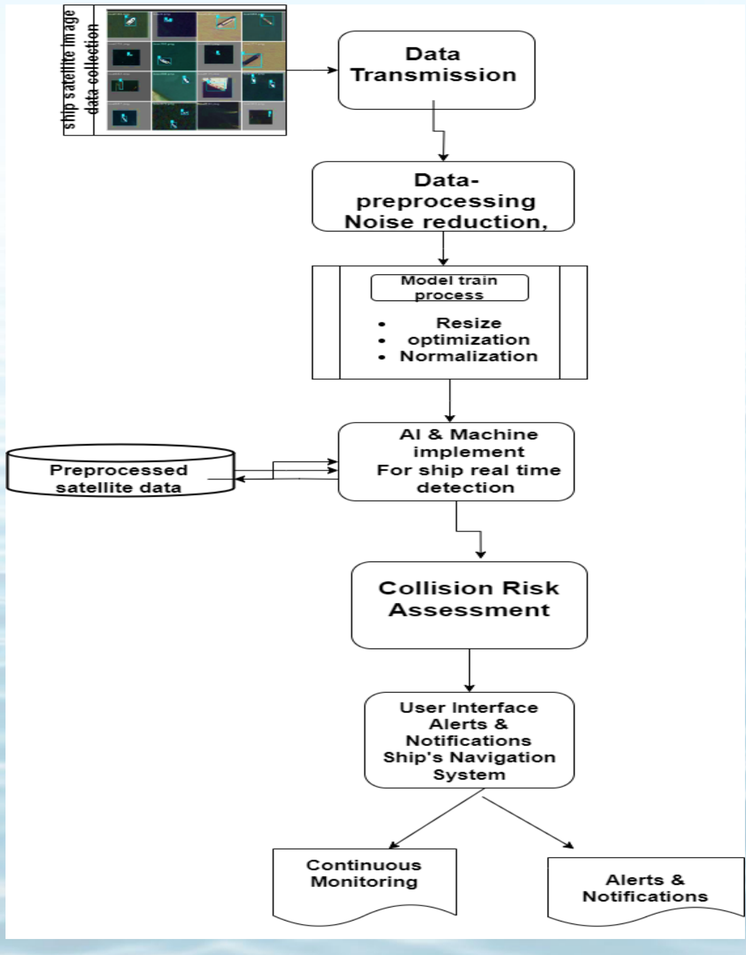

Figure 2. Architecture model and dataflow diagram for the collision avoidance system for ships using AI

8.6 Real-Time Alert Mechanism

The technology is meant to generate real-time alarms that are sent immediately to the pilots via the ship's bridge interface. The warnings comprise both visual and aural signals, which provide clear and actionable information regarding the detected ship's location, speed, and trajectory concerning the host vessel.

8.7 Validation and Optimization

the system is continually monitored and tested against actual marine operations. Machine learning models are regularly retrained with new data to increase accuracy and adapt to changing marine circumstances. Feedback from pilots and operators is used to improve the warning system and the user experience.

9.Algorithm for AI-Based Ship Collision Avoidance

The following is an overview of the algorithm used to implement the ship detection system:

9.1 Step 1 Data Collection and Preprocessing

The procedure begins with the collection of a large dataset of ship photographs from various maritime situations, such as ports, open seas, and congested routes. These photos are based on satellite data, onboard cameras, and other pertinent sensors. The obtained data is then annotated to identify the ships and other noteworthy items in the photos. The photos are scaled and normalized to guarantee uniformity, which is required for accurate model training.

9.2 Step 2 YOLO Model Initialization

The YOLO model is set up using pre-trained weights from an appropriate dataset, such as COCO or a bespoke maritime dataset. The model is meant to divide each input image into a grid and forecast bounding boxes and class probabilities for each grid cell, allowing it to recognize many objects, including ships, in a single run.

9.3 Step 3Model Training

The pre-processed and annotated images are fed into the YOLO model for training. During training, the model learns to detect ships by optimizing the bounding box predictions and minimizing the difference between the predicted and actual ship locations. The training process involves adjusting the model's hyperparameters, such as learning rate, batch size, and the number of epochs, to achieve optimal detection accuracy.

9.4 Step 4 Real-Time Ship Detection

Once trained, the YOLO model is installed in the ship's detecting system. The technology continuously takes real-time photos from the vessel's sensors and feeds them into the YOLO model. The model analyses each image in real-time, recognizing and locating neighbouring ships by creating bounding boxes around detected objects. The model's high-speed processing capabilities ensure that even under high-traffic or demanding environmental conditions, the detection is quick and precise.

9.5 Step 5 Collision Risk Assessment

The system assesses the potential collision risk by analysing the detected ships' proximity and movement trajectories. This involves calculating the relative speed and direction of nearby vessels. If a ship is detected within a predefined danger zone, the system triggers an alert, providing the ship's pilots with the necessary information to take corrective action.

9.6 Step 6 Alert and Communication

When the technology detects a potential collision risk, it automatically warns the ship's pilots via the bridge's communication systems. The signal includes vital information about the identified ship, such as its location, speed, and direction, allowing the crew to make prompt and educated decisions. The technology could also work with other onboard systems to recommend or conduct evasive manoeuvres automatically.

9.7 Step 7 Continuous Learning and Updates

The identifying system is intended to continually learn and improve over time. New data gathered during operations, particularly from near-miss incidents or difficult detection scenarios, is given back into the system to further develop the YOLO model. This continuous learning technique ensures that the system continues to function effectively in various and changing maritime situations.

10.Device Configuration

The device configuration for the AI-based ship detection system entails strategically placing high-resolution cameras and other sensors on the vessel to ensure complete coverage of probable collision zones. These devices are linked to a central processing unit with a strong GPU that runs the YOLO model efficiently in real-time. The technology works with the ship's current communication infrastructure, such as the bridge's alarm systems, to send fast information to the crew. Furthermore, the system is designed to withstand tough marine conditions, ensuring consistent functioning even in low visibility or strong waves.

Detailed information regarding the system configuration for implementing this project work is given in Table 1.

Table 1. Show the System Configuration

Component	Specification	Purpose
High-Resolution Cameras	4K resolution, 360° field of view, night vision enabled	Captures real-time images and video of the surrounding area for ship detection.
Radar Sensors	X-band, high accuracy, weather-resistant	Provides additional data on the proximity and movement of nearby ships, especially in low visibility.
LIDAR Sensors	360° coverage, long-range detection	Enhances object detection by providing precise distance measurements.
Central Processing Unit (CPU)	Multi-core processor, high-speed data processing	Coordinates data input from all sensors and manages overall system operations.
Power Supply Unit (PSU)	Redundant power supply, marine grade, UPS backup	Provides stable power to the entire system, ensuring continuous operation.
Communication Interface	Integrated with ship's bridge system, VHF, AIS compatible	Ensures seamless communication of alerts and data to the ship's crew.

11.Result and Discussion

The attached photographs show how the AI-based ship identification system effectively identifies and localizes adjacent vessels in a variety of marine situations.

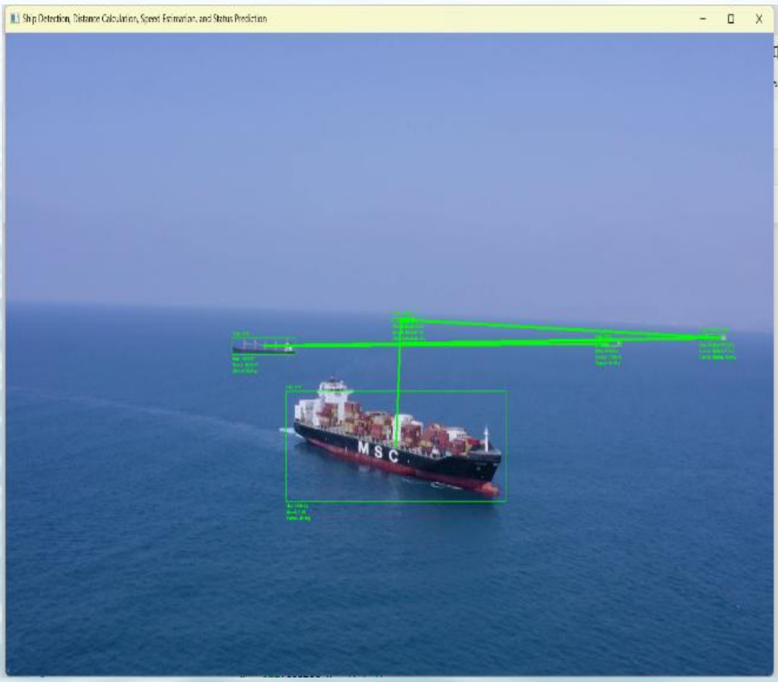

Figure 3. Show the AI-based collision avoidance for real-time ship detection

The YOLOv8 model accurately spotted ships in tough circumstances such as low visibility and choppy seas.

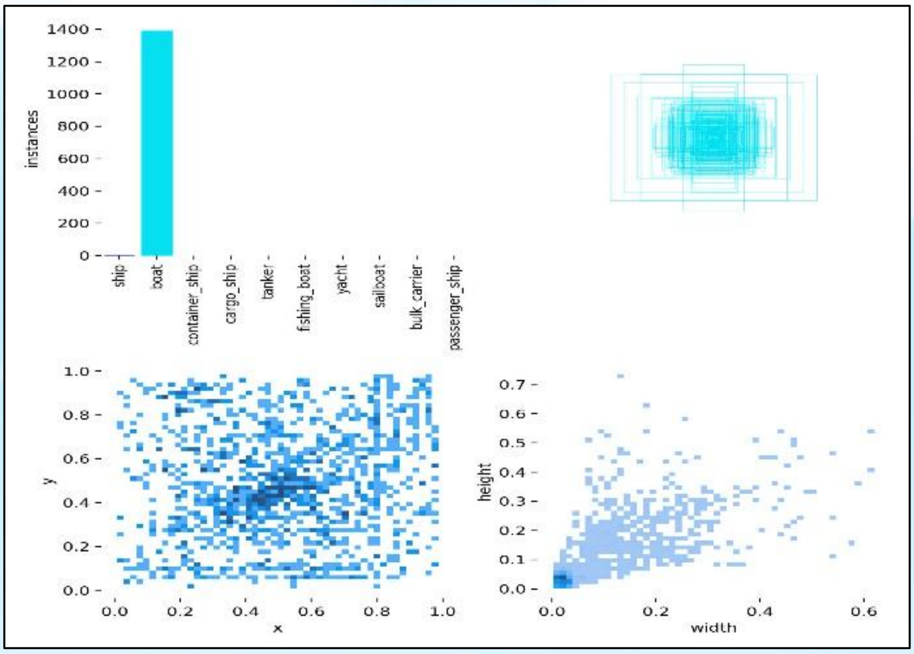

Figure 4. The image and label distribution plot for the ship satellite image

The attached photos demonstrate the system's performance in various settings, emphasizing its robustness and dependability in improving maritime safety. The debate shows that the integration of modern sensors and the YOLOv8 model has considerably increased situational awareness on board, lowering the likelihood of a collision. The outcome of the model is represented in Figure 3 to Figure 4, Which shows the real-time detection of objects and the performance of model.

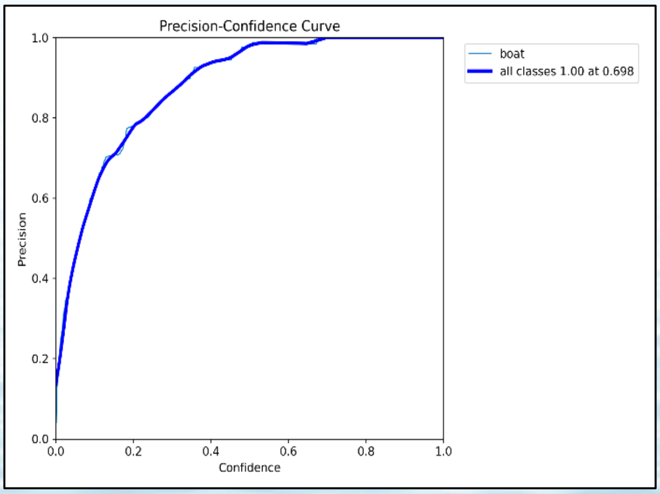

Figure 5. Representation of the accuracy plot of the model

12. Conclusion & Future Scope

In conclusion, the AI-based ship recognition and collision avoidance system represents a substantial leap in maritime safety, with an astonishing 99.06% accuracy attained using the YOLOv8 model. This technology not only improves real-time detection and situational awareness, but it also integrates smoothly with existing navigation systems, providing prompt collision alerts. Its performance under a variety of settings demonstrates its potential to become a standard in sea navigation. Future advances will most likely focus on fine-tuning the system, broadening its application to more difficult settings, and improving operational efficiency to enable even safer and more efficient marine operations.

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A LITERATURE REVIEW ON GREEN PORT AND INCENTIVES

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Abstract: The idea of green ports emerged after various initiatives to reduce emissions from port activities. Green port refers to the incorporation of environmentally sustainable practices into a port's operations and management. One of the first issues that come to mind regarding the environmental impacts of ports is carbon emissions. Carbon emissions in ports mainly arise from three main factors: handling equipment, tugboats and ships. This study reveals prominent research on carbon emissions from these factors in ports. Studies in the literature have shown that the application of new technologies, improving fuel efficiency, and adopting alternative fuels are essential strategies to reduce these emissions and their related effects. Various incentives from both industry and governments are being implemented around the world to reduce emissions. Ports provide incentives to ships based on their type or size, such as discounts on port dues, tonnage tax, and registration fees. Given the decarbonization strategies of both the World Maritime Organization and the European Union, such initiatives will increase and become even more important in the future.

Keywords: Green port; Sustainability; GHG Emissions, Decarbonization

1. Introduction

As in many sectors, sustainability is one of the most current issues in the port industry. Port sustainability can be defined as the implementation of policies and actions that effectively address the present and future requirements of port stakeholders, while simultaneously safeguarding and preserving human and natural resources (AAPA, 2007). Although sustainability comes to mind when talking about green ports, green focuses only on environmental issues. In other words, green port takes into account just one aspect of sustainable ports. Because sustainability also considers social, economic and environmental issues.

Ports implement environmental management strategies to uphold their social license and worldwide competitiveness, while simultaneously reducing any negative impacts. Certain ports use these programs to ensure compliance with regulations, while others consider sustainability to be a fundamental aspect of their operational strategy. Starting from the early 2000s, Europe has established environmental management by fostering collaboration among ports, research institutions, and specialized organizations. A proficient port environmental management system (EMS) recognizes environmental concerns that may be alleviated. Researchers highlight the need of including stakeholders in order to determine the key environmental factors that should be measured to assess the performance of a port in terms of its environmental impact (Dinwoodie et al., 2012; Şakar and Çetin, 2012; Alzahrani et al. 2021).

The emissions sources at a port can be categorized into three aspects: handling equipment, tugboats and ships. Quay cranes, RTG (rubber tyred gantry) cranes, straddle carriers, reach stackers and yard tractors for in-port transportation can be given as examples of port handling equipment. Tugboats are motorized marine vehicles that help ships maneuver quickly and safely in port areas. Ships, on the other hand, are marine vehicles that provide both short-sea and deep-sea maritime transportation services and differ according to the cargo they carry, such as containers, tankers and dry cargo. Apart from their maneuvers in the port, ships also cause GHG emissions due to the operation of auxiliary machines while they are at the berth (Alamoush et al., 2022b).

This study, which is part of the initiative known as the "Green Port Alliances" project, specifically targets the in-port services sector, which has been overlooked in the European Union (EU) Green Deal goal to decarbonize the maritime industry. The project has received funding under Erasmus+ Partnerships for Innovation-Alliances (ERASMUS-EDU-2023-PI-ALL-INNO) and receives financial support from the European Commission. The second part of the study deals with studies on carbon emissions caused by port equipment. The third section presents prominent research on ship-related GHG emissions in ports. The fourth section discusses current studies on carbon emissions from tugboats in ports. The fifth section reveals the initiatives implemented in important ports around the world regarding green ports. The final section concludes the study by suggesting future research directions.

2. Emissions arising from handling equipment

Port environmental research centers on examining energy usage and emissions inventory in order to apply specific actions aimed at reducing emissions. Compared to studies on emissions caused by ships, the number of studies on emissions from in-port handling equipment is less. However, the number of studies conducted in this field has been increasing recently.

Yang and Cheng (2013) compared RTG cranes and electric RTGs for energy savings and carbon emission reduction in container terminals. Their results showed that electric RTGs offer significant performance improvements, achieving 86.60% energy savings and 67.79% carbon emission reduction. A study conducted by Yu et al. (2017) has indicated a strong correlation between emissions from yard tractors and the placement of export containers. Sim et al. (2018) evaluated the carbon emissions of five operations at a container terminal in South Korea, including ship maneuvering, ship at berth, container loading and unloading, container transportation, container receiving and delivery, using the system dynamics method. Yun et al. (2018) proposed a simulation model to address complex stochastic processes in container terminals. Simulation experiments show that reduced speed in waterway channels can reduce emissions by 48.4% and 32.9%, while LNG use can reduce emissions by 11% for ships and 8% for total emissions. The study conducted by Martinez-Moya et al. (2019) presented crucial data on the actual energy usage and carbon emissions of Port of Valencia, Spain. According to the findings, yard terminal tractors and RTGs are the primary contributors to emissions, making up 68.1% of the total carbon emissions from the terminal. Okşaş (2023) estimated the total carbon emissions produced by container handling equipment at Ambarlı container port, which handles 30% of Türkiye's total container volume. The study revealed that yard tractors caused the most carbon emissions in the port.

In recent literature reviews, there are also studies on the effect of the use of alternative fuel, renewable energy and new technologies on reducing greenhouse gases in ports. Alzahrani et al. (2021) reviewed existing research on digital technologies for decarbonizing seaports, focusing on carbon reduction, renewable energy use, cost-performance optimization, smart control technologies, and green port practices. Hoang et al. (2022) examined advanced renewable energy technologies, clean fuels, and smart grid strategies for port-to-ship interactions. In their study, Fadiga et al. (2024) highlighted the necessity of technological innovations, regulatory structures, and cooperation among stakeholders in order to attain viable marine ports.

In the literature, when port handling equipment is mentioned, the first thing that comes to mind is the optimization of the operations in which these equipment are used. Planning port inland operations, berth assignment to ships and optimization of crane scheduling problems can be given as examples. Thanks to mathematical models developed to solve such problems, energy savings can be achieved in port operations optimization and therefore carbon emissions can be reduced. However, in many cases, too much equipment movement occurs in both shore operations and yard area operations to reduce the time that ships stay in port, resulting in excess energy consumption and carbon emissions. In this regard, it will become more important to develop multi-purpose mathematical models that, on the one hand, maximize the service quality and speed for ships and, on the other hand, minimize GHG emissions.

3. Emissions arising from ships

The activities of numerous ships are a significant source of GHG emissions at ports. Ships release GHGs during docking and departure maneuvers. Additionally, the process of idling while waiting for docking or departure permission further causes emissions. While in port, ships frequently utilize auxiliary engines and boilers to provide electricity for various aboard systems, including lighting, air conditioning, and cargo handling equipment. Typically, these engines combust marine diesel oil or heavy fuel oil, emitting carbon dioxide (CO2), nitrogen oxides (NOx), sulfur oxides (SOx), and particulate matter (Alzahrani et al., 2021).

