Evaluating the Gap in Specialised Training for Container Ship Deck Officers: Implications for Maritime Safety

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Abstract: Container ships play a vital role in global trade by transporting a significant portion of general cargo worldwide. Despite extensive safety regulations, accidents continue to occur, often due to human error and non-compliance with mandatory cargo stowage and securing requirements. This study analyses the need for specialised training for seafarers responsible for cargo operations on container ships to ensure compliance with International Maritime Organization (IMO) regulations and reduce accidents. A review of statistical data on container ship accidents, a comparative analysis of training standards for different vessel types, and an examination of current IMO regulations related to container ship crew training were conducted. The analysis revealed that human error is the largest contributing factor to accidents, and a significant proportion of safety recommendations are related to cargo handling and transportation. However, the STCW Code and IMO model courses lack specialized training for container ship deck officers, in contrast to the extensive training provided for tanker officers. A survey of nautical students who completed their first contract as junior cadets on container ships confirmed the findings, highlighting the need for ship type-specific training. The study recommends that the IMO review the current training standards for container ships and consider introducing type-specific training for all crew joining container ships to address this gap and improve maritime safety.

Keywords: *Container Ships; Maritime Safety; Crew Training; Specialised Training.*

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I. INTRODUCTION

Cellular container ships are essential for global trade, transporting over 60-70% of general cargo, including industrial goods, electronics, clothing, and food. Their efficiency and cost-effectiveness have revolutionized logistics and international trade. However, shipping remains a high-risk industry, with accidents continuing despite the IMO's (International Maritime Organisation's) extensive safety regulations.

Investigations by IMO committees, flag administrations, and classification societies reveal that many container ship accidents result from non-compliance with mandatory cargo stowage and securing requirements, often due to human error. Despite existing IMO instruments and various studies on maritime training, there is no comprehensive research addressing the gaps in training that contribute to human error in container ship operations.

The evolution of container ships is a fundamental aspect of maritime logistics driven by technological advances, economic requirements, and environmental considerations, and has been characterized by the increasing size of vessels, integration of advanced technologies, and drive towards sustainable practices. The future of container shipping is likely to be shaped by these continuing trends as well as by the emerging challenges and opportunities for shipping considered from a global perspective.

The size of container ships has been steadily increasing, with the capacity of the largest vessels increasing from 5,500 TEU in 1995 to over 24,000 TEU in 2023 [1].

The introduction of ultra-large container vessels (ULCV) is expected to continue, with forecasts suggesting the development of vessels in excess of 27,000 TEU [2]. However, the economic feasibility of such large ships depends on market conditions including freight rates and load factors [3].

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The increased size of container ships has significant implications for port infrastructure, necessitating investment in facilities to accommodate these large vessels [4].

The continuing trend of increasing ship size will continue to shape the shipping industry but will also require careful consideration of economic and operational conditions to ensure long-term stability of investment.

Although the evolution of container shipping has been marked by significant progress, it faces challenges related to standardization and adaptation to new technologies. The need for uniform standards in container shipping often conflicts with the rapid pace of technological change, creating dynamic tensions that affect the evolution of the industry, including crew training standards.

This study analyses the need for specialized professional training for seafarers responsible for cargo operations on container ships, ensuring compliance with IMO regulations, and reducing accidents caused by human error [5].

II. METHODS

This study reviews the statistical data of container ship accidents, focusing on human error and non-compliance issues. A comparative analysis of the training standards for container ships and other vessel types is performed. A regulatory review of the current IMO regulations and guidelines related to container ship crew training is conducted. The need for type-specific training for deck officers is verified by processing survey forms completed by 4th year nautical students of the Nikola Vaptsarov Naval Academy (NVNA) upon returning from their first employment as junior deck cadets on board container ships.

The research is limited to the training requirements of master and deck department officers, but the results may be extended to other ranks, as appropriate.

III. ANALYSES OF INCIDENTS WITH CONTAINER SHIPS

Despite the continued efforts of all shipping organisations concerned, we have witnessed container ship accidents and incidents every year. Competent authorities investigate the causes of these occurrences, the analysis of which is used by maritime authorities to establish new safety standards and to improve existing standards. Shipping companies apply this knowledge to improve their operational safety.

Comprehensive analysis requires a reliable and detailed representation of the accident operating environment, including the participants (persons, ships, port terminals, operators), conditions (hydrometeorological), situation (sequence of errors and omissions), triggering factors (proximate causes), and root causes (personnel and organizational factors). The IMO developed a specific methodology for maritime risk assessment (FSA). Unfortunately, owing to high reputational risks, accident conditions and accidents are often concealed by companies. Thus, they could not be statistically reported and analysed. Although flag administrations are obliged to conduct such investigations, they are also stakeholders, as the reported results affect their image as the body responsible for the control of ships under their flag. Statistical analyses in the field of maritime safety are mainly conducted at the request of international insurance companies, and the results affect corporate insurance policies in maritime transport. The institutional systematic statistical analysis of maritime safety has only been introduced in recent years and is limited to specific shipping areas.

It is common practice for parties to contracts of carriage (shipowners and charterers) to resolve their disputes through arbitration, avoiding the public interest and thus preventing independent and objective investigation and analysis of incidents with fewer consequences.

In 2008, the IMO Maritime Safety Committee (MSC) adopted a Code for the Investigation of Marine Casualties and Incidents [6]. The relevant amendments to SOLAS Chapter XI-1 were also adopted to make Parts I and II of the Code mandatory.

In order to achieve efficiency in the collection and processing of world shipping statistics, the IMO developed the Global Integrated Shipping Information System (GISIS). Its official website allows online access to information provided to the IMO Secretariat by maritime administrations in accordance with the IMO instruments. GISIS consists of several subsystems, including modules with different focuses, in accordance with MSC-MEPC.3/Circ.4/Rev.1 [7]. One was designed to systematize information about maritime accidents and incidents.