There are various studies in the literature on ship-related emissions in ports. Winnes et al. (2015) investigated potential reductions in ships' GHG emissions from ports' efforts. The researchers calculated emissions in various scenarios, including alternative fuel, ship design, and operation. The study found that emissions from ships in the port area are projected to increase by 40% to 2030. Styhre et al. (2017) analyzed GHG emissions from ships in using data from Gothenburg, Long Beach, Osaka, and Sydney ports. The model calculates the aggregate greenhouse gas (GHG) emissions for each port to be 150,000, 240,000, 97,000, and 95,000 tonnes of carbon dioxide equivalents per year for each port. The study discussed four measures aimed at reducing emissions: decreased speed in fairway channels, on-shore power supply, decreased turnaround time at berth, and the use of alternative fuels. The extent to which emissions may be reduced is contingent upon the frequency of ship visits, with ships that make 10 or fewer calls making a substantial contribution.

Alamoush et al. (2020) classified the technical and operational steps implemented by ports to decrease GHG emissions and enhance energy efficiency. After analyzing 214 papers, researchers found a total of 7 primary categories and 19 subcategories. The findings indicate a lack of adequate investigation into the development of ports in developing countries. It is also evident that implementing a single strategy may not be sufficient to achieve decarbonization of ports, since the potential for reducing emissions, the complexity of the task, and the associated costs vary significantly. Paulauskas et al. developed an approach (2020) to evaluate the potential reduction of ship emissions in ports, taking into account the effect of human factors. The research findings indicate that the expertise and qualifications of port pilots and ship masters have a substantial impact on the execution of ship maneuvers, which in turn affects the number of emissions produced by ships. Lohuh et al. (2023) revealed that ship activities in the anchorage zone contribute significantly to air pollution in the Busan Port area. This is particularly true for emissions such as NOx (8.78%) and volatile organic compounds (7.52%), which form secondary aerosols when they react with oxidized substances.

Barone et al. (2024) analyzed the impact of electrical energy storage systems on the energy system of ships providing short-sea shipping services and therefore the environmental footprint during port stays. The authors developed a dynamic modeling tool to assess the viability of charging these devices during navigation and utilizing them as substitutes for conventional diesel generators. The findings indicate that the utilization of lithium-ion batteries and supercapacitors leads to a substantial decrease in the release of pollutants, hence resulting in a notable reduction in both fuel consumption and carbon dioxide emissions. Their study also emphasizes the importance of reducing emissions from ships during maneuvering in port areas, highlighting the need for appropriate education and training to improve decision-makers' qualifications. Qi et al. (2024) proposed a multidimensional approach to analyze carbon emissions from ships at port, utilizing AIS data, constructing a three-dimensional tensor, and decomposing it for feature extraction. Validated using Tianjin Port data, this method offers valuable insights for energy-saving and emission reduction strategies. The approach in that study, validated using Tianjin Port data, provides valuable information for energy saving and emission reduction strategies.

4. Emissions arising from tugboats

Although reducing GHG emissions is one of the most popular topics in the maritime industry, the impact of tugboats has been little researched in the literature. Tugboats play a vital role in maritime operations and significantly contribute to port emissions through the release of engine exhaust gasses. The emissions are principally caused by the burning of diesel fuel, resulting in the production of a variety of GHG. Currently, there are more than 21,000 tugboats in operation worldwide, which collectively release 40 million metric tons of carbon dioxide annually. Despite its apparent insignificance, it is worth noting that this accounts for just 4% of the overall shipping emissions (Jameson, 2022). The EU ETS System, which entered into force on January 1, 2024, will initially be applied to ships carrying cargo and passengers with a gross tonnage of 5000 and above. Therefore, tugboats are exempt from this for now due to their small size (EU Climate Action, 2024). Currently, 40% of the tugboats in the worldwide fleet are 15 years old or younger. Since tugboats may work for more than 30 years, retrofitting will be necessary to reduce carbon emissions from the whole fleet of tugboats (Jameson, 2022).

There is an increasing concern regarding port emissions, likely due to the fact that major commercial ports are situated in densely populated cities. It is crucial to understand the impact of port activities on the health of citizens and its global ramifications. This issue is of utmost importance to the public. Ortega et al. (2022) made a study to determine GHG emissions caused by the Spanish tugboat fleet from 2004 to 2017 and their impact on the country's shipping sector. The methodology used by the International Maritime Organization and Gini concentration index was applied to the fleet. Results showed that emissions concentration increased by region and decreased by age and size, indicating that tugboat activity varied by region but evolved more homogeneously with age and size. Ergüven et al. (2023) analyzed GHG emissions of tugboats in Izmit Bay, Türkiye. Their study shows that tugboat emissions account for an average of 10% of all ship emissions for port areas.

The operation of tugboats is a crucial component of port operations, and effective scheduling and planning of tugboat operations have a direct and substantial influence on the timely arrival and departure of vessels at the port. Moreover, effective planning of tugboats reduces unnecessary maneuvers, thus reducing energy consumption and therefore carbon emissions. Hence, it is useful to mention some of the current prominent studies on the subject. The tugboat operation involves the simultaneous provision of tug services by several tugboats to a single vessel at the same time. Therefore, scheduling the tugboat operation is an uncommon scheduling challenge. For this purpose, various studies have been conducted in the literature for effective planning and scheduling of tugboats. Liu (2009) proposed a hybrid evolutionary strategy algorithm to optimize tugboat scheduling problem, using a multi-dimension integer encoding and a local search strategy based on crossing-over. The algorithm effectively solves the tugboat operation scheduling problem, combining parallel and dedicated processors in a general set multiprocessor tasks scheduling. Wang et al. (2014) addressed the tugboat assignment problem in container terminals using a hybrid scheduling rule (TAP-HSR) to minimize ship turnaround time. In that study, a mixed-integer programming model and scheduling method were described, and an improved discrete PSO algorithm was proposed, showing better solutions than GA and basic discrete PSO.

Kang et al. (2020) addressed tugboat scheduling problem that involves uncertainty in the arrival and towing processing times of container ships for major ports. The authors formulated a mixed integer linear programming model and developed a special algorithm for large-scale problems. Extensive numerical experiments demonstrate the practical importance of the models and algorithms. Zhu et al. (2021) proposed a mixed integer programming model and a variable neighborhood search algorithm to minimize carbon emissions. Numerical experiments show that the model reduces emissions by 46.93% compared to dispatching rules and 10.46% with barge transshipment. Zhong et al. (2022) introduced a bi-objective, mixed-integer linear programming model for scheduling green tugboats. The first objective of the model minimizes the maximum completion time of the tugboats where the second objective minimizes the total fuel consumption of the tugboats. By doing so, the model aims to enhance port service levels, decrease operating expenses, and reduce emissions. The validity of the model is shown by a case study conducted in Guangzhou Port. The results demonstrate the trade-off between different objectives and serves as a foundation for developing scheduling plans for port tugboats. Tugboats are mostly not taken into consideration in berth allocation and crane assignment problems. An exception to this is a study by Jiang et al. (2024) on dry bulk ports. The researchers considered ship-borne emissions and the availability of tugboats in optimizing port operations. However, the emissions of tugboats were not taken into account.

5. Green Port Incentives

Climate change is a significant concern, and policies such as incentives are crucial for decarbonizing maritime transportation. Incentives schemes and grants are established to support investments in technology adoption in ports, land transport, and ships, which reduce ship emissions, waste, noise, and improve safety. These incentives advance sustainability implementation and internalize socio-environmental externalities. Port authorities provide voluntary incentives, while national, international, or intergovernmental programs often provide grants to support investment in innovative decarbonization measures (Hossain et al., 2021; Alamoush et al., 2022a).

Shipping economic measures (fees and incentives) represent 48% of global measures to reduce shipping emissions and are mainly applied by port authorities. Ports grant incentives to ships according to their type or size, such as discounts on port dues, tonnage tax, and registration fees. Incentives range from 5% to 20% discount/rebate for ships that register in one of the environmental indices or certification programs, with some increasing this percentage to up to 50% (Christodoulou, et al., 2019). International focus on port incentives for ships has led to literature recommends to reduce shipping emissions in ports, cruise ships, and ferries. The ITF and OECD study has reviewed port-based incentives aiming at reducing shipping GHG emissions and demonstrated the impacts and challenges of port-based ships incentives (ITF/OECD, 2018). There are various incentives launched around the world, both by industry and governments. Some of these are briefly explained below.

The ESI (Environmental Ship Index), initiated by World Port Climate Initiative (WPCI) and the International Organisation of Ports and Harbors (IAPH), allows ports to register as incentive providers for certified ships by registering fuel consumption and air emissions. Ports offer incentives as percentage reductions in port dues, with examples including New York, Los Angeles, Rotterdam, Antwerp, Hamburg, Le Havre, Busan, Tokyo, and Dubai (Becqué et al., 2017; ITF/OECD, 2018).

The CSI (Clean Shipping Index), founded by public authorities and run by shipping stakeholders in Gothenburg, Sweden, is an online tool used by shippers and ports to compare fuel efficiency in cargo car riers, reducing the environmental footprint of supply chains. Ports like Stockholm, Gothenburg, Vancouver, Prince Rupert, Turku, Petroport and Mariehamn use the CSI for environmentally differentiated port dues (CSI, 2024).

The GA (Green Award) is a private initiative in Rotterdam aimed at promoting shipping safety and environmental protection in the Netherlands and beyond. It involves oil, chemical, and bulk carriers, requiring shipowners to inventory emissions and implement measures to reduce them. Ports such as Rotterdam, Amsterdam, Hamburg, Barcelona and Buenos Aires provide GA-based incentives (e.g. discounts on port fees, etc.). The GA also has a waste module which is designed for ships that take responsible initiatives on ship waste to be recognized in the GA ship certification program. It serves as a verification body for port reductions on ship waste fees, aligning with the EU Directive (EU) 2019/883. Waste handling has been integrated into the Green Award program for over 20 years, making it a logical step for Green Award to cooperate (GA, 2024).

RightShip's GHG Rating rates commercial vessel emissions, ranging from A to E. It's the gold standard for emissions comparison in the shipping industry and incorporates EEXI values. Ports can assess emission profiles to develop decarbonization strategies, such as port incentive programs, to attract more efficient vessels (RightShip, 2024).

GM (Green Marine) is an environmental certification program for the North American (USA and Canada) marine industry, certifying ships, ports, terminals, and shipyards for better environmental performance in air emissions reduction, water pollution, noise, and garbage indicators. The program is now available to European shipowners through a partnership with Surfrider Foundation Europe (GM, 2024).

National governments and port authorities also initiate various incentive programs for ships to reduce Sox (Sulphur Oxides) or NOx (Nitrogen Oxides) emissions. These programs, such as the Green Ship program in Long Beach, Finland's Investment Aid, Hong Kong's Fair Wind Charter, Norway's Business Sector NOX Fund, and Sweden's Differentiated Port and Fairway Dues program, support the adoption of emissions reduction technologies and alternative fuels. These programs depend on revenues from emissions tax and tariff changes (Alamoush, et al., 2022a).

Current shipping incentive schemes may not significantly change shipowners' decisions to invest in green technologies on operating ships. Port costs account for only 10% of ships' voyage costs, and port dues account for almost 10%. However, port dues represent almost half of European ports' revenues. Port authorities typically provide financial incentives and rebates for ships that comply with incentive programs, but it is important to assess whether the incentive received can cover the extra cost of being greener. A high value incentive can be profitable and make a good business case for shipowners (ESPO 2019; Alamoush et al., 2022a).

Port authorities should offer discounts on port dues, pilotage, towage, anchorage, and other port fees. Other incentives, such as booking and docking priority, can contribute to reducing ship turnaround time and port demurrage. Some ports provide electricity tax exemption for ships using OPS, while others provide rebates related to ship emissions performance on the waste collection fee (COGEA, 2017; Mjelde et al., 2019).

6. Conclusion and Future Research

Ports are one of the most important links in the supply chain. Rising levels of activities in ports undoubtedly cause environmental problems, including high energy consumption and high GHG emissions, with high health impacts among populations living in coastal cities close to ports. The idea of green ports emerged after various initiatives to reduce the number of emissions from port activities. Green port refers to the incorporation of environmentally sustainable practices into a port's operations and management. One of the first issues that come to mind regarding the environmental impacts of ports is carbon emissions. Carbon emissions in ports mainly arise from three main factors: handling equipment, tugboats and ships. The number of studies on carbon emissions caused by port handling equipment has been increasing in the literature, especially in the last decade. The vast majority of research on port handling equipment is focused on efficient planning of equipment. For this purpose, optimization models have been developed in studies. Such models can also be used in the field of decarbonization, as efficient planning and use of port handling equipment will also allow for the reduction of carbon emissions. Emissions of GHGs from ships in ports are of significant importance due to their significant impact on global climate change and local air quality. Studies in the literature have also shown that the application of new technologies, improving fuel efficiency, and adopting alternative fuels are essential strategies to reduce these emissions and their related effects. In the literature, there are very few studies on the emissions caused by tugboats in ports. Studies on tugboats have mostly been about operational planning. However, in recent years, the number of studies on emissions caused by tugboats has been increasing.

Various incentives from both industry and governments are being implemented around the world to reduce emissions. Ports provide incentives to ships based on their type or size, such as discounts on port dues, tonnage tax, and registration fees. Moreover, various indices have been developed by different institutions to measure emissions caused by ships. Taking these indices into account, ports offer significant incentives to shipping companies, especially discounts on port fees. It can be said that such incentives will increase even more in the future. Given the decarbonization strategies of both the World Maritime Organization and the European Union, such initiatives will increase and become even more important in the future. Future studies to individually investigate the ports that best implement decarbonization and incentive practices and to standardize this would be very useful.

Acknowledgements

This study is part of the project called Greenport Alliances, funded with support from the European Union's Erasmus+ programme. Project Number: 101139879.

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CLASSIFICATION ANALYSIS OF BULLYING EXPRESSIONS IN MARITIME

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Abstract: While the importance of the human factor in the maritime domain should be as old as maritime history, the consequences of the late recognition of this importance are manifested today as the unpredictable effects of the human factor in the vast majority of maritime accidents. Human factors in maritime involves not only assessing the cognitive activities of seafarers in terms of parameters such as safety and crisis management, but also examining the effects of negative behavioural patterns such as bullying, abuse, harassment and mobbing among seafarers. While research on seafarers' mental health generally focuses on more visible issues such as long voyages, isolation, age and gender equality, the invisible tip of the iceberg is the lack of clarity on the differences between a male-dominated hierarchy and bullying. Workplace bullying refers to a situation where a person or a group of persons repeatedly and regularly harasses, offends, socially excludes or negatively affects an employee's work task over a period of time (Einarsen, Hoel, Zapf and Cooper, 2003). In this review, we examined the use of magazine and condescending expressions reflecting the bullying culture and the effects of this situation on the mental health of seafarers by including the grey literature. We aim to reveal a framework on bullying and harassment culture among seafarers by collecting previous studies.

Keywords: bullying; human factor; seafarers

1. Introduction

The maritime industry the organisations within it are surrounded by macro external factors such as technology, demographics, political/legal factors, social/cultural factors, natural factors and economy, as well as micro external environmental factors such as shippers, substitute modes of transport, suppliers and distribution channels [1]. Depending on the organizational culture, the basic functions required for the operation and management of a ship include contracting and enforcement, financial management, communication and information management, human resource management, risk management and insurance, supervision and quality improvement market research and marketing. Among these functions, communication and information management provides management of data flows and communication for operation and management units [2]. Human resources management, on the other hand, covers activities such as identifying adequate manpower, organizing training activities, performance evaluations and determining the wage policy, in terms of human resources management, there are differences in demographic characteristics among the individuals who perform this profession and should not be ignored. Human beings act with the idea the student years and the continuity of the culture and the development of the sector are developed with the idea of belonging to this society. Although autonomous processes have started to develop in the sector today, it is clear that the human factor has an unchanging place. Considering the severity of the working conditions on ships which is the working area of maritime laborers and the conditions according to the labor law. They have to struggle with many psychological difficulties and discrimination that affect their relations with other people in common living spaces and their productivity in business life.

Temporal differences in the working conditions of the sector, where personnel and operational management processes are carried out with the idea at safe management, cause individuals to be affected in their cognitive psychology. Stress, fatigue, nutritional disorders, etc. which are among the norms affecting cognitive psychology can be listed as the difficulties that seafarers are directly exposed to. Fatigue and stress represent a state of physical and/or mental weakness and affect everyone regardless of occupation and cultural influences. It is also a symptom accompanying many diseases and is recognized as one of the most frequent reasons for seeking medical attention [3]. Maritime stressors lead to typical stress symptoms such and insomnia, loss of concentration anxiety, low tolerance, changes in eating habits, psychosomatic symptoms and illnesses and overall decreased productivity with the possibility of burnout and chronic liability syndrome [4]. Problems caused by shift work lifestyle, mainly manifested by chronic sleep deprivation hormonal imbalance, inflammation, impaired glucose metabolism and irregular cell cycles. Individuals are exposed to fatigue and stress as result of intensive work, and their metabolic health is at risk, along with nutritional disorders. Such long–term conditions lead to a range of health disorders such as obesity, metabolic syndrome, type II diabetes, gastrointestinal dysfunction, impaired immune function, cardiovascular disease, excessive sleepiness, mood and social disturbances and increased cancer risk [5].

In addition to the cognitive problems, the intimidation behaviors of the sea people who play a role in the organization, especially the intimidation behaviors applied by the superiors to their subordinates, are also frequently seen. The intimidation behavior, which is defined as trying to get rid of competitors by strengthening one’s own position by applying moral pressure on employees or by directing employees to mistakes can be seen in all other occupational groups [6]. Although intimidation behavior is seen as a behavior of dismissal from work on the basis of professions, sexist discrimination among seafarers, especially against women seafarers is frequent [7]. Due to differences in the maritime sector women are disproportionately victims of workplace bullying and harassment compared to men. The mobbing has become more visible with the lack of crew and technological developments [8].

This article focuses on the types of cognitive impairment caused by intimidation in the maritime sector and the concept of gender inequality, grey literature and confusion about mobbing. The grey literature problem makes it difficult to solve the problems in the maritime sector and negatively affects the mental health of maritime workers. In this respect, protecting the mental health of maritime workers and ensuring gender equality are of great importance for the sustainable development of maritime life.

2. Method

The literature on bullying and mobbing in the maritime sector must be understood for a number of reasons, including the need to characterize incidents, understand their causes, develop preventative measures, create a safe and healthy work environment, protect seafarers’ rights, and fulfil legal requirements. In this study, researches on bullying and mobbing in maritime industry, including grey literature, were systematically reviewed. To classify various study categories concerning maritime matters. The logical and systematic classification of many distinguishing characteristics was aided by the use of a classification system. It was selected from popular databases that the Istanbul Technical University library network permitted access to, including Google Scholar, Web of Science, PubMEd and Semantic Scholar. This study includes and analysis of 150 articles that were published covering the years 2009-2024. In order to evaluate a substantial number of articles related to bullying and mobbing in maritime industry, relevant keywords and date ranges used during the literature review process for alignment with the objectives of our study are illustrated in Figure 1.

Keywords :

Years:
2009-2024

Figure 1. Flow of the search method.

Through an analysis of previous studies, this study aimed to clarify bullying and mobbing in the maritime industry, determine its origins, and suggest actions that would increase seafarers’ understanding of this issue. In order to precisely determine the psychological, behavioural and physical elements that lead to bullying, particularly for female seafarers, the literature search was broadened to include phrases like ‘gender inequality in maritime’. The study also aimed to explore the impact of bullying and mobbing on seafarers’ mental health and job performance, providing a comprehensive understanding of this issue within the maritime industry.

The research objects' methodology emphasizes on self-reporting as the main means of investigating workplace psychology, featuring particular emphasis on bullying and harassment at work. Self-reporting is employed since it is straightforward cost-effective, and effective in obtaining data from a significant participant pool, with the main emphasis on comprehending individual perceptions of their surroundings [8].

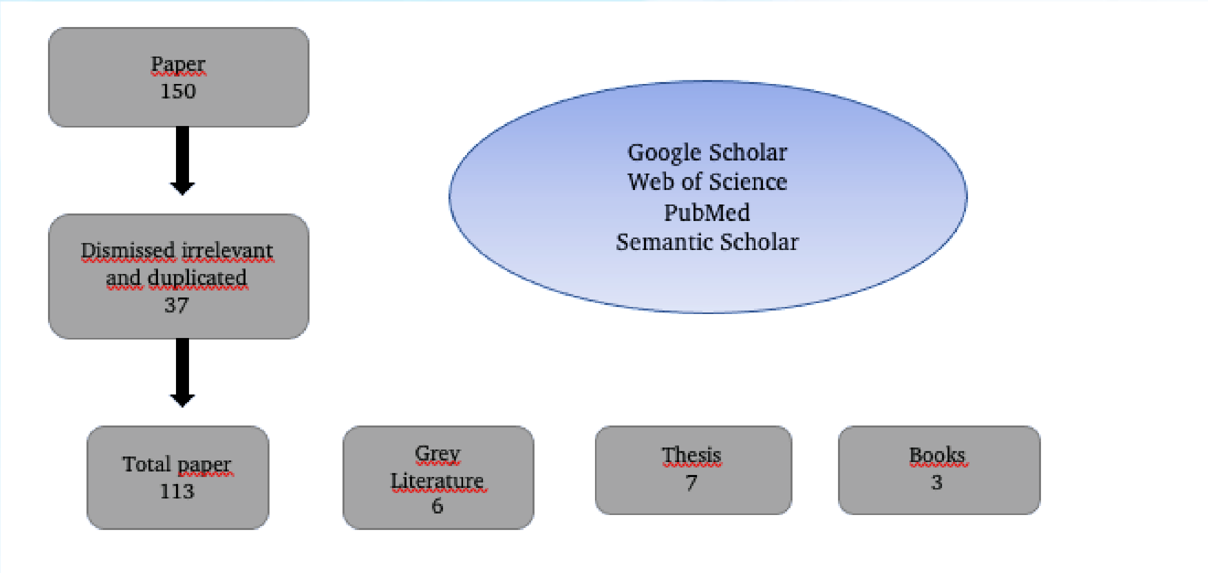

Figure 2. Flowchart of the literature search and selection method.

In our study, while collecting data and information on publications on harassment and bullying in the maritime industry, we also consulted sources that are not included in the official and scientific publication tools, known as 'grey literature', but which contain data, reports or reviews that may be relevant to the issue. Information on harassment and bullying in the maritime industry was obtained through internet searches for papers on seafarers' mental health, harassment and bullying among seafarers, and harassment in the maritime industry. Diverse viewpoint and experiences of harassment and bullying in the maritime sector were gathered by means of the integration of multiple sources. Our understanding of the difficulties faced in this area was broadened by this multifaceted approach.

3.Result

Upon reviewing prior research on bullying and mobbing incidents involving maritime workers, two distinct categories of bullies have been identified: proactive and reactive. Reactive bullies frequently hey paranoid views of the world, a persistent sense of threat, interpret unintentional incidents as proactive acts, and feel that it is acceptable to respond violently when they are thought to be provocative [9]. In this Study, various literature and media examples are analyzed to better understand the effects of psychological factors such as gender discrimination, mobbing and stress in the maritime industry.

Shi, Zen and Wang (2021) aimed to draw attention State of cognitive awareness of seafarers by using fMRI Technology in their study. Cognitive psychology is seen as a branch of psychological science that focuses directly on people's minds. fMRI Technology is particularly useful for investigating intrinsic Brain activities and understanding cognitive processes and neuropsychiatric diseases [10].

Figure 3. Multi- channel wireless physiological sensor [11].

Wang N et al. Argue that acquired occupational behavior plays a lifelong role in shaping brain structures. The deterioration of cognitive psychology due to occupational reasons may cause Brain complexity. Brain complexity is considered as a valuable biomarker reflecting Brain health, aging and various Health conditions and it is important to observe [12]. According to the study, it was determined that brain complexity increased depending on the traveling time, social isolation, mobbing and stress. Together with these factors, it is thought that complexity directly affects balance and navigation skills.

According to Jepsen, Zhao and van Leeuwen, seafarer fatigue includes more than one risk factor and contributes to the development of chronic diseases common in seafarers as well as acute effects such as cognitive impairment and accidents. In addition to long shifts, port and anchorage operations can be counted as the causes of chronic fatigue. According to the study, it is necessary to address the concept of fatigue not only in this way but also in contracts and legal framework [13].

Seafarer fatigue is directly the supported by issues such as work family conflicts, gender discrimination and mobbing. Boström and Österman drew attention to the importance of supporting victims of bullying and harassments in their study with Swedish Seafarers in 2022. Addressing the concept of bullying and harassment in the sector needs to be done not only as a concept but also with a policy and legal framework. It's a thought that this disturbing behaviour can be prevented by 'crew courage' [14]. It should not be forgotten that this climate will threaten maritime trade safety.

The complexities that occur in the minds of seafarers with increasing pressure and stress can reveal cases that may results in serious death. In a study conducted by Çakır in 2021, seafarers over the age of 30 are 1.5 Times more at risk than young seafarers. Seafarers working on deck have a higher risk of medical evacuation compared to Engine room or galley personnel, which is attributed to physically demanding tasks and occupational accidents on deck. Older seafarers are more prone to cardiovascular and circulatory diseases [15].

Figure 4. Experimental scenario [11].

According to the study of Dickinson, M. (2013), employers' perspectives and experiences with female sailors varied widely. These views were frequently in the unofficial hiring practices of the companies. These practices ranged from open "equal opportunities" policies the permitted women to hold any position or rank to unofficial practices that rejected all applications from female seafarers, irrespective of their rank, credentials, or experience. There was evidence that gendered stereotypes still existed in the sector, and companies with little to no experience hiring women as engineering or navigation officers were more likely to voice them. Employers that had worked with or employed woman seafarers typically reported highly favorable things about their abilities, and a number of them as sees sed women's professional performance as being on par with-if not better than-that of men [16].

One study points out that bullying and harassment can even be considered institutionalized within an organizational. Colleagues learn to behave badly as part of the corporate culture and progression and appraisal systems are often unfair to certain individuals. In this environment, some seafarers find it very easy to make other people's lives miserable by abusing the concepts of "shipboard discipline" and "maritime traditions".

According to the Said and Behforouzi, some of the recommendations will improve the mental health of the seafarers in a positive way. The fundamental recommendations can be listed as follows:

1) Investigation of bulling in more details,

2) Building a support system for victims,

3) A supportive work environment without panic,

4) Creating motivation to feel belongingness to the work environment,

5) Motivation of the seafarers to fill complaint forms in case pf bulling or mobbing,

6) Giving adequate information seafarers of their right to report when bullied [17].

Another investigation has shown that physical sickness and declining mental health are related. An employee's well-being can help an organization succeed by preventing low production and lowering the cost of inadequate health insurance. Organizations that are progressive should make sure that the health outcomes of their programs contribute to the general well-being of their workforce. Among the key components of employee well-being are the physical workspace and the culture of the company. An organization discloses its goals for the welfare of its workforce, as required by its corporate social responsibility programmed [18].

The American Psychological Association defines bullying as a form of hostile behavior that purposefully and persistently causes harmful distress to another individual. A range of behaviors, such as physical contact, verbal abuse or more subtle acts, might be indicative of this tendency. Bullying can have serious consequences on the mental health and well-being of the victim, leading to feelings of fear, anxiety and depression. It is important for individuals to recognize the sings of bullying and take action to prevent it from occurring [19].

According to a recent study, it's critical to make sure victim and their close family members get the help they need when bullying or harassment occurs at work. It is also important for managers to know what protocols to adhere to in such circumstances. The most effective effort against bullying, though, lies in organizing preventive measures. Some issues, tough, require long-term adjustments to working and employment conditions at sector level. These include promoting climate of respect and inclusion, providing regular training on conflict resolution and implementing clear reporting procedures. By addressing the root causes of workplace bullying, organizations can create a safer and more supportive environment for all employees [20].

4. Conclusion

Because of the unique conditions of the maritime industry, incidents of bullying and mobbing often go unreported. This industry is especially susceptible to emotional and psychological issues because it involves working in tight quarters on board for extended periods of time. Several marine companies have created procedures to prevent bullying and harassment on board ships in response to increased awareness in recent years. The way the ship sails and the corporate policies both have an impact on the reporting procedure. Open lines of communication and encouraging staff members to report incidents of this kind are practices of certain companies. Certain individuals might adopt a conventional or limited view point in general the Maritime industry has reporting procedures and specialized processes in place to address bullying and mobile concerns. Bullying and mobile and incidents in the Marine sector must be legally reported, notwithstanding the fact that Report criteria vary from ship to ship and company to firm. Employees should adhere to business policies and procedures in such circumstances and seek assistance when needed.

In the literature review stress factors that threaten the health of seafarers, how cognitive psychology is affected by these stress factors, gender inequality and intimidation were analysed. Considering the negative effects of long shift hours and social isolation on seafarers in maritime life it has become more important to monitor the current conditions. Seafarers' being away from their homes and families increases psychological stress factors by causing work- family conflict (WFC) risks. Work and family conflicts exacerbate loneliness and social isolation among seafarers and have a negative effect on the job satisfaction and motivation. The pressure behaviours Applied by the colleagues of the people and the common gender inequality directly affect the cognitive psychology and jeopardize the safety of maritime trade. Some activities are carried out in terms of improving the working conditions, shift hours, isolation, wage satisfaction, mobbing and gender equality of seafarers. The Maritime Labour Convention, which is the most important of these studies, has emerged to regulate the current working conditions of seafarers and is seen as important step forward in terms of seafarers' rights. However, it should not be forgotten that the effective implementation of this convention requires continuous improvement and supervision. With the necessity of improvement and supervision, the sustainability of marine life can be ensured.

Grey literature, i.e., reports, technical documents and Industry reports that are not academic publications but provide valuable and practical information in their ideas of expertise, contribute to a better understanding of important issues such as gender discrimination and mobbing in the maritime industry have a negative impact on employee morale and productivity, leading to a loss of talent in the industry in the long term.

In conclusion, the health and safety of employees in the maritime sector should be addressed by considering not only physical but also psychological factors. In this direction, more research should be contacted to better understand the challenges faced by seafarers in terms of workload, social isolation, gender discrimination, mobbing and stress, and solutions should be developed. Improving seafarers' welfare will also improve overall work performance and safety.

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A REFLECTION ON SEAFARER EDUCATION AS PERCEIVED THROUGH THE EXPERIENCE OF BOTH SEAFARERS AND TEACHERS: AN APPROACH TO EDUCATION THAT LEAVES NO ONE BEHIND.

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Abstract: Though I growing up in environment where sailors and ships were not around, What attracted me to a career of seaferer?Having dual-purpose education of navigation and engineer and I'd like to present my toughts on dual-purpose education,as well as the charactoristics of polytechnical collage in Japan nowadays. Nowadays so many types of youngster will be on board as a students and a cadets.As a good example,I introduce my struggles and experiences I had during my career of seafer who has Developmental Disorder. I suggest one of sollution to adapt such as diversities of human resource.

Keywords: Dual-Purpose Education, HOLAS for SOLAS, Education that leaves no one behind

1. Introduction

Since April last year, I have been working as an engineer teacher at the National Maritime Polytechnical College of Namikata, a two-year college offering dual education in navigation and engineering at level 4. Before I started teaching, I worked as an engineer on a Japanese cruise liner called Pacific Venus for about nine years. I was born in Kyoto, Japan. I grew up in an environment surrounded by mountains with no sea nearby and no relatives or acquaintances who were seafarers, but as I was looking for a career path, I came to know about maritime.

I was fascinated by the profession of seafarer, where even the smallest domestic cargo ships are 70 meters long and carry cargoes of 1,000 tons, which is an unthinkable amount in everyday life, and the great responsibility of safe operation, and finally decided to go to the Namikata Maritime Polytechnical College, where I am currently working. I was fascinated by the profession of seafarers and decided to study at the Namikata Maritime Polytechnical College, where I am currently working.

1.1. Namikata

The college offers a two-year course to obtain a Class 4 navigator's or engineer's license, with one year and three months of classroom and practical training in the college, followed by nine months of practical training on a large training ship, generally in the second year, after which students take an oral examination.

1.1.1. Attractions of the College of Maritime Technology

A very compact college with about 90 students per year group.

The teachers are all licensed seafarers with a third class or higher and have practical experience.

This is one of the main attractions of the college, as all the teachers have experience as seafarers.

About 20% of the enrolment is not 18-year-olds who have just graduated from high school, but older than that.

The fact that the teachers do not have teaching qualifications and are therefore, for better or worse, not like teachers, is part of the strange charm of the college.

1.1.2. Features of education at the College of Maritime Technology

In high school, I studied without knowing "what is the use of this knowledge", and to be honest, it was not interesting. This is the first time that I have found learning interesting.

I come from a seafarers' background. If I were in the opposite position of teaching now, I would still ask myself, "How can this knowledge be used?" and "How far do I need to learn?"

All teachers have worked in the merchant ship before becoming teachers, so their relationship with students is closer to that of master and apprentice or senior and junior than to that of teacher and student.

There was also plenty of practical training, and although the ship was small (43 gross tons), it was operated by students who had just entered the college and knew nothing about it, under the guidance of the teachers. Although the ship is small, it is equipped with plant and navigational instruments that are as close as possible to those of a large ship, and I remember being impressed by the fact that the students were able to move the ship with their own hands, and I am reminded that the students feel the same way when I read their impressions from my current position as a teacher. I am reminded that the students feel the same way when I read their impressions as a teacher.

1.1.3. Realization of the effects of practical education

We feel that there is no better education than practice. Also, as the same teachers oversee both classroom lecture and practical training, it is a great feature that what is taught in class can be linked to practical training, which also leads to effective learning for the students.

In addition, the college offers dual-purpose education of navigator and engineer, disappearing in Japan these days.

Students decide whether to become a navigator or an engineer when they start their careers. Once they are employed, they can choose to work as either a navigator or an engineer as a result.

1.1.4. Reaffirming the benefits of dual-purpose education

This is introduced as a confirmation that the University offers dual-purpose education and that students themselves will decide whether to become a navigation officer or an engineer when they choose them company.

A license that you will no longer use at first glance may seem like a waste, but learning knowledge and skills that are indirectly related to your job in an environment where you can learn not only the expertise you really need but also as a liberal option and as a liberal education, fostering a sense of mutual respect will be a great help when working on board in the future. .

The sense of unity that comes from the fact that both students, who will in the future be navigators and engineers on different paths, received the same education and learned from each other in friendly competition and sometimes in cooperation, and the basic knowledge they have of each other's work has helped them a lot in their work.

1.1.5. Significance of education with elders

Secondly, about 20% of the students each year come to the college from a variety of backgrounds, including university and working life.

The age range is relatively wide, with this year's oldest being 46 years old. They come to the college partly because they are attracted by the better income, but that is only one aspect.

They are called 'elders' because they have been interested in seafaring for a long time but didn't know how to become a seafarer, or they found their way to seafarers when they were searching for a new life. We have noted that their motivations are very inspiring to the students.

There are also other influences that such elders can have on students, such as being leaders in dormitory life or providing guidance from the perspective of a member of society to new graduates who have just graduated from high school and don't know much about society from their own experiences.

But above all, their willingness to take the lead and set an example for students is a major factor.

Naturally, they have quit their jobs and are studying without any income, even though there is public assistance, so their enthusiasm is very high because of their determination. Their enthusiasm and the experience they have gained from studying in society have a positive influence on current students, and at the same time they themselves are stimulated by the young students who they share life.

2. Aiming for education that leaves no one behind

2.1. As a seafarer with a diagnosis of ADHD

I am now in a teaching position as a teacher, but when I was a seafarer I was never very good, and if anything, I was not very good at my job.

Sometimes I made mistake to consumes more fuel than necessary due to incorrect valve operation.

On another occasion, during restoration work, I made a mistake in wiring and damaged the compressor of an air-conditioning unit that had just been changed. I spent many days in despair and distress because of my inability to do my job.

Later, as I met various information, which I might have possibility of a developmental disorder (ADHD). This was because my frequent careless mistakes, excessive concentration and lack of concentration skills, such as being distracted by other things and forgetting what I should be doing, matched the characteristics of ADHD.

A visit to the hospital resulted, as expected, in a diagnosis of ADHD and medication, which was very effective.

The most significant thing is that I am now able to control my concentration.

Until I started treatment, for example, when I was concentrating on a certain task, it was difficult for me to notice when someone called out to me.

The mind of a person with ADHD tendencies is an image of a person with ADHD, various thoughts are constantly going through his or her head and various sounds are echoing in his or her head, as if he or she is in the middle of a busy street.

Therefore, when I try to work in it, I tend to completely shut out everything around me because I force myself to concentrate on that one point. Later, because of the treatment, I felt the buzzing in my head become quieter, like a wave receding, and this made it much easier for me to do my work. It is also thanks to this that I have managed to remain in the industry and continue working.

2.2. Outcomes of the on-board formation of mutual assistance

These conditions cannot be overcome by medical treatment alone. To help these young seafarers of today to overcome the afflictions of their times, it is essential to cooperate with the following onboard organizations.

2.2.1. Formation of third relationships

One is an organization like the seafarers' community I belong to, “Seafarer Group Hataokai International”

“The Hataokai International” is a social organization made up of seafarers, which aims to share and mutually encourage the work-related problems and life struggles of 'seafarers' beyond company they belong to.

The purpose of the photography exhibition on display here is also to encourage the person in front of you through photographs of people, nature and the sea taken in the course of your work, an event that has been held in various parts of the world for over 30 years.

This is why it is extremely important to build third relationships outside of such professional work, and to have comrades who share the same struggles and problems faced by the same seafarers' community and search for solutions, while continuing their "altruistic" and "social contribution" activities.

Generally, it is very difficult to open about your struggles in a working relationship, especially to other companies in a small ship. However, it is not certain that friends from different jobs can truly understand each other's advice. In this respect, the seafarers' community, which includes people of all ages and from different companies, can be a very important source of support.

2.2.2. Importance of listening closely and receptive communities beyond disposal of one’s failure

These communities are characterized by the fact that they do not directly deny or blame the person, but rather think together about what the cause of the problem might be.

I was able to work more smoothly thanks to treatment for my developmental disability, and I always try to bring that experience and perspective to the work I do today to help seafarers with the same problems and issues.

According to current problem-solving methods, when accidents or hazards occur, they are resolved by methods such as “near-misses reports” or “incidents reports”, but the solutions are currently limited to sharing examples, issuing reminders or incorporating them into training.

Of course, these things are very effective and meaningful, but it seems that they are only an external approach.

It is not only about thinking about events from the outside, but also about why the people who caused them are the way they are.

I believe that by focusing more on the inner human approach through dialogue and listening activities, incidents and accidents can be further reduced. From this perspective, I am now conscious of the appropriate way to talk to people depending on who I am talking to in my work.

3. Suggestions for elements to be added to current seafarer education

3.1. Characteristics of the modern student

3.1.1. Tendency to want answers quickly

One of the characteristic tendencies of today's students seems to be a tendency to "seek answers quickly". I think this is because the spread of the internet has made it easy to find the answers they are looking for with a single search.

However, the internet environment on board ships is not the same as on land, even though it is gradually being improved. In addition, especially in Japan, there is a lack of information on the internet in areas related to ships.

What is important in this situation is the ability to combine all kinds of information on board, such as drawings, instruction manuals and data, to find answers.

For this reason, we believe it is important to teach students as much as possible the importance of thinking for themselves and linking and combining knowledge, while at the same time fostering diversity and tolerance through exchange and dialogue activities with as many people as possible who have lived different personalities and lives.

3.1.2. Tendency not to change or value one's own lifestyle

Another feature of the trend is that the shorter time on board and the ability to have a more personal life (home, family events, etc.) are more important than higher salaries.

While it is understandably very difficult to maintain shore-based and one's own private activities when working on board as a seafarer, we are entering an era when it is important to improve the communication environment, which is still improving, and to show respect for 'personal lifestyle' as a key company policy.

3.1.3. Lack of fear experience

In modern society, the distribution of the internet and online games has created an environment of simulated experiences, allowing anyone to easily experience a variety of things.

On the other hand, even if mistakes are made in simulated spaces, they do not lead to major injuries or fatal accidents, so it is undeniable that this may have an impact on the ability to perceive crises and to respond quickly in the actual workplace.

There are situations on board where you need to feel the fear before you make a mistake that could lead to a serious accident, such as handling heavy objects, exposed rotating parts, hot areas, or, on deck, the snap-back zone of a hawser or a fall from high.

How will you communicate the fear you should feel?

In general, “hazard prediction training” is often implemented, but I feel that it should be taught one step further. However, in my case, I feel that it is important in the future to talk about examples and have students imagine what would happen if their hands or other parts of their body were to get caught in such an accident, so that they can have a simulated experience and accumulate experiences of fear.

I think that it is important in the future to let students imagine what would happen if their hands were involved in an accident. And I know that nothing can convey the true horror of the accident better than the stories of those who have experienced it.

4. These characteristics should be mastered by today's students

To summarize what has been mentioned so far, I intend the following issues should be reflected in future education.

(i) Communicate the importance of practical training and real-life experience opportunities.

(ii) Deepen insight into many knowledge and skills, not only in specialized fields.

(iii) Developing the ability to choose the best solution to things from a large number of options.

(iv) Learning about fear and how to respond to it.

(v) Developing insight into the unseen.

(vi) Aiming for education that leaves no one behind.

(vii) Respect for diversity and individual lifestyles

(viii) How to provide feedback on field experience.

So how do we reflect them?

5. HOLAS for SOLAS (Happiness Of Life At Sea for Safety Of Life At Sea)

I agree with the practice of HOLAS activities, which is the foundation of SOLAS, as well as the development of STCW improvements and METs that lead to SOLAS and practice.

5.1. Extracurricular activities complementing the curriculum

The requirements of the STCW Convention and many other international regulations demand a wide range of qualification requirements and competencies for seafarers, and colleges are increasingly driven by the curriculum, making it difficult to achieve the content described in the previous section 4 in the collaging field alone.

It is understandable that various METs are necessary to maintain maritime safety, but it is difficult to be so driven by them that they also cover education, as described in 4, without rich character development, mutual interaction and dialogue activities.

Since my time as a seafarer, I have been able to gain this kind of complementary education and experience by belonging to a seafarers' group, which was born out of a naturally occurring demand within the seafarers' community.

Based on the experiences of the small crew and other senior members of the same seafarers' group, we are convinced that the following examples of additional extracurricular activities can be practiced developing skills that will be more useful in seafarers' lives and in job practice.

(i) Regular roundtable discussions to share stories and experiences on board, to empathize with each other and to encourage friendly competition.

(ii) Friendship and encouraging activities by visiting and interviewing seafarers and their families.

(iii) Social contribution activities through photo exhibitions using photographs taken in between jobs.

5.2. Happiness Of Life At Sea

As an educator, I feel that an important factor in achieving safety at sea, including accident prevention and hazard generation, is to improve the welfare and well-being of seafarers and enrich their personal development.

In other words, it is also necessary to actively engage in activities to improve seafarers' well-being at sea, HOLAS, which is the foundation to support safety at sea SOLAS, as proposed by Professor Jin Yong Xing, the current Chair of the Maritime Technology Cooperation Centre-ASIA, at IMLA in the past. The seafarers' well-being at sea, the foundation of maritime safety SOLAS, as advocated by IMLA Chair Professor Jin Yong Xing, needs to be addressed.

6. Conclusion

The most important characteristic of seafarer's work is that it requires physical and mental labor, as well as the ability to adapt and apply oneself to various situations in a timely manner.

Many new seafarers and young seafarers can feel very anxious about the various demands made on them by their superiors in such an environment. Safety and all other competence development and METs need to support them in removing this anxiety so that they can move forward with a sense of self-belief.

This can be achieved not only through educational activities and on-the-job training at college and in the field, but also by being proactive in extra-curricular activities, increasing knowledge and building on successful experiences, regardless of the field of specialization, to gradually eliminate anxiety when tackling things.

I intend that the most effective way to maintain a harmonized synergy between education in college and education in the field is to have them explore and learn how to tackle (approach) and solve problems using extracurricular activities as a subject.

I conclude that the most effective way to improve and maintain maritime safety SOLAS is to let seafarers experience success, to let each one of them realize that they are happy to be a seafarer, that seafarers' work is interesting, that life on board is happy and that the experience on board is valuable, and to carry out activities in the hope of other people's happiness as well, and to continue HOLAS activities in the seafarers' community as a whole. We conclude that this will be a major factor in improving and maintaining maritime safety SOLAS.

7. Postscript

When I was a student, I had excellent grades, and this was also the case in practical training.

When I started working and getting on board, of course there were many useful things I had learnt at college, but naturally there were many areas where I felt that it was not enough.

Take flanges, for example. Flanges are used in many pipelines on board ships, but until I started working, I didn't even know that there were different types of flanges with the same diameter but different pressure, that is, different thicknesses and sizes.

I remember being astonished that I did not have the knowledge that I would be expected to have as a matter of course if I were a seafarer in the field.

It is not easy to cover everything that needs to be taught, as there is only a limited amount of time available for education in colleges and yet the number of mandatory curricula is large.

I always tell students that what they are taught at college is only part of the knowledge they will use on the ship, and that there is far more in the world that they do not know, and that the most important thing is to acquire "the activity of exploring that new knowledge on their own, and the methods and tricks to approach knowledge".

To this end, we see improving the well-being of seafarers, students and seafarers, and giving them the opportunity to spontaneously think about how they should explore, as the key to educating seafarers to be independent in a challenging environment.

I think the very simple and most important thing here is to be honest and sincere with the people in front of you, the students and seafarers.

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ANALYZING THE EFFECT OF PSYCHOLOGICAL VIOLENCE ON SEAFARERS' WORKING TIME AT SEA

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Abstract: The main purpose of this study is to examine the connection between the psychological violence factor that seafarers who actively continue to work at sea or who work on land in different sectors and the psychological violence factor that they have suffered/think that they have suffered during the time they are currently working on board or during the time they work on board and their distancing from the profession/thinking about distancing from the profession. The study is divided into two main sections. In the first part, the theoretical explanations of the concept of psychological violence are given. The definition and history of psychological violence, the reasons for the occurrence of psychological violence and the subheadings of the reasons related to the maritime sector, the stages of psychological violence, the types of psychological violence and the forms commonly encountered in the maritime sector, the compilation of psychological violence studies in different sectors, including the maritime sector, and finally, the definition of the intention to quit the job and its relation with psychological violence will be examined. In the second part, the study conducted to examine the relationship between psychological violence and intention to quit in the maritime sector, methodology, findings and conclusion are presented. In this study, two questionnaires were used. Firstly, Leymann's LIPT (The Leymann Invertory of Psychological terrorization) scale with 45 questions was used to measure psychological violence. According to Leymann, these factors that fall within the scope of psychological violence are listed under 5 sub-headings. These are; preventing the individual from expressing himself/herself, attacks on social relations, violence against the social reputation of the individual, attacks against the quality of life and work of the individual, and direct physical attacks and harassment. Then, a 13-question turnover intention questionnaire was used to examine the correlation with turnover behavior. These two scales, together with the form collecting the demographic information of the participants, were applied on a total of 301 employees who continue their active working lives in the Turkish maritime sector. "SPSS 14.0" program was used for the analysis of the data obtained. According to the results of the analysis after the application of the scales, there is a positive and moderately significant correlation between the total score of the psychological violence scale and turnover intention. ($r=.52$; $p<.001$) In other words, as mobbing increases, turnover intention also increases (Table 1).

Table.1 Correlation Coefficients Related to Variables

Variables	1	1a	1b	1c	1d	1e	2
Mobbing Total	1						
Personal Humiliation	,898**	1					
Criticizing	,892**	,760*	1				
Social Exclusion	,953**	,791**	,850**	1			
Social Control	,920**	,757**	,774**	,835**	1		
Physical Harassment	,846**	,676**	,723**	,778**	,799**	1	
Turnover Intention	**,526****	,485**	,390**	,488**	,529**	,447**	1
**.Correlation is significant at the 0.001 level (2-tailed)							

Intention to quit was found to have a positive and moderately significant relationship with each sub-dimension of mobbing ($p<.001$). The strength of the relationships was found to be with the social control sub-dimension ($r=.53$; $p<.001$), followed by social exclusion ($r=.48$; $p<.001$) and personal humiliation ($r=.48$; $p<.001$), physical harassment ($r=.45$; $p>.001$) and criticism ($r=.39$; $p<.001$) (Table 1).

There is a negative and low level relationship between turnover intention and age (r=.-21; p<.001), that is, turnover intention decreases with increasing age. When the relationship between age and mobbing is analyzed, it is seen that there is a negative and moderate relationship. (r=-.33; p<.001) This shows that the perception of mobbing decreases with increasing age. Analyses were conducted to examine whether psychological violence and turnover intention differ according to marital status, gender, type of ship, working time and education level demographic variables and differences were observed.

With this study, various results were obtained including demographic variables, taking into account the result of a positive significant relationship between psychological violence and turnover intention.

Keywords:Maritime, Psychological Violence, Mobbing, Leymann Psychological Violence Scale, Turnover Intention

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A RESEARCH ON IMPROVING GLOBAL ENERGY CONSUMPTION ON WITH PURE CLEAN ENERGY CYCLE

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Abstract: In this study, possible, rational and strategic measures that should be taken in the short, medium and long term in order for the overall clean energy strategy to be accepted and implemented on the international platform were envisaged. Reliable, scientific statistical data show that the increasing world population, needs and renewable energy sources that will replace the hydrocarbon-based fuels spent to produce, distribute and consume them will never be a permanent solution to the problem. It seems that global energy consumption education in the short term, energy use design and engineering works in the medium term, and all clean energy research in the long term, although difficult, can only be possible by establishing international authority, determining and implementing relevant laws and standards. In order to leave a healthy and clean environment to future generations, the global hydrocarbon-based open energy cycle, which is estimated to be used for at least fifty more years, must be replaced by completely clean closed cycle energy systems with absolutely rational measures. Completely clean energy means that all components of recyclable renewable energy systems such as wind, solar, wave and water are produced from biodegradable materials. Otherwise, with the illusion of renewable energy, the earth and even space will soon turn into plastic, radioactive, chemical and biological garbage. In this context, there is an urgent need for absolutely, rapidly, seriously, global and international scientific management, research and inventions, along with concepts such as completely clean energy and usage optimization.

Keywords: energy, international, strategy

1. Introduction

The fact that is encountered in a global context in the 21st century, but is not a surprise, is that existing energy resources are used irresponsibly by continuously increased global population at a level that threatens life and this problem has not yet been solved consciously and consistently. Population and per capita energy consumption increased between 1970 and 1980. In the 1990s, per capita energy consumption accelerated. Energy consumption and population growth rate stabilized in the first decade of 2000. Although energy consumption continued to increase between 2010 and 2020, efforts to improve energy efficiency resulted in a moderate increase in consumption (Figure 1) [1-4].

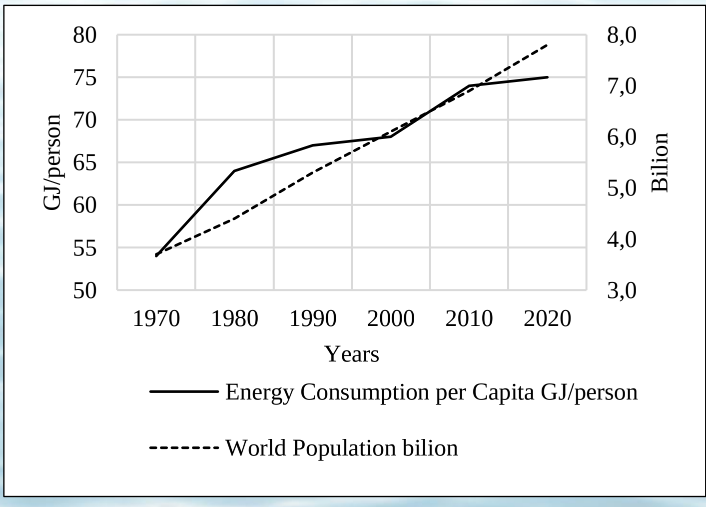

Figure 1. World energy consumption per capita in the last fifty years.

On the other hand, irresponsible use of global energy, decreased the energy usage efficiency and increased the waste energy, the amount of carbon dioxide, nitrogen, sulfur and other polluting gases and particles discharged into the air, water and soil. In case of the pollutants not reduced to the mandatory limits accepted in the Paris convention, the serious vital hazards expected to occur in the next half century proved scientifically, experimentally and observationally. Due to the rapidly developing global economic growth and industry in the last fifty years, the emission rate of exhaust gas, especially CO_2, has increased to a life-threatening level, although small decreases have been observed over time. While global SO_2 emissions have decreased significantly in developed countries in the last 50 years due to technological developments and the increase in renewable energy sources, studies continue in developing countries. Energy use improvement requires global courage and sustainable, radical solutions that are not yet fully understood. Environmental policies, clean energy and emission control technologies are the instruments required to reduce CO_2, SO_X, NO_X, NH_4 and N_2O emission levels and their vital effects on climate change and the ozone layer. However, scientific research based on statistical data does not seem to meet the administrative, financial, legal and especially technical global basic principles required for real improvement in clean energy production, transportation, storage, use and waste. (Figures 2&3) [5-28]

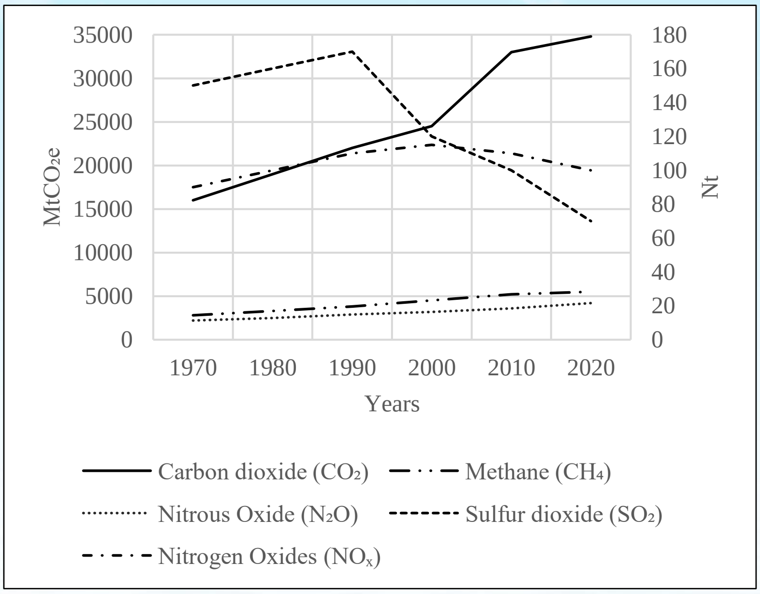

Figure 2. CO_2, SO_X, NO_X, NH_4 and N_2O emissions

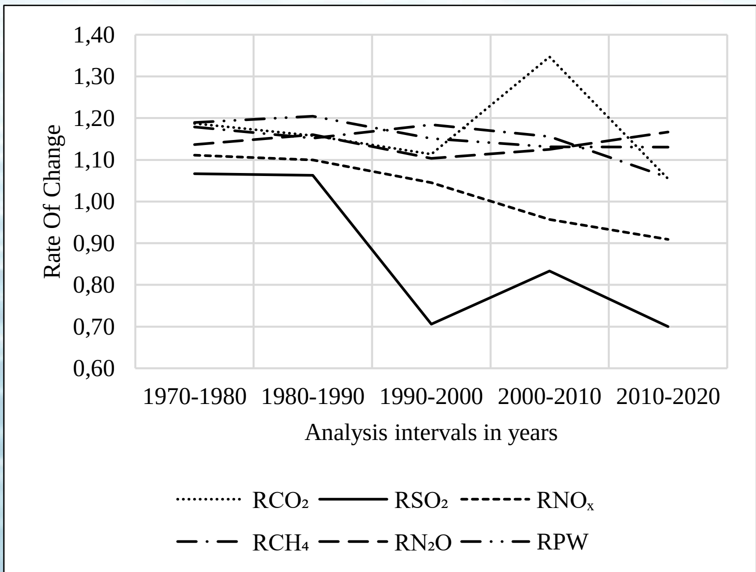

Figure 3. World population and polluting flue gases rate of changes.

Although the amount of carbon dioxide is an indicator of good combustion, the greenhouse effect it creates has become a vital factor that will seriously affect future generations by causing serious global seasonal changes in the last fifty years. While increasing the combustion efficiency in hydrocarbon-based fuel consumption, which has a large share in meeting energy needs, depends on the amount of carbon dioxide formed as a result of combustion, on the other hand, the increase in the greenhouse effect also depends on this. In this case, there is no choice but to burn hydrocarbon-based fuels in the most efficient way. However, it is certain that this remedy cannot eliminate the expected global threat to life due to its limited applications. From this perspective, global cooperation for radical and permanent clean energy use improvement has become an inevitable reality. On the other hand, finding new completely clean and renewable energy sources is not enough to solve the problem of improving the use of energy (Figure 4) [29-32]. but biodegradable energy systems design is also required. Otherwise, the world and even space will soon be filled with plastic, radioactive, chemical and biological waste. In this context, the need for a global authority that will effectively ensure the production, use and control of completely clean global energy and biodegradable systems with sustainable education and standards seems inevitable. In this study, the definition of completely clean energy was used in the sense that all components of recyclable energy production or consumption systems such as wind, solar, wave and water are made of biodegradable materials.

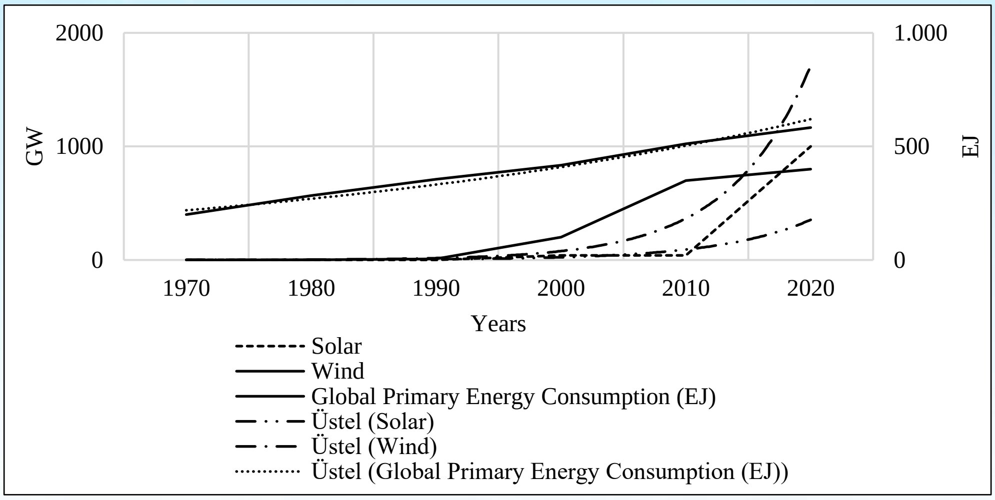

Figure 4. Renewable energy production versus to global primary energy consumption.

The comfort demand on especially in cooling and heating, has a significant share in global energy use and systems design. Until mid of 2000, the rate of changes in population and energy consumption was seemed in parallel, but after 2000 comfort energy demand was increased per capita (Figure 5) [33-40].

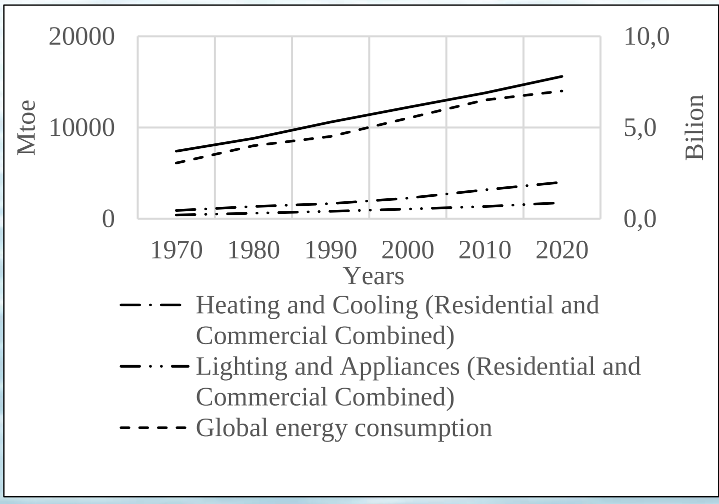

Figure 5. Comfort demand in global energy consumption per capita

Scientific statistical analysis shows that hydrocarbon-based global energy resources (Figure 6) which are life-threatening if consumed irresponsibly, have reserves of at most 50-150 years (Table 1) [41-46].

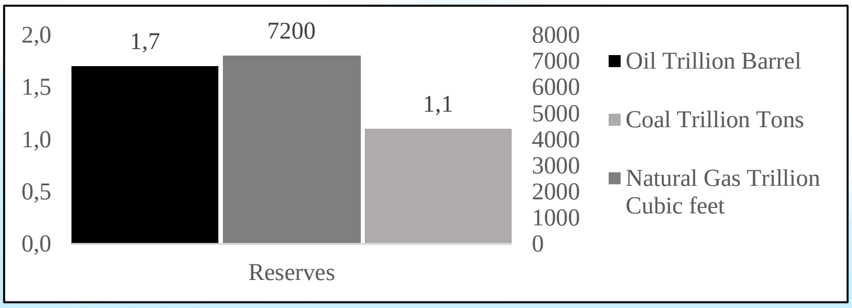

Figure 6. Estimated global hydrocarbon-based energy reserves.

Table 1. Estimated duration of hydro-carbon based energy reserves

Source	Oil	Natural Gas	Coal
Units	Trillion Barrel	Trillion Cubic feet	Trillion Tons
Reserves	2.E+15	7.E+15	1.E+12
Yearly consumption	4.E+13	1.E+14	8.E+09
Estimated duration	48.6 years	55.4 years	137.5 years

Unless open-loop energy systems (Figure 7), which are depleted with use, are replaced by reliable, sustainable closed-loop energy systems (Figure 8), looking positively to the future in terms of human and environmental health does not seem possible for at least the next 50-150 years.

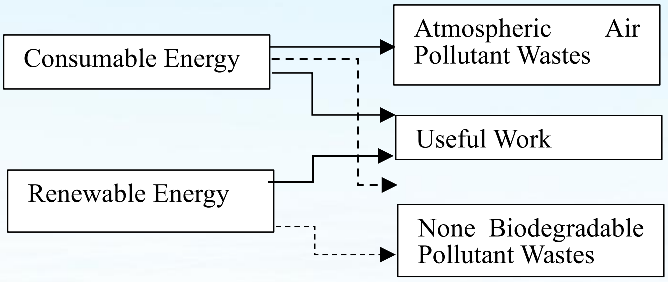

Figure 7. Open loop, polluting energy system.

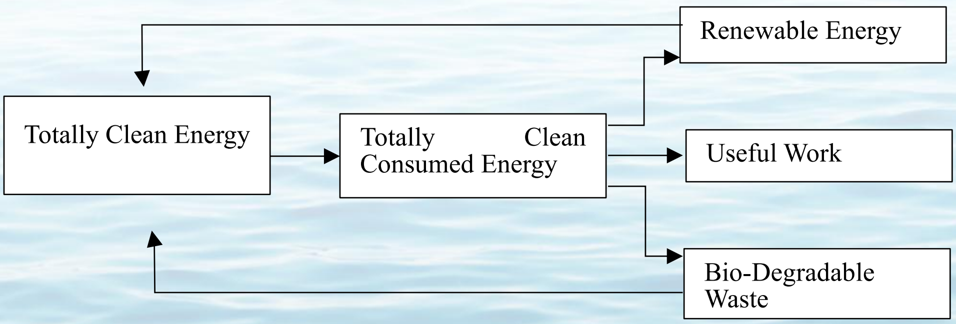

Figure 8. Closed loop, totally clean energy system.

Although the overall implementation of the clean energy cycle takes a long time (Figure 9) at least a solution to replace the increasingly accelerating hydrocarbon-based energy consumption is an inevitable and irreversible need. If this imperative need is not met, scientific statistical data show that there is nothing left but to watch the tragedy of global life. Unless completely clean new energy sources are found and biodegradable systems are developed for the production, transportation and use of these energies, this scientifically determined situation is increasingly turning into a deadly danger due to misuse of energy.

In the long term, global cooperation is required to discover completely clean energy sources and biodegradable systems and to eliminate the vital dangers posed by hydrocarbon-based energy sources. From this perspective, no matter how successful the measures to be taken in the short and medium term are, studies on the discovery, production and implementation of completely clean energy sources and biodegradable systems need to be accelerated and absolutely successful.

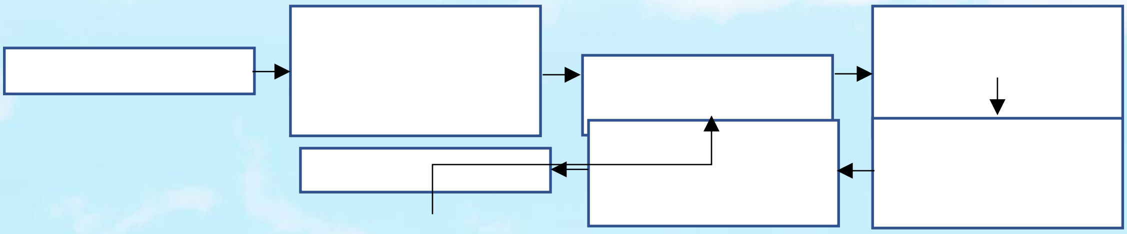

Figure 9. Biodegradable closed-loop energy systems

It is now an indispensable, irreversible fact that every effort should be made to improve sustainable global energy use optimization in the long term by means of measures that should be applied successfully in the short and medium terms.

2. Globalization phenomen in energy usage optimization

Although the global life-threatening risks at all stages of the energy use optimization process are known to everyone, the results obtained from the statistical information show that no meaningful method has been applied in this regard since today. SWOT analysis, using keywords frequently used in the literature on energy use optimization (Table.2), draws attention to the realities as well as the dangers regarding the improvement of global energy use, and shows that a long-term permanent solution can only be achieved with a very serious global sustainable scientific structuring and solidarity. Although it is not an easy goal to achieve, it is certain that energy use optimization efforts are a vital global task to be achieved for future generations and humanity [47-49]. The global structuring planned to optimize energy use will strengthen the permanent elimination of life-threatening situations, provide more effective management, and eliminate vital problems with global cooperation.

Table.2 Keywords frequently used in references related to energy use optimization.

Acceptance	Development	Innovation	Research
Adaptability	Displacement	Integration	Resilience
Advantage	Economic	International	Resistance
Awareness	Education	Investment	Resource
Behavioral	Efficiency	Job	Saving
Biodiversity	Emissions	Land	Security
Business	Energy	Leadership	Skill
Climate	Environmental	Life	Social
Collaboration	Equitable	Limits	Stability
Communication	Externality	Loyalty	Standards
Community	Finance	Maintenance	Storage
Competitiveness	Focus	Management	Subsidies
Complexity	Gaps	Market	Sustainability
Compliance	Geopolitical	Organization	Technology
Conservation	Global	Policy	Training
Control	Greenhouse	Pollution	Upgrades
Coordination	Grid	Protection	Waste
Cost	Growth	Public	Workforce
Cultural	Health	Quality	
Data Security	Incentiv	Regulatory	
Depletion	Infrastructure	Renewables	

Irresponsible use of available resources in the open energy cycle for profit has become an important threat that negatively affects the current global energy stock and cannot be ignored. Even though it may be difficult and take a long time, the establishment of a global authority equipped with necessary and sufficient powers that will determine the vision, mission, goals and tools required for the short, medium and long periods in order to improve global, sustainable energy use seems inevitable. Unless deliberately prevented, in this study, Global Energy Use Optimization (E_{OUG}) (1) was assumed to be a function of global respected Global Authority (A_G), compulsory Global Training (T_G) and Global Standards (S_G) respectively.

$$E_{OUG} \propto (A_G, T_G, S_G) \quad (1)$$

2.1. Short-term measures in energy usage optimization

Although the Paris Convention obliges the OSPAR Commission [50] to coordinate international efforts to protect the marine environment in the North-East Atlantic by implementing various programs and measures aimed at reducing pollution and protecting ecosystems, this mandate is not global. From this perspective, meaningful and consistent optimization of sustainable global energy use in the short and medium term is now an inevitable and vital reality. In order to permanently eliminate this problem, it is necessary to establish an independent global authority that will manage administrative, legal, financial and technical standards, starting simultaneously with global training program (Figure 10).

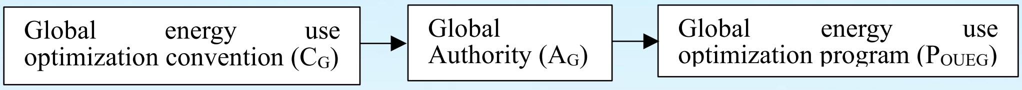

Figure 10. Global authority in energy use optimization.

Unless excessively profit-oriented energy use habits are corrected through improvement training, positive results cannot be obtained from the efforts made for medium and long-term global completely clean energy, systems and use. Global education regarding awareness, knowledge and especially application behavior in energy use optimization has become one of the dominant global issues that must be addressed without delay. In this context, compliance of all states with the energy use improvement training programs prepared by the global authority to be established, analysis of the outputs and taking corrective measures will form the basis of the studies to be carried out in the short term. Reliable data obtained from global energy use optimization training and inspections will enable the international authority to make more accurate analysis and interpretation, thus enabling scientific studies and projects carried out in the medium and long term to progress in the right direction and faster (Figure 11).

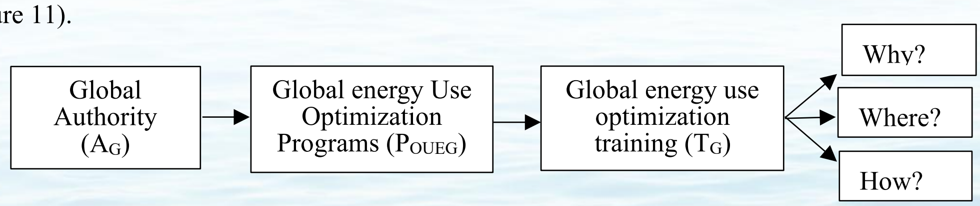

Figure 11. Global energy use optimization training.

2.2. Mid-term measures in energy usage optimization

The most effective factor in the success of global energy use optimization programs (P_{OUEG}) is the need to determine global standards (S_G) that do not include comfort demands by the global authority (A_G) (Figure 12). Determining the global administrative (S_{GA}), financial (S_{GF}), legal (S_{GL}) and technical (S_{GT}) standards that will be included in the global energy use improvement program will extend the open-ended period in the design and production of completely clean energy sources and the systems that will use these energies in the long term.

Physical, chemical and thermodynamic properties such as pressure, temperature, heat and quantity are used to determine engineering design, manufacturing and operating standards of energy-related system elements. Considering the global threat to life related to energy use, these conventional standards need to be revised as global standards (S_G) to reject persistent comfort demands but meet defined safety conditions.

If the optimized standards are rigorously implemented worldwide and become a habit, at least a 50% improvement in global saving of water, electricity, fossil, renewable and clean energy can be achieved. It was assumed that the administrative, financial and legal problems that would arise in the uncompromising implementation of Global Technical Standards (S_{GT}) would be resolved by the global authority (A_G), which derives its power unconditionally from the consensus of all global state administrations. The establishment of an independent global authority that will manage the irresponsible global energy use, which has become a vital threat, with discipline based on new global regulations and standards in the medium and long term in administrative, financial, legal and technical terms, seems to be a mandatory need.

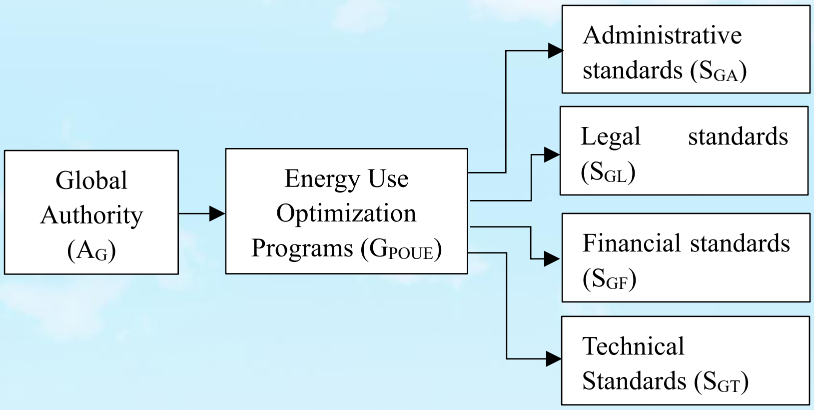

Figure 12. Global energy use optimization standards.

2.3. Long-term measures in energy usage optimization

The aim of the issues planned to be carried out in the short-and medium-term regarding energy use improvement is, on the one hand, to slow down the progress by reducing the vital threats arising from energy use errors, and on the other hand, to give time to the studies being carried out to find totally clean energy and related biodegradable systems with positive results expected in the long term. The open-end, Long-term, Energy use Optimization Time period is a variable (t_{OEL}) (2) depends on the Hydro-Carbon based Energy Usage Rate (R_{UECH}) [51-55], Renewable Energy Production Rate (R_{PER}) [56-61] and the biodegradation of energy systems components (R_{BSE}) [62-67].

$$t_{OETL} \propto (R_{UECH}, R_{PER}, R_{BSE}) \quad (2)$$

3. Former research and methodologies in optimizing energy use.

Although the completely clean closed energy cycle includes administrative, financial and legal mandatory standards, the technical standards to be determined by the authority are mandatory numerical values to be used in all applied global fields and disciplines that consume energy, as they depend on theory, calculations, measurements and experiments.

3.1. Global standardization in improving energy use

The dominant factors affecting the production, transportation, storage, use and waste stages of all kinds of energy and the administrative, financial, legal and especially technical procedures related to them are based on numerical and analytical scientific solutions and accepted standards (Table 2). For this reason, all administrative, financial, legal and especially technical standards currently in force regarding energy production, transportation, storage, use and waste need to be rearranged by the global authority to be established. The global standards to be reorganized should be the basic principles that will slow down the increase in global energy use errors, which are now understood to be absolutely life-threatening, and reset the use of clean energy. It is very difficult to determine administrative, financial, legal and technical standards for improving and controlling energy use. In order to improve global energy use, which prioritizes comfort and interests, instead of methods such as education, warning, sanctions and punishment, implementing permanent, global, mandatory global standards, although time-consuming and difficult, would be a much smarter solution.

Table 2. Global energy use improvement mandatory standards.

Mods of stages and mandotories			Production (P)	Transfer (T)	Storage (S)	Usage (U)	Wastes (W)
Requirements	(r)	Amount	S_{GTRP}	S_{GTRT}	S_{GTRS}	S_{GTRU}	S_{GTRW}
Systems	(s)	Properties	S_{GTSP}	S_{GTST}	S_{GTSS}	S_{GTSU}	S_{GTSW}
Components	(c)	Properties	S_{GTCP}	S_{GTCT}	S_{GTCS}	S_{GTCU}	S_{GTCW}
Dimensions	(d)	Seizing	S_{GTUP}	S_{GTUT}	S_{GTUS}	S_{GTUU}	S_{GTUW}
Limitations	(l)	Values	S_{GTLP}	S_{GTLT}	S_{GTLS}	S_{GTLU}	S_{GTLW}

Global energy management system (S_{MEG}) includes the needs, facilities, facility components, size, limitation (r, s, c, d, l) in the energy production, transportation, storage, use and waste stages (P, T, S, U, W) must have the capacity to collect data regarding the determined standards, conduct multiple analysis, take necessary precautions and impose sanctions (3).

$$S_{MEG} \propto [P, T, S, U\ W] \times [r, s, c, d, \ell] \quad (3)$$

In the long-term solution, qualified energy savings and environmental cleanliness can be achieved by improving global electricity use in biodegradable systems with a certain electrical power that is designed, produced and used in accordance with the global standards determined by the authority. It will not be possible to change these values based on global standards for benefit and comfort purposes. This hypothesis also applies to other phases of the totally clean energy use optimization programs. As application areas expand and diversify, mandatory global technical standards will also increase. What is important here is to accurately and precisely determine and comply with engineering design, production, usage and waste standards that will fully comply with the principles of optimizing energy use.

3.2. Mandatory standards to apply global energy management

Global energy use improvement standards are the basic, rational and measurable values required mandatorily implemented at all stages of a completely clean, closed-loop energy management system (4). In determining the set of mandatory standards for short, medium and long-term global energy use improvement programs, energy need (r), system (s) in which energy will be used, system elements (c), dimensions (d) and limitations (ℓ) are the dominant application areas that can be expanded according to need. Existing or newly discovered completely clean energy sources that will be needed in the short, medium and long term, systems and system components required for production, transportation, storage, use and waste, dimensions and limitations regarding industrial design and manufacturing are included in the scope of these standards. The main purpose of all standards to be determined is to provide rational improvement in events at all stages without compromising safety and security It is necessary to determine the dominant independent factors that will determine the standards to be prepared to achieve sustainable meaningful improvement in the production, transportation, storage, use and waste stages of electricity, water and fuel in totally clean energy closed loop (Table 3).

Table 3. Mandatory global fields and standards to be implemented in totally clean energy closed loop.

Independent variables		Dependent variables														
		Phases and fields														
Mandatory global standards.	Unit	Production			Transfer			Storage			Usage			Waste		
		Electricity	Water	Fuel	Electricity	Water	Fuel	Electricity	Water	Fuel	Electricity	Water	Fuel	Electricity	Water	Fuel
Dimensions	w, l, h, r, etc.	PED	PWD	PFD	TED	TWD	TFD	SED	SWD	SFD	UED	UWD	PFD	PED	PWD	PFD
Flow rates	m^3/h	PEFR	PWFR	PFFR	TEFR	TWFR	TFFR	SEFR	SWFR	SFFR	UEFR	UWFR	UFFR	WEFR	PWFR	WFFR
Power	kW	PEP	PWP	PFP	TEP	TWP	TFP	SEP	SWP	SFP	UEP	UWP	UFP	WEP	WWP	WFP
Pressure	kg/cm^2	PEp	PWp	PFp	TEp	TWp	TFp	SEp	SWp	SFp	UEp	UWp	UFp	WEp	WWp	WFp
Temperature	C°	PET	PWT	PFT	TET	TWT	TFT	SET	SWT	SFT	UET	UWT	UFT	WET	WWT	WFT
Velocity	m/s	PEv	PWv	PFv	TEv	TWv	TFv	SEv	SWv	SFv	UEv	UWv	UFv	WEv	WWv	WFv
Volume	m^3	PEV	PWV	PFV	TEV	TWV	TFV	SEV	SWV	SFV	UEV	UWV	UFV	WEV	WWV	WFV
Weigth	kg	PEW	PWW	PFW	TEW	TWW	TFW	SEW	SWW	SFW	UEW	UWW	UFW	WEW	WWW	WFW
Limitations	max.	PEL	PWL	PFL	TEL	TWL	TFL	SEL	SWL	SFL	UEL	UWL	UFL	WEL	WWL	WFL
Time	s	PEt	PWt	PFt	TEt	TWt	TFt	SEt	SWt	SFt	UEt	UWt	UFt	WEt	WWt	WFt
Heat	cal	PEH	PWH	PFH	TEH	TWH	TFH	SEH	SWH	SFH	UEH	UWH	UFH	WEH	WWH	WFH

3.3. Influence of the mandatory standards on the global energy future.

It was envisaged that the global standards to be determined by the authority with independent and dependent variables, without considering personal and national interests and comfort, would reduce flue gas emissions and increase their quality by providing 40%-60% energy savings in the short, medium and long-term stages of the energy improvement program. On the other hand, it was assumed that the independent and dependent variables that make up the global standards could be expanded by the authority when necessary. Although the determination, acceptability and implementation of mandatory standards for all stages of the global energy use improvement program may seem very difficult and impossible for a few generations in terms of personal and national interests, the 50-100-year consumption period of all existing energy resources and the effects they will create during this period considering the life-threatening situation, it is an inevitable fact that must be dealt with.

The standards to be determined by the authority are scientific, measurable, precise numerical values that are completely loyal to the principles of improvement, and there should be no possibility of personal or national change during the design, manufacturing and use stages. For example, the level of illumination required for eye health, the pressure and amount of water to flow from the sink fixtures, the amount of electricity, water and fuel to be consumed by the factory, the type and size of packaging material, the speed of vehicles such as cars, trains, elevators and escalators, etc. Here, increasing the speed, size, quantity and type for personal and national benefit and competition is out of the question. Since global standards will be the standard for everyone and every nation, it is out of the question to change these values when the vital danger that will be faced after 100 years at most is well understood. From this perspective, inventions such as solar panels, lithium-ion batteries, multi-headed combat missiles, and genetically modified food production, which we console ourselves with excuses such as comfort, security, and communication for personal and national interests, are temporary. These behaviors will not be able to eliminate the life-threatening situation that is determined by reliable statistical data and analysis to occur within 150 years.

4. Conclusion

Meeting the needs related to population growth, comfort, personal, national and international interests with an open energy cycle cannot be a solution to the sustainable improvement of energy use in the short and medium term. Some success can be achieved on an individual basis in the short and medium term with training on the economical use of energy produced using all available resources. Structuring the global authority that will ensure the management and control of a completely clean closed-loop energy system and determining mandatory, especially technical, standards will provide reliable and sustainable solutions for events at every stage of energy. Although it is very difficult to achieve this goal on a global scale, the vital danger that is expected to occur within 150 years, according to reliable scientific statistical data, must be permanently eliminated. Studies and research on completely clean energy sources such as electricity, water, wave, wind and hydrogen, and the design of completely biodegradable systems and system components that will be involved in the production, transfer, storage and use of these energies need to be accelerated. An authority that will manage the completely clean, global closed energy cycle with mandatory standards must be established.

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DETERMINATION OF NEW TECHNOLOGIES AND FUTURE SKILLS OF SEAFARERS TOWARDS SMART SHIPPING

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Abstract: The maritime industry has focused on increasing the energy efficiency of ships to achieve more sustainable and greener shipping. Shipping is also investigated new technologies and approaches through the impact of Industry 4.0. In this regard, this paper addresses initiatives such as artificial intelligence, the Internet of Things, big data analytics, cloud computing, cybersecurity, blockchain, augmented reality, digital twins, additive manufacturing, and advanced robotics which are considered to be adopted on smart ships in the future. These innovative technologies are expected to be overly placed onboard within more digitalized and autonomous ship concepts. On the other hand, the rapid developments in the system components and differences in operations onboard reveal a need regarding new skills and competencies for seafarers. Identifying the human abilities required for the efficient management of the operations of smart ships is essential for sustaining efficient operations within marine vessels. This paper categorizes the skills into the four classes such as technical, cognitive, social, and individual. Different types of competencies such as adaptability and flexibility, energy efficiency knowledge and awareness, self-learning motivation, teamwork, communication, skills to cope with complexity, reasoning and decision making, monitoring and analyzing data via software environment, data processing, etc. are determined under these categories. The paper presents significant knowledge on the possible technologies and skills for seafarers to sustain effective operations in future shipping to maritime companies, stakeholders, and researchers interested in the relevant field.

Keywords: Maritime; Industry 4.0; Shipping 4.0; Digitalization; Future skills of seafarers; Smart shipping

1. Introduction

Digitalization forces all sectors to take action beyond their limits and encourages them to constantly review their values and interactions within the scope of adaptation to the changing ecosystem (Heilig et al. 2017). Industrial evolution includes 4 stages on the way from steam engines to automation, as illustrated in Figure 1 (Culot et al. 2020; Oztemel and Gursev 2020).

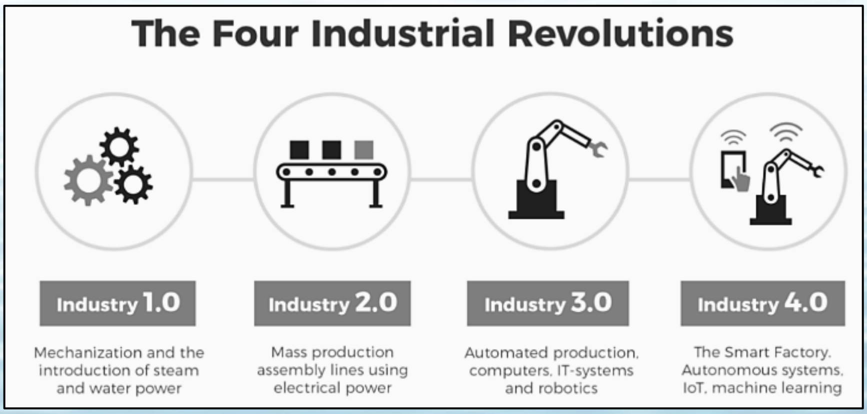

Figure 1. The industrial revolution.

Industry 1.0 was revealed by the mechanization of generation thanks to hydroelectric and steam-powered equipment. In Industry 2.0, mass production using electric power was performed. Industry 3.0 encouraged the advent of computers and the automation of production. Lastly, Industry 4.0 is mainly known for adopting smart technologies to produce intelligent systems (Emad et al. 2020).

Developments, especially with the rise of new technologies in recent years, are causing the maritime sector, like other sectors, to change faster than ever. On the other hand, the maritime industry is seen as one of the four cornerstones of globalization, which has a direct impact on global trade (Zaman et al. 2017). In this sense, the rapid introduction of different technologies in the maritime industry and the definition of the gradual transition of autonomous ship concept from the experimental stage to the application stage are of great importance.

The pathway of smart shipping within a more digitalized vehicle concept that is called Maritime Autonomous Surface Ship (MASS) has been introduced by the International Maritime Organization (IMO) (IMO 2018). The transition consists of 4 stages where different levels of human-machine interactions are required. While Degree 1 includes some automated systems within the ship, Degree 4 represents autonomous ship design where auto navigation may perform without any human interactions (Karatuğ et al. 2022). The pathway and description of degrees have been shown in Figure 2.

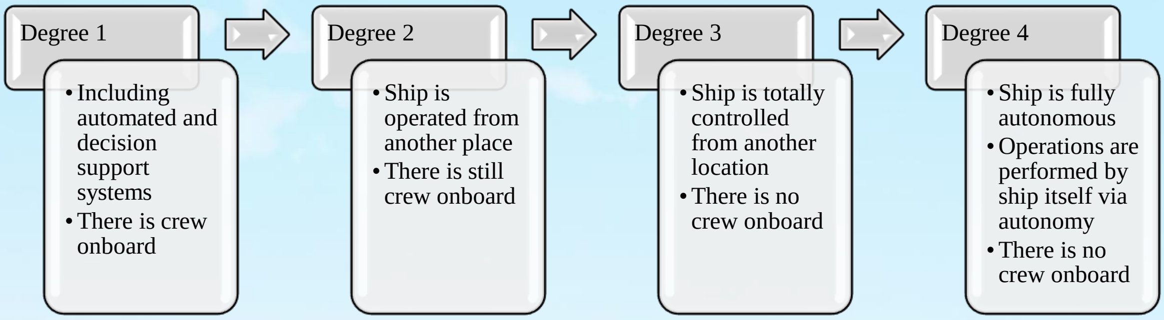

Figure 2. The pathway of the MASS

On the other hand, the rapid developments in the nature of the shipping industry and the marine vessels create several differences within the operations (Shahbakhsh et al. 2022). One of the main challenges is the definition of the human element and its role within the new concept ships in the future. It is observed that the correlation between common practices, current competencies, and future trends is getting weaker (Oksavik et al. 2020). To eliminate this weakness, the human roles, skill standards, and requirements for the efficient operation of digitalized systems should be reviewed and re-shaped concerning the employment of the maritime business. In addition, new abilities and system requirements should be defined considering the digitalization process (Sharma and Kim 2022).

This paper has presented Industry 4.0, its impact on the shipping industry, and seafarers' required skills for more digitalized marine vehicles. In this regard, the new technologies for maritime business that need to be adopted due to technological developments such as artificial intelligence, the Internet of Things, cyber security, data analytics blockchain, etc. have been given. Moreover, the possible application areas of these technologies onboard have been introduced. In addition, it is clearly understood that the rapid developments in technology reveal new skill requirements for seafarers. In this sense, the competencies needed have been presented under four categories such as technical, cognitive, social, and individual.

The remainder of the paper is as follows: Section 2 presents the new technologies, approaches, and their possible application fields onboard that are revealed due to Industry 4.0. Section 3 addresses the new skills and competencies that need to be adopted by seafarers to perform efficient operations onboard in the future. The conclusions of the paper are given in Section 4.

2. Industry 4.0

The concept was first presented within the initiatives made by the German government in 2011. It enables to combination of advanced technologies, smart sensors, and the internet, to generate autonomous and intelligent structures (Jahani et al. 2021).

The technological pillars of the Industry 4.0 (Baum-Talmor and Kitada 2022; Ichimura et al. 2022) are given in Table 1.

Table 5: Technological pillar of Industry 4.0

Technology	Feature	Possible application field
Artificial Intelligence (AI)	An intelligent system that can benefit from the data, identify specific patterns thanks to comparisons and provide some decisions regarding the operations.	Decision support system structure for any kind of operation, collision avoidance, vessel detection, optimization of the operations within the ship
Internet of Things (IoT)	A technology that provides a dynamic and real-time communication network between physical and virtual systems/equipment through the internet.	Real-time monitoring of critical equipment and parameters, developing digital twin of the ship
Big Data Analytics (BDA)	A system that allows compiling complex and huge amounts of data collected from different crucial points of smart concept ships and inferring meaningful results from them	Optimization of any kinds of operations, fleet and cargo managements, anomaly detection, pattern recognition
Cloud Computing (CC)	A software where data can be collected virtually and accessible by devices belonging to designated people and companies. It ensures some advantages to users such as flexibility, agility, and scalability.	Data storage, Real-time data monitoring from multiple devices
Cybersecurity	A term means protecting integrity, confidentiality, and accessibility of data.	Securing the ship and cargo from any attack within the virtual environment
Blockchain	An intelligent approach that provides following operational procedures in the digital environment. It can be also defined as a digital record book that is encrypted in the digital environment.	Digitalization of documentation, bill of lading, and customer clearance
Augmented Reality (AR) / Virtual Reality (VR)	AR refers to the technology of superimposing information on the image in the real environment while VR enables the relevant environment to be developed and experienced in a virtual environment. AR systems require some smart devices like smartphones or goggles.	Seafarer training, risk management, advanced application of simulator-based training
Additive Manufacturing	An approach that refers to manufacturing spare parts for equipment belonging to both the deck and engine room with 3D data and printers.	Spare part management, production of any kinds of ship equipment
Advanced Simulation or Digital Twin	An approach that enables virtual monitoring of operational values in real-time collaborating with cloud computing and IoT technologies.	Optimization of operations, maintenance works, and virtual tests for operations enhancement
Advanced Robotics	A structure that represents the collaboration between humans and robotics. It can be included in the maritime industry with especially rapid developments in autonomous ship designs. According to advances in maritime industry, robotic equipment can be placed on ships as a supportive device for humans or devices that operate fully autonomously.	Maintenance, loading and unloading cargo, deck operations, ships inspections
Sources: (Lambrou et al. 2019; Sanchez-Gonzalez et al. 2019; de la Peña Zarzuelo et al. 2020; Sullivan et al. 2020; Johansson et al. 2021; Kostidi et al. 2021; Sharma et al. 2021; Song 2021; Baum-Talmor and Kitada 2022; Ichimura et al. 2022; Madusanka et al. 2023)		

Within the parallel of Industry 4.0, the general expression of digital developments in the maritime field was named as Shipping 4.0 (Shahbakhsh et al. 2022). It mainly covers two aspects: smart ports and autonomous ships. Shipping 4.0 promises more efficient and safer navigation as a result of including more digitalized systems and technologies in the operations performed within marine vessels (Ceylani et al. 2022) . As presented in Table 1, it is obvious that the new approaches and technologies will be part of operations in the future shipping and their including will be getting higher in parallel with more autonomy in ship's operations.

In this regard, some actions among the business have already been taken to adopt digitalization of the maritime transportation. Ichimura et al. (2022) has identified some pillar, private maritime companies such as

CMA CGM, Hapag-Lloyd, ONE, Evergreen, OOCL, and HMM, and evaluated their strategies. They observed that the companies identified their strategic plans and worked on the adaptation of new technologies according to their needs.

3. Required Skills for New Technologies

The technological advancements are revealing the requirement for reconsidering the ship design and operations. In the future, it is obvious that different kinds of approaches and technologies will be adopted by maritime companies to both ensure sustainability and achieve more efficient shipping. However, the readiness of the business from the perspectives of human work sources, facility structure, source management, adaptability level of the maritime companies to new technologies, and legal frameworks should be evaluated. New technologies adopted for different areas within marine vessels are expected to reveal new competencies and skills for seafarers. These new skills can be classified into four classes as illustrated in Figure 3: technical, cognitive, social, and individual.

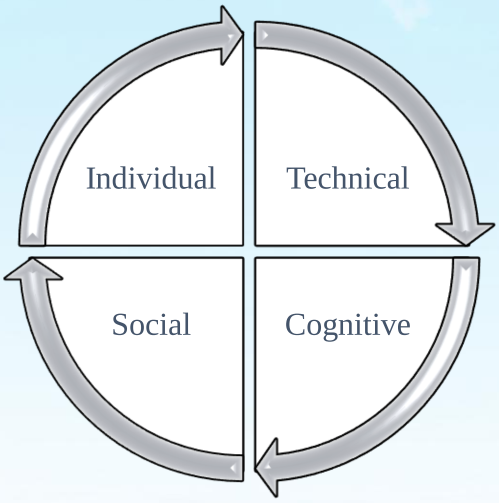

Figure 3. Skills required for possible new technologies applied within marine vessels

In addition, there are some different competencies for each skill. These competencies are presented in Table 2.

Table 6. Skills and competencies for possible new technologies

Skill	Competency
Technical	Monitoring and analyzing operational data
	Information, data processing, and data interpretation
	Analysis via deep learning and machine learning methods
	Programming
	Troubleshooting regarding new approaches/technologies
	Data-based decision making
	Source management
	Cloud computing application
	Cyber security application
Cognitive	Problem and conflict solving
	Reasoning and decision making
	Interpretation of complex system
	Critical thinking
	Advanced capability to use digital technologies
	Mentality & psychology
Social	Effective communication
	Teamwork
	Management of cultural differences
	Leadership

Individual	Adaptability & flexibility
	Sustainability of knowledge
	Creativity
	Awareness of sustainable shipping
	Awareness of green shipping
	Awareness on new technologies, shipping 4.0, and autonomous ship concept
	Time management
	Self-learning motivation
	Awareness of up-to-dates regulations and policies
Sources: (Kandemir and Celik 2017; Tran 2018; Nguyen 2018; Cicek et al. 2019; Emad et al. 2020; Oksavik et al. 2020; Kilpi et al. 2021; Baum-Talmor and Kitada 2022; Ceylani et al. 2022; Shahbakhsh et al. 2022; Sharma and Kim 2022)	

4. Conclusion

Rapid technological developments in the industry force the shipping business to consider adopting innovative approaches to the vessels. Artificial intelligence, cloud computing, data analytics, cyber security, and blockchain are some of the new advancements. These technologies mainly focus on using smart equipment onboard, monitoring and analyzing data, and taking actions based on data analytics. In fact, it is expected that semi-autonomous, fully autonomous, and robotic operations will be placed onboard in parallel with proceeding on MASS degrees. In this regard, new skills and qualifications will be needed for seafarers in the future to operate systems adequately and effectively.

This paper addresses the new competencies of the mariners. Hence, the skills are classified under four classes such as technical, cognitive, social, and individual. While technical skills include data monitoring, analysis by deep learning and machine learning methods, programming, and cyber security approaches, cognitive skills cover complex problem solving, critical thinking, ability to use advanced digital technologies, and mentality. In addition, the humans will actively work on the ship operations within the smart ships either onboard or at remote control centers. Therefore, social and individual skills will be important for future operations. In this regard, social skills contain mostly teamwork while individual skills cover human-based learning factors such as awareness of green and sustainable shipping, self-learning motivation, and awareness of up-to-date policies.

This paper presents a brief and comprehensive framework regarding new technologies that can be possibly adopted on the ships and new skills to be considered for the seafarers on the operation of smart ships in the future. The analysis can be extended by performing interviews with marine experts, conducting analysis on ranking skills to reveal their importance, and grouping the skills ship-based, department-based, and MASS degree-based.

Acknowledgements

This paper is funded by Istanbul Technical University (Project ID: 45698).

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EMPOWERING MARITIME PROFESSIONALS: THE CREWINEDU ONLINE TRAINING AND E-LEARNING PLATFORM

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Abstract: The maritime industry's success has always relied on a competent and adaptable workforce. However, recent global events, particularly the COVID-19 pandemic, have exacerbated the challenges of traditional training methods. Travel restrictions and social distancing measures have significantly disrupted access to in-person maritime training and courses, creating a critical need for innovative solutions. Taking into consideration current challenges, this study aims to introduce "CrewinEdu", a comprehensive online training and e-learning platform designed to address this very need. CrewinEdu empowers maritime professionals with the knowledge and skills they need to flourish in their careers, regardless of location or current circumstances. "CrewinEdu" seamlessly integrates within the broader "Crewin" ecosystem, a multifaceted and AI-powered solution catering to the maritime industry's recruitment, operational, and educational needs. This study specifically focuses on "CrewinEdu"s unique offerings tailored for instructors and maritime academic institutions. The platform equips instructors with a versatile suite of tools to cultivate engaging and effective learning experiences. CrewinEdu offers an extensive course catalog aligned with international regulatory standards. This catalog is complemented by interactive learning modules that blend e-learning materials, video tutorials, and simulations to facilitate knowledge acquisition and retention. Instructors can leverage comprehensive assessment tools to gauge learners' understanding of critical concepts. These assessments can be delivered through the platform's web interface or mobile applications, ensuring flexibility and accessibility regardless of location. Furthermore, detailed performance reports, accessible online and offline on instructors' devices, enable them to monitor learner progress and identify areas for improvement. By analyzing performance data, instructors can tailor their teaching methods to address individual student needs and ensure mastery of critical skills. "CrewinEdu" empowers maritime academic institutions by enhancing course delivery and content management for instructors. The platform facilitates the creation of a global learning environment, expanding the reach of maritime education programs to geographically dispersed or disadvantaged student populations. Furthermore, "CrewinEdu" fosters collaboration between instructors, promoting knowledge exchange within the maritime education community. By harnessing the potential of online learning, "CrewinEdu" equips maritime professionals with the necessary skills to navigate the complexities of the contemporary maritime landscape. This comprehensive platform empowers instructors, fosters collaboration within the maritime education community, and expands the reach of high-quality maritime education on a global scale. CrewinEdu is expected to yield significant benefits for both learners and institutions. Learners will gain flexibility and accessibility in their professional development, with the ability to learn at their own pace and from any location with an internet connection. Maritime institutions can leverage CrewinEdu to enhance course delivery, streamline content management, and expand their student base to include geographically dispersed or disadvantaged populations. This study will delve deeper into CrewinEdu's functionalities and explore its potential to transform maritime education and training, ultimately fostering a more skilled and adaptable maritime workforce prepared for the future.

Keywords: maritime education, online learning, professional development, maritime training platform

1. Introduction

The maritime industry is an essential pillar of global trade, with over 80% of international goods being transported by sea (Global Maritime Forum, 2020). This industry relies heavily on a skilled and adaptable workforce to maintain safety, efficiency, and competitiveness. Historically, maritime training has been conducted through in-person classes and hands-on experiences, which provide direct, practical knowledge essential for maritime operations (Nautical Institute, 2020). However, the COVID-19 pandemic has significantly disrupted traditional training methods, highlighting their limitations and the urgent need for innovative solutions.

Travel restrictions, social distancing measures, and other pandemic-related challenges have made it difficult for maritime professionals to access necessary training (Lloyd's Register Foundation, 2020). This situation has underscored the importance of developing flexible, accessible, and effective training solutions that can be delivered remotely. The rapid advancement of digital technologies offers an unprecedented opportunity to transform maritime education and training (DNV GL, 2021).

This industry paper aims to introduce CrewinEdu, a comprehensive online training and e-learning platform designed to address these challenges. CrewinEdu provides maritime professionals with the skills and knowledge they need to excel in their careers, regardless of their location or current circumstances. The platform is an integral part of the broader Crewin ecosystem, which encompasses solutions for recruitment, operational processes, and education, thereby addressing the multifaceted needs of the maritime industry.

CrewinEdu leverages advanced technologies, including artificial intelligence (AI), interactive learning modules, and a robust technical infrastructure to deliver a dynamic and engaging learning experience. By providing a flexible and accessible learning environment, CrewinEdu aims to enhance the quality and reach of maritime education, supporting the development of a skilled and adaptable workforce ready to meet the industry's evolving demands.

2. Goals of the Project

The primary aim of the CrewinEdu project is to revolutionize maritime education and training by providing a comprehensive, flexible, and accessible online learning platform tailored to the unique needs of maritime professionals. The project seeks to address the critical challenges faced by traditional training methods, particularly in light of the disruptions caused by the COVID-19 pandemic. Specifically, the objectives of CrewinEdu are to enhance accessibility to maritime training by offering a robust online platform that eliminates the barriers of geographic location, travel restrictions, and logistical constraints that hinder access to traditional in-person training (International Maritime Organization, 2020). Additionally, CrewinEdu aims to improve the quality and consistency of training by providing high-quality, standardized training that meets international regulatory standards, ensuring consistent skill levels across the global maritime workforce (World Maritime University, 2021). The platform also promotes lifelong learning and professional development, supporting maritime professionals in updating their skills and knowledge throughout their careers (Lloyd's Register Foundation, 2020). Furthermore, CrewinEdu aims to foster a global learning community, creating a collaborative and inclusive environment that facilitates knowledge exchange and professional networking among maritime professionals and educators (International Transport Workers' Federation, 2021). Lastly, the platform leverages advanced technologies, integrating AI, interactive learning modules, and data analytics to provide a cutting-edge, engaging, and personalized learning experience.

3. The Need for Innovative Training Solutions

The maritime industry faces unique challenges in training and professional development. Traditional methods often involve significant travel and time away from work, leading to high costs and disruptions (Maritime and Coastguard Agency, 2021). The COVID-19 pandemic exacerbated these issues, making it difficult for maritime professionals to access necessary training (Lloyd's Register Foundation, 2020). This situation underscores the critical need for flexible, accessible, and effective training solutions that can be delivered online. CrewinEdu addresses these needs by providing a platform that enables maritime professionals to learn at their own pace and from any location with an internet connection (BIMCO, 2022).

3.1 Challenges in Traditional Maritime Training

Maritime professionals often require extensive travel to attend training sessions, resulting in high costs and time away from work (Maritime and Coastguard Agency, 2021). Geographic limitations and the scarcity of training centers make it difficult for many professionals to access necessary training (World Maritime University, 2020).

Variations in training quality across different centers can lead to inconsistencies in the skill levels of maritime professionals (European Community Shipowners' Associations, 2021).

3.2 Impact of COVID-19 on Maritime Training

Global travel restrictions have made it nearly impossible for many maritime professionals to attend in-person training sessions (Lloyd's Register Foundation, 2020). Social distancing requirements have limited the capacity of training centers, reducing the number of professionals who can receive training at any given time (Lloyd's Register Foundation, 2020). The pandemic has accelerated the demand for remote training solutions that can be accessed from anywhere, at any time (Lloyd's Register Foundation, 2020).

4. Overview of CrewinEdu

CrewinEdu is an integral part of the broader Crewin ecosystem, which encompasses solutions for recruitment, operational processes, and education. CrewinEdu focuses on the educational aspect, offering a comprehensive online training and e-learning platform designed specifically for the maritime industry. This platform integrates advanced technologies, including AI, to provide a dynamic and interactive learning experience. It caters to the needs of both maritime professionals and academic institutions, offering a range of tools and resources to enhance learning and teaching.

CrewinEdu offers a vast library of courses aligned with international regulatory standards. These courses cover various aspects of maritime operations, safety procedures, and professional development. The catalog is continually updated to reflect the latest industry standards and practices. Unlike competitors, CrewinEdu ensures that all courses are regularly reviewed and updated to maintain compliance with the most current regulations and industry best practices.

The platform boasts interactive learning modules that combine e-learning materials, video tutorials, and simulations. These modules are designed to enhance knowledge acquisition and retention by providing engaging and practical learning experiences. CrewinEdu's simulations are particularly advanced, offering realistic scenarios that are unparalleled in the industry, giving learners hands-on experience in a virtual environment.

Instructors can leverage a variety of assessment tools to gauge learners' understanding of critical concepts. These assessments can be delivered through the platform's web interface or mobile applications, ensuring flexibility and accessibility. The assessment tools include quizzes, exams, and practical simulations. CrewinEdu stands out with its AI-driven analytics, which provide deeper insights into learner performance and personalized feedback, a feature that sets it apart from other e-learning platforms.

CrewinEdu provides detailed performance reports that allow instructors to monitor learners' progress and identify areas where they may need additional support. These reports can be accessed online and offline, enabling instructors to review data at their convenience. Performance reports include metrics such as quiz scores, completion rates, and time spent on each module. This level of detail helps instructors to tailor their teaching methods and ensure that each learner masters the necessary skills and knowledge.

5. Technical Infrastructure

CrewinEdu’s technical infrastructure is meticulously designed to support its comprehensive suite of features and ensure a seamless user experience. The platform is built on a robust cloud infrastructure, which offers scalability and reliability essential for accommodating a large number of users and diverse functionalities.

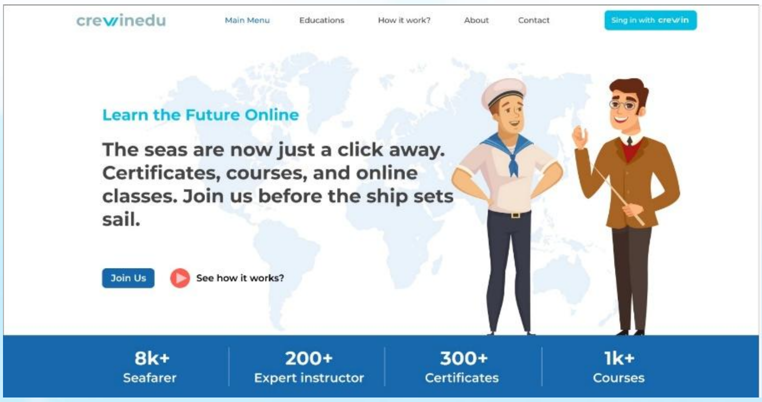

Figure 1. CrewinEdu Landing Page

5.1 Cloud Hosting and Scalability

CrewinEdu is hosted on a cloud platform that ensures high availability and scalability. This infrastructure can dynamically scale resources to handle varying loads, ensuring that users experience consistent performance even during peak times (DNV GL, 2021). The cloud hosting solution also provides redundancy and failover mechanisms, minimizing downtime and ensuring uninterrupted access to the platform (DNV GL, 2021).

5.2 Data Security and Privacy

Data security and privacy are paramount for CrewinEdu. The platform complies with international standards such as the General Data Protection Regulation (GDPR) to protect user data (DNV GL, 2021). Advanced encryption methods are employed to secure data in transit and at rest, safeguarding sensitive information from unauthorized access (DNV GL, 2021). Regular security audits and updates are conducted to maintain the integrity and security of the system.

5.3 AI and Machine Learning

AI and machine learning technologies are integral to CrewinEdu's infrastructure. These technologies power personalized learning experiences by analyzing user data and providing tailored content and recommendations (DNV GL, 2021). AI-driven analytics offer deep insights into learner performance, enabling instructors to identify areas where learners may need additional support.

5.4 Interactive Learning Modules

The platform supports interactive learning modules that combine e-learning materials, video tutorials, and simulations. These modules are designed to enhance knowledge acquisition and retention by providing engaging and practical learning experiences (World Maritime University, 2021). The technical infrastructure supports the seamless integration of multimedia content, ensuring a rich and immersive learning environment (World Maritime University, 2021).

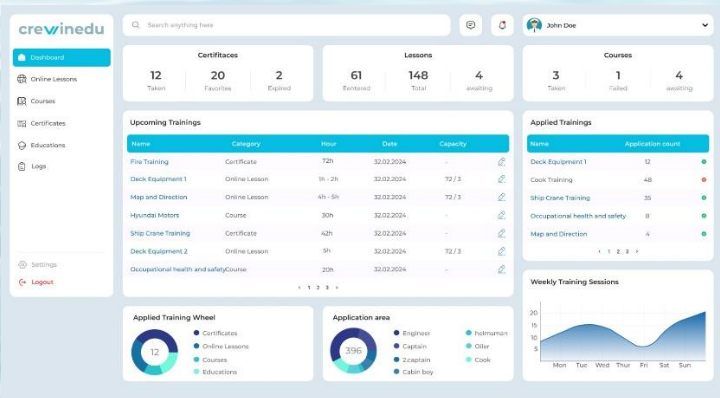

Figure 2. CrewinEdu Dashboard Page

5.5 Assessment and Reporting Tools

CrewinEdu features comprehensive assessment tools, including quizzes, exams, and practical simulations, which are integrated into the platform's technical infrastructure (European Maritime Safety Agency, 2020). These tools are designed to gauge learners' understanding of critical concepts and provide immediate feedback (European Maritime Safety Agency, 2020). Detailed performance reports are generated to help instructors monitor learner progress and identify areas for improvement (International Maritime Organization, 2020).

5.6 Mobile Accessibility

The platform's mobile applications for both Android and iOS ensure that learners and instructors can access the platform's features from any location (UK Maritime and Coastguard Agency, 2022). The mobile apps are designed to provide a user-friendly interface and seamless functionality, making it easy for users to engage with the platform on the go (UK Maritime and Coastguard Agency, 2022).

6. Methodology

The development and implementation of CrewinEdu follow a rigorous, user-centered design approach, ensuring that the platform meets the needs of maritime professionals, instructors, and academic institutions.

6.1 User-Centered Design

The user-centered design methodology places users at the heart of the development process. This approach involves collecting and analyzing user feedback through surveys, interviews, and usability testing to understand their needs, preferences, and pain points. Insights gathered from this feedback inform the design and functionality of the platform, ensuring that it is intuitive, effective, and aligned with user expectations (BIMCO, 2022).

6.2 Agile Development

Agile development methodologies are employed to ensure that CrewinEdu remains responsive to the evolving needs of its users. This approach involves iterative development cycles, where features are developed, tested, and refined based on user feedback. Agile development allows for continuous improvement and the rapid incorporation of new features and enhancements (BIMCO, 2022).

6.3 Collaborative Course Development

CrewinEdu fosters collaboration between instructors through online forums and collaborative course development opportunities. Instructors can share best practices, resources, and teaching methodologies, enhancing the quality and consistency of the courses offered on the platform. This collaborative approach ensures that course content is relevant, up-to-date, and aligned with industry standards.

6.4 Performance Analytics and Feedback

AI-driven analytics play a crucial role in the platform's methodology. These analytics provide deep insights into learner performance, identifying strengths and areas for improvement. Instructors can use this data to tailor their teaching methods and provide personalized feedback to learners. The continuous feedback loop ensures that the platform evolves in line with user needs and delivers effective learning outcomes (DNV GL, 2021).

6.5 Integration with Industry Standards

CrewinEdu courses are meticulously designed to align with international regulatory standards (International Maritime Organization, 2020). The platform's content is regularly reviewed and updated to ensure compliance with the latest industry regulations and best practices (International Chamber of Shipping, 2022). This alignment guarantees that learners acquire skills and knowledge that are recognized and valued by the maritime industry (International Maritime Organization, 2020).

6.6 Global Collaboration

CrewinEdu's methodology emphasizes global collaboration and inclusivity. The platform supports the creation of a global learning environment, enabling maritime academic institutions to expand their reach to geographically dispersed student populations (International Transport Workers' Federation, 2021). By promoting inclusivity in maritime education, CrewinEdu ensures equal opportunities for all learners, regardless of their location or background (Lloyd's Register Foundation, 2020).

6.7 Continuous Improvement

CrewinEdu is committed to continuous improvement through regular updates and enhancements based on user feedback and technological advancements. The platform’s development team conducts regular evaluations to identify areas for improvement and implement new features that enhance the learning experience. This commitment to continuous improvement ensures that CrewinEdu remains at the forefront of maritime education and training.

7. Stakeholders

The successful development and implementation of CrewinEdu involve collaboration and engagement with a diverse range of stakeholders, each playing a crucial role in ensuring the platform meets the needs of the maritime industry. Maritime professionals, including learners and instructors, are key stakeholders. Learners seek to enhance their skills and knowledge through the CrewinEdu platform and provide valuable feedback on the learning experience and content. Instructors utilize CrewinEdu to deliver courses, assess learners, and contribute to the development of educational content. Maritime academic institutions, such as training centers and universities, leverage CrewinEdu to expand their reach and improve course delivery. Training centers offer maritime education and training programs, while higher education institutions integrate CrewinEdu into their maritime programs to provide flexible and accessible learning options. Industry regulators and standard-setting bodies, including the International Maritime Organization (IMO) and national maritime authorities, ensure CrewinEdu meets international and local regulatory requirements. Maritime industry organizations, such as shipping companies and maritime associations, benefit from the improved skills and knowledge provided by CrewinEdu. Technology providers, including software developers and cloud service providers, are responsible for developing and maintaining the platform, ensuring it is robust, user-friendly, and technologically advanced. Research and development partners, such as maritime research institutes and technology research labs, contribute insights and data that inform the development of CrewinEdu and support the innovative aspects of the platform. By engaging with these stakeholders, CrewinEdu ensures that the platform is responsive to the needs of the maritime industry, provides high-quality and compliant training, and leverages the latest technological advancements to deliver an exceptional learning experience.

8. Advantages Over Competitors

CrewinEdu offers several advantages over its competitors, positioning it as a leading platform in maritime education.

8.1 Comprehensive Features

CrewinEdu offers a comprehensive suite of features that distinguish it from competitors. The platform's extensive course catalog is continuously updated and aligned with international standards. Interactive modules enhance student engagement and knowledge retention. Advanced simulation capabilities provide realistic, hands-on experience that is unparalleled in the industry. AI-driven insights offer personalized learning experiences and predictive analytics for performance improvement.

8.2 Global Learning Environment

The platform facilitates the creation of a global learning environment, enabling maritime academic institutions to reach geographically dispersed student populations and cater to students in remote areas who may not have access to traditional training centers (International Transport Workers' Federation, 2021). By promoting inclusivity in maritime education, CrewinEdu ensures equal opportunities for all learners (Lloyd's Register Foundation, 2020). CrewinEdu's global reach and inclusive approach are more extensive than those of its competitors, ensuring broader access and engagement (INTERTANKO, 2021).

8.3 Collaboration and Knowledge Exchange

CrewinEdu fosters collaboration between instructors, promoting knowledge exchange within the maritime education community. This can be achieved through online forums where instructors can share best practices, resources, and teaching methodologies. Collaborative course development opportunities allow instructors to work together to create new or improved learning materials (Nautical Institute, 2020). The community aspect of the platform facilitates communication and knowledge exchange among instructors. The collaborative features of CrewinEdu are designed to be more interactive and user-friendly compared to those of competitors.

9. Benefits for Learners

9.1 Flexibility and Accessibility

CrewinEdu provides learners with the flexibility to study at their own pace, allowing them to balance their professional commitments with their learning goals. Learners can learn from any location with an internet connection, eliminating the need for travel and time away from work or home. Access to course materials 24/7 enables learners to create a personalized learning schedule. CrewinEdu's flexible and accessible learning environment offers unmatched convenience compared to other platforms.

9.2 Enhanced Learning Experience

The platform's interactive features create an engaging and effective learning experience for maritime professionals. Interactive learning modules combine various learning styles to cater to diverse learners. Video tutorials provide visual demonstrations of key concepts and procedures. Practical simulations allow learners to apply their knowledge in a safe and controlled environment (World Maritime University, 2021). The quality and interactivity of CrewinEdu's learning modules are designed to be superior to those offered by competitors.

9.3 Career Advancement

By equipping learners with the necessary skills and knowledge, CrewinEdu supports their professional development and career advancement. The platform's courses are designed to meet industry standards, ensuring that learners are well-prepared for the demands of the maritime industry. Learners can leverage their acquired knowledge and skills to increase their employability by demonstrating their proficiency to potential employers. Pursuing promotions or leadership roles within their existing companies and staying up-to-date with the latest industry trends and regulations. CrewinEdu's focus on career advancement and compliance with industry standards provides a competitive edge over other e-learning platforms.

10. Conclusion

The CrewinEdu online training and e-learning platform represents a significant leap forward in maritime education. By addressing the challenges of traditional training methods and leveraging the potential of online learning, CrewinEdu empowers maritime professionals and academic institutions alike. The platform's comprehensive features, including an extensive course catalog, interactive learning modules, and detailed performance reporting, create a dynamic and effective learning environment. As the maritime industry continues to evolve, CrewinEdu stands ready to support the development of a skilled and adaptable workforce, ensuring the industry's continued success and growth. The unique advantages of CrewinEdu, including its advanced simulation capabilities, AI-driven insights, and global learning environment, position it as a leader in maritime education, providing unparalleled value to its users.

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ENSURING ACADEMIC INTEGRITY: BEST PRACTICES OF PHILIPPINE UNIVERSITIES IN DRAFTING EFFECTIVE POLICIES

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Abstract: This paper reports the findings from a review of universities' academic integrity policies in the Philippines. The study aims to describe best practices in drafting academic integrity policies. This study extracted, reviewed, and evaluated information from policy documents to describe academic integrity policies. Access, approach, responsibility, detail, and support were examined and critiqued. Findings revealed that none of the universities' policies met all of the core elements of exemplary policy, lacked specific language on practices that support the promotion of academic integrity, and were more frequently focused on punitive rather than educative approaches. However, some best practices are widely observed. These findings confirm further opportunities for policy development related to promoting academic integrity and its prevention.

Keywords: academic integrity; academic dishonesty; best practices

1. Introduction

The International Center for Academic Integrity (ICAI) defines academic integrity as a commitment to six fundamental values: honesty, trust, fairness, respect, responsibility, and courage (ICAI 2020). Academic integrity is about mastering the art of scholarship by giving credit and acknowledgments to the contributions of others to one's intellectual efforts (University of Tasmania 2010). Conversely, academic misconduct is any act or behavior, intentional or unintentional, minor or major, by students that fail the expectations of universities in preparing or submitting academic tasks for examinations or assessments.

In higher education institutions, academic integrity policies are essential for fostering an equitable and moral learning environment. Prior research on higher education institution (HEI) policies about academic integrity has been carried out mainly in the Western countries, including Australia (Bretag et al. 2011; Kaktiņš 2014; Mahmud & Bretag 2014), New Zealand (Möller 2022), Canada (Eaton 2024; Eaton et al. 2023; Miron et al. 2021; Stoesz et al. 2019; Stoesz & Eaton 2022), the European Union (Foltýnek & Glendinning 2015; Glendinning 2013), Latvia and Lithuania (Anohina-Naumeca et al. 2018), and Southeastern Europe (SEEPPAI 2017).

In Australia, Bretag et al. (2011) investigated academic integrity policies at 39 universities and found discrepancies in the rules, review procedures, decision-making processes, and teaching methods. Their findings demonstrate the disparity between the punitive and educational approaches to academic integrity and the absence of explicit statements about institutional responsibility for maintaining academic integrity standards. As a result of their study, Bretag et al. proposed a model that exemplifies the core elements of academic integrity policies. Kaktiņš (2014) investigated the wording employed in plagiarism policies at Australian institutions and found that these policies tended to move away from punitive positions and toward more instructional and pedagogical approaches, seeing students as trainee researchers. Mahmud and Bretag (2014) identified gaps in Australia's postgraduate research regulations concerning the Australian Code for Responsible Conduct of Research and proposed a framework designed to ensure postgraduate research integrity.

Canada has also emerged as a key location where academic integrity policies have been studied. Eaton (2017) called for a more harmonized approach among Canadian universities to maintain consistency across provinces. Stoesz and Eaton (2022) criticized the persistently punitive nature of academic integrity policies and the limited support available for students and academic staff in Western Canada. Furthermore, Stoesz et al. (2019) and Miron et al. (2021) identified a need for specific guidelines for contract cheating in Ontario's academic integrity policies and suggested opportunities for policy development to promote academic integrity and prevent contract cheating. Eaton et al. (2023) identified inconsistencies across policies and offered an update to Bretag et al.'s (2011) exemplary academic integrity model to include an element of 'Equity.'

In New Zealand, Möller (2022) also evaluated the policies of eight public institutions using the model criteria set by Bretag et al. (2011). The results showed that none of the universities fulfilled these requirements and that several needed improvement, especially in support and accessibility.

Studies throughout the European Union by Foltýnek and Glendinning (2015) and Glendinning et al. (2013) also highlighted the differences in systems and policies for academic integrity among 27 different EU nations. Using an academic integrity maturity model, they found that the UK had the highest score and a clear difference between the Western and Eastern EU countries. According to this research, the EU should work together to strengthen current laws and procedures. Furthermore, Lithuanian policies, as explored by Anohina-Naumeca et al. (2018), indicate accessibility issues and a lack of systematic institutional approaches to promoting academic integrity. Similar problems were noted in the Southeast European studies conducted by Glendinning et al. (2017) and SEEPPAI (2017), where higher education institutions (HEIs) primarily fell into the lower to intermediate categories of academic integrity maturity. These studies highlight the notable regional variations in academic integrity policies. Themes that have surfaced underscore the need for a more instructional strategy, excellent staff and student assistance, frequent policy reviews and updates, precise definitions and assertions of accountability, and early detection and resolution of new threats to academic integrity.

Studies on academic integrity policies emphasize the significant variability in academic integrity policies across different regions. Several research has benefited from applying the exemplary academic integrity policy model developed by Bretag et al. (2011), which offers a solid foundation for analysis and policy improvement.

Bretag et al. (2011) enumerated five core elements of exemplar academic integrity policy: access, approach, responsibility, detail, and support. As explained by Bretag et al., access means that the policy is easy to locate, read, well-written, clear, and concise. In addition, the policy uses comprehensible language, logical headings, and links to relevant resources. It is also downloadable as an easy-to-print and-read document.

The second element in academic integrity is the approach, which implies that academic integrity is viewed as an educative process and appears in the introductory material to provide a context for the policy. There is a clear statement of purpose and values with a genuine and coherent institutional commitment to academic integrity through all aspects of the policy.

The third element is responsibility, which implies that the policy clearly outlines responsibilities for all relevant stakeholders, including university senior management, academic and professional staff, and students.

The fourth element is detail, which means that the policy describes a range of academic integrity breaches and explains those breaches using easy-to-understand classifications or levels of severity. Details of how breaches are identified (such as through text-matching software) are provided. Processes are detailed with a clear list of objective outcomes, and the contextual factors relevant to academic integrity breach decisions are outlined. Extensive but not excessive details about reporting, recording, confidentiality, and the appeals process are provided. Exemplary policy incorporates simple flow charts to demonstrate how the policy is enacted in practice.

The final element is support, which implies that systems are in place to implement the academic integrity policy, including procedures, resources, modules, training, seminars, and professional development activities to facilitate staff and student awareness and understanding of policy.

Recent studies using Bretag's framework show none of the universities' policies met all of the core elements of exemplary policy, lacked specific language on practices that support the promotion of academic integrity, and were more frequently focused on punitive rather than educative approaches.

In the ASEAN context, Roe et al. (2022) noted that the vast majority of studies on academic integrity mainly focused on issues of plagiarism, as opposed to other, potentially more challenging to spot forms of academic dishonesty such as contract cheating (Ahsan, Akbar, & Kam, 2022), or the use of Automated Paraphrasing Tools (Roe et al. 2022).

This paper describes the academic integrity policies of selected universities in the Philippines. Specifically, it seeks to answer the following research questions:

1. How is academic integrity defined in terms of scope and penalties?
2. How may the academic integrity policies be described in terms of Bretag's 2011 model?
3. What are the best practices of Philippine universities in their academic integrity policies?

2. Method

This research uses a descriptive design. Documentary analysis was used primarily to draw answers to the research questions. Content analysis was used to compare and contrast the contents of academic integrity policies from four major universities in the Philippines on specific variables. The four universities were chosen based on reputation, university standings, and research traditions. More specifically, the samples for this study are selected based on the QS Asian University Rankings 2024 by Quacquarelli Symonds. According to the QS Asian University Rankings 2024, the four universities were ranked from 179th to 78th ranking and 44th to 18th for Southeast Asia Sub-Region. The universities were chosen based on these lists as these rankings are the world's most famous university ranking systems.

The five core elements that guided the document analysis are access, approach, responsibility, detail and support, as used in Bretag's Core Elements for Exemplar Academic Integrity Policies.

The Baseline Standard Scaling Model developed by Khan, Khelalfa, Sarabdeen, Harish, and Reheja (2019) was used to determine the best practices in academic integrity policies. The categories used in selecting best practices were access level, name of policy or identity, purpose of the policy, the definition of academic integrity, scope of the policy, definition of misconduct, reporting status, and record-keeping. The scores of 0-2 were awarded, with two being the highest. A score of 2 indicates that the policy is explicit regarding scope, who is affected, and how the policy works.

3. Results and Discussion

This section presents the study results in the order of the research questions.

3.1 Definitions of academic integrity

The definition and scope of academic integrity policies and the penalties for breaches slightly varied among the four universities. Table 1 shows the similarities and contrasts in the terms used and the nature of actions and behavior included in their policies.

Table 1: Definitions and Scope of Academic Integrity Policies

Element	Univ A	Univ B	Univ C	Univ D
Term used	Intellectual Dishonesty	Academic Dishonesty	Cheating	Academic Dishonesty
Scope	1. Plagiarism 2. Fabrication, falsification, distortion and destruction of data 3. Copying or providing the means to copy exam answers, homework, projects, laboratory, experiments, term papers, etc.; possession and use of cheat devices during an examination; allowing another person to take an examination in one's name; and impersonating another student or allowing someone	1. Any form of dishonesty committed in the conduct of an academic exercise. 2. Deception or providing false information 3. Tampering with and falsifying school or public documents and communications which affect the official processes of the university 4. Use of someone else's data/identifying characteristics/personal effects to commit fraud 5. Committing any form of misinterpretation	Cheating in any form during an examination, test, or written report, including reaction papers, case analysis, experiments or assignments required. The act of cheating includes, but is not limited to, the following: • Unauthorized possession of notes or any material relative to the examination or test, whether the student uses them or not. • Copying or allowing another to copy from one's examination papers. In the latter case, both parties are liable. • Looking at another student's examination paper or allowing another student to look at their examination paper. • Communicating with another student or any person in any form during an	1. Cheating on an assignment, examination or test; for example, by copying from another's work or using unauthorized materials before or during the test, including the use of electronic devices; 2. Plagiarism, which represents as one's own the work of another, whether published or not, without acknowledging

	to impersonate oneself in an academic activity, and manipulating a corrected exam paper. 4. Submission of the same work in two or more courses without the instructor's consent 5. Other acts analogous to 1,2,3, and		examination or test without permission from the teacher or proctor. This includes leaking examination questions to another or other student/s. • Having somebody else take an examination or test for one's self or prepare a required report or assignment. If both parties are students, both are liable. • Plagiarism; and • Other forms of academic dishonesty as duly approved by University authority	the precise source; 3. Participation in the academic dishonesty of another student, even though one's work is not directly affected; 4. Any conduct recognized as dishonest in an academic setting.
Penalties	1. Suspension 2. Expulsion 3. Withdrawal of degrees; withdrawal of honors, disqualification from graduation with honors 4. Cancellation of registration 5. Withdrawal of IT privileges	1. Written reprimand for minor offenses 2. Mandatory work in the form of community service 3. Loss of privileges related to the nature of the offense 4. disciplinary probation (first warning or final warning status) 5. Mandatory drug testing at the student's expense, at the discretion of named school administrators, for a specified period (especially in cases related to dangerous drugs, substance abuse or endangering behavior) 6. Mandatory psychological/clinical assessment and compliance with the recommendations of an accredited specialist 7. Restriction against participation in school activities/further contact with aggrieved parties 8. Suspension or expulsion from on-campus housing 9. Ban from entering campus 10. Permanent disqualification from receiving any form of a Certificate of Good Moral Character 11. Suspension/deferment of graduation 12. Non-readmission after the end of the current semester 13. Dismissal (exclusion) 14. Expulsion	1. Probation 2. Suspension 3. Dismissal 4. Expulsion	1. Reprimand 2. Suspension 3. Non-readmission 4. Exclusion 5. Expulsion 6. Discipline of recognized/accredited student organizations

From Table 1, it can be gleaned that universities have definite descriptions of student behaviors covered in their academic policies. It is also noted that the nature and gravity of breaches of academic policies determine the gravity of the punishments.

3.2 Exemplars of Academic Integrity Policy

Based on the core elements of exemplar academic integrity policy, namely access, approach, responsibility, detail, and support, the academic integrity policies of the four universities were examined and analyzed. Table 2 summarizes the similarities and differences among the four universities.

Table 2. Comparison of Academic Integrity Policies of Major Schools in Manila

Exemplars Academic Integrity Policy	Univ A	Univ B	Univ C	Univ D
Access	Downloadable; Open Access; 2012 edition	Downloadable; Open Access; 2024	Downloadable; Open Access; 2018-2021 edition	Downloadable; Open Access; 2018 edition
Approach (Educative)	Attached to the university ethos are "values and virtues that make Filipinos proud" (p.1)	Truth, honesty, justice	Core Values: faith, service, communion	Core values of goodness, discipline, and Knowledge
Responsibility	Student Disciplinary Council; College Disciplinary Committee; Ad Hoc Disciplinary Hearing Committee	Committee on Discipline	Student Discipline Formation Office; Dean of Student Affairs	Dean of Students, Registrar, Academic Committee
Detail	1. Plagiarism 2. Fabrication 3. Copying or providing means to copy exams, etc. 4. Submission of the same work in two or more courses	A. Dishonest behavior during exams and tests B. Plagiarism C. Fabrication or the submission of falsified data, information, citations, sources or results in an academic exercise	*Students' academic requirements, such as assignments, term papers, computer programs/ projects, and thesis papers, should be their work. He/she must distinguish between his/her ideas and those of other authors. The student must cite references, direct quotes, and other sources (including data obtained from tables, illustrations, figures, pictures, images, and video) following the prescribed format of the discipline.*	Included 31 specific offenses, including plagiarism, cheating and analogous acts
Support	Found in other documents	Sample cases for all offenses included in the Code of Academic Integrity	Supporting materials ● Code of Ethics for University Faculty ● Code of Ethics for Integrated School Faculty ● Ethical Conduct of Research ● Student Handbook	Found in other documents

This study has found that while a significant proportion of academic integrity policies have a punitive element, a similarly considerable proportion of universities provide an educative approach and/or attempt to frame their policies with a broad commitment to academic integrity (Bretag, 2011). It is also important to note that these universities publish and regularly update their institutional policies, showcased in their respective student handbooks.

3.3 Best practices of Philippine universities in their academic integrity policies

The Baseline Standard Scaling Model developed by Khan, Khelalfa, Sarabdeen, Harish, and Reheja (2019) was used to determine the best practices in academic integrity policies. Access level, policy name or identity, policy objective, definition of academic integrity, policy scope, definition of misconduct, reporting status, and record-keeping were the categories that were used to choose the best practices. Two was the highest score, with scores ranging from 0 to 2. A score of two means that the policy makes clear its objectives, affected parties, and operational procedures. Table 3 summarizes the based on the Khan et al.'s scaling model.

Table 3. Baseline Standard Scaling Scores of Philippine AI policies

	Univ A	Univ B	Univ C	Univ D
Access	2	2	2	2
Name of Policy/Identity	2	2	2	2
Purpose of policy	2	2	2	2
Definition of AI	1	1	1	1
Scope of Policy	1	1	1	2
Definition of Misconduct	1	2	1	2
Reporting System	1	1	2	2
Record Keeping	0	1	2	2
Total Score	11	12	13	15

This study found that all four universities had an academic integrity policy regarding open access. This best practice helps to create a learning environment that is inclusive and transparent. For the name category, each of the four universities has a different name for their policy. This finding could indicate a vast gap in understanding concepts relating to academic integrity among the universities or how universities value or see academic integrity. The varying definition is also seen in the Definition of Academic Integrity and Misconduct. Similar results can be seen for the category Record Keeping with two policies with general record-keeping details in their policy document. This means that most policies reviewed needed to have a Purpose of Policy available or explicitly stated in their policy document. Purpose of Policy is a section of a policy document that determines the tone/ideology of the policy, whether it is educative or punitive. If the policy includes this section, it will take advantage of a significant opportunity to strengthen it. One university's policy scored a '2' for the Scope of Policy, and three just met the standards. For the Reporting System category, this study found one policy that met the standards and three just met the standards. Finally, for the Record Keeping category, two met the standards, and two did not meet at all.

Bretag et al. (2011) have stated that the definitions and explanations of academic integrity in university policies affect how universities teach about academic integrity. Based on the results above, the review highlights serious and significant inconsistencies in all identified categories against which the policies were reviewed. From definitions of academic integrity to the scope of the project and other criteria, different universities have different approaches to setting up policies on academic integrity. While differing approaches are expected, the possibility of a different understanding of the concepts behind the policies may be of concern for the education sector in the Philippines. For each of the eight categories, one set of policies identified scored '0' on the baseline standards scale. This is a very significant finding because the process for giving punishments is equally important as knowing the nature of the offenses.

The policies reviewed show the best practices in strict compliance with the five elements of Bretag's Model of Exemplary Academic Integrity Policy.

4. Conclusions and Recommendations

Recommendations are needed to improve the Philippines' existing academic integrity policies. This study recommends the following based on the framework of Bretag et al. (2011). Regarding access, academic integrity policies should be accessible in print or online to all students, staff, and other stakeholders in the university. Accessibility will significantly impact the academic community and highlight its commitment to the six values of academic integrity: honesty, trust, fairness, respect, responsibility, and courage. Academic policies should include undergraduate students, postgraduate students, academic and non-academic staff, and the administration.

The core element of the approach, whether punitive or educative, influences the institution's adoption of academic integrity practices. Thus, a more educative and less punitive approach should be encouraged to ensure the policy's effectiveness.

Thirdly, the responsibility of each stakeholder affected by the policy should be clearly articulated. The organization's staff, students, and non-academic personnel should be collectively accountable for academic integrity breaches. As such, the roles and responsibilities of each category must be presented in the policy. In addition, in the case of a violation of academic integrity, the steps to address the responsibilities of individuals at the faculty or institution level need to be clear and well-defined. Research has shown that policies and practices must be intertwined with teaching and learning practices (Perkins & Roe, 2023).

Fourthly, the issue of details is crucial in ensuring the effectiveness and adoption of the policy. Academic integrity-related terms such as academic misconduct, dishonesty, cheating, plagiarism, etc., are to be clearly defined in the context of each institution. In addition, standard operating procedures for rendering penalties must also be contextualized and defined.

Finally, support in disseminating information regarding the policy, the content of the policy, staff and student familiarization with the policy and continuous updating via modules, workshops, announcements, and sharing sessions are essential to sustain the existence, acceptability, and effectiveness of academic integrity policy.

Recommendations are also made for the Philippines to have a standard policy for all educational institutions addressing academic integrity issues. There should be more initiatives by universities to promote academic integrity, such as training, knowledge sharing, and good practices, including university staff being well trained in knowing the types of plagiarism and other ways academic integrity can be breached and the correct ways.

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Istanbul
SEP. 2024

Proceedings of

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