A number of researchers are addressing the problem of improving the maritime accident analysis system, and it is widely believed that there is a noticeable shortage of data on the consequences of maritime accidents [8]. Ma and Deng [9] develop a complex network approach to risk factor identification and find that controlling strategies can be different depending on the situation. Fan and Yang [10] developed a machine-learning model for marine accident research in confined waters. Weng and Yang [11] applied a statistical method to estimate worldwide marine accidents and determine accident fatality rates. Maya et al [12] used a fuzzy cognitive map to estimate the risk factors for marine accidents. Chen et al [13] used a logistic model to analyse total loss ship accidents and found that they were mainly due to sinking and collision. Gucma and Androjna [14] used a simplified estimation framework for the assessment. Chen et al [15] conducted a systematic study of total loss marine casualties worldwide, identifying grounding and sinking as critical risk factors, and developed a model to analyse human factors associated with marine casualties [16]. Yildirim and Bashar [17] delineated human factors influencing marine casualties using a Human Factor Analysis and Classification System (HFACS) framework. Paolo et al [18] performed a similar analysis using the cluster analysis method.

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A detailed analysis of accident rates specifically for container ships [19] was carried out by the World Maritime University (WMU), which presented in-depth statistics on the 445 maritime accidents involving container ships studied, based on data for the period 2011-2022, extracted from the GIS Maritime Casualty and Incident (MCI) module, supplemented mainly with EMCIP data. In addition to statistics on the loss of containers at sea, the report contains information on casualties, consequences, incidents, human errors, contributing factors, and safety recommendations. The analysis methodology was based on IMO recommendations, according to MSC-MEPC.3/Circ.4/Rev.1.

The analysis shows that the average annual loss of containers at sea over the 15-year period from 2008 to 2022 is 1,566 units and has a steadily increasing trend in container losses at sea, although reduced losses were recorded in 2022 and 2023.

Specifically, for container ships, one-third of the casualties occurred in ports and their approaches (33.26%). This can be explained by the dynamic working environment and higher intensity of cargo handling activities compared to other ship types.

Although no official data comparing the casualty rate of container ships with that of oil tankers have been published, it is possible to compare the total number of recorded casualties in GISIS, taking into account the number of ships of the respective types. When a reference was made for the period 01.01.2015 - 10.01.2025 [20], a total of 182 accidents with oil tankers and product carriers, and 323 with container ships, respectively, were recorded. At the same time the number of registered ships was 7 323 and 6 844 respectively. Recalculating these figures, it appears that on average there were 4.72 accidents per 1 000 container ships and only 2.47 accidents per 1 000 oil tankers and product carriers (averaged) per year. This shows that the safety problem of container ships is quite topical, and they are definitely not inferior in terms of the number of accidents to other types of cargo ships, but just the opposite. While the IMO has been actively working for decades and introducing measures to improve the safety environment for tankers, container ships have remained out of focus.

The WMU analysis for the period 2011-2022 shows that human error is the largest contributing factor to accidents, accounting for 39% of the total. Environmental impacts and equipment failures are almost equally likely, with approximately 15% of cases each. Accidental events were not identified in 43% of the cases in the database, which reduced the ability to draw conclusions and take corrective action. The proportion of human errors is impressive, with statistical analyses showing that they most often lead to occupational accidents and collisions.

From the point of view of introducing future corrective measures, statistics on the distribution of the "focus areas" of the prescribed safety recommendations are very important. The largest number of recommendations (28%) were made to improve safety in cargo transportation and related activities. In terms of human factors, 21% of the recommendations were made. Nearly half of the corrective actions are related to cargo handling and transportation, crew actions, and company procedures. Hence, it can be concluded that the current maritime training system has significant gaps in the training of container ship crews regarding the performance of safe cargo transportation activities

IV. INTERNATIONAL STANDARDS FOR SEAFARER TRAINING

Prior to 1978, the training and certification of seafarers and other standards related to their qualifications were individually regulated by all countries that had a merchant fleet. As a result, standards vary widely, which creates a number of inconveniences and often leads to serious operational difficulties such as delays of ships in ports and disputes between administrations over the application of standards, and has a negative impact on the overall safety of shipping. To permanently solve this problem, the IMO initiated the adoption of a specialized convention, International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW).

First established in 1978, the STCW standardized educational procedures for seafarers. Since then, it has been the most influential normative document in maritime education. The Convention and the Code (STCW Code) were amended in 1995 and 2010. These amendments were implemented in response to the recognized need to update the qualification requirements for seafarers.

As the last significant revision of the Convention was made in 2010, it has been accepted that today's version should be abbreviated as STCW 2010.

To achieve full implementation of the minimum global standards of competence set out in the Convention, it is necessary to be familiar with the full set of rules and recommendations presented in the Convention and the Code.

Articles of STCW 2010 and its Annex provide a legal framework for the implementation of mandatory technical standards. Part 'A' of the Code sets out the minimum requirements applicable to candidates for certification of individual competencies. To relate the provisions for alternative licencing to those for basic licencing under Chapters VII and II, III, and IV, respectively, the competency standards are divided into seven functions as follows. Three of them (1, 2 and 3) are related to deck department. For the purpose of this study only Function 2 “Cargo handling and stowage” has to be analysed as it is the only one related to the cargo operations.

As per STCW crew members are divided into three levels of responsibility depending on the position they hold on board: Management level, Operational level, and Support level. The so-called "top four" (master, chief mate, chief engineer officer and second engineer officer) are assigned to

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the management level. The remaining officers are considered to be operational level and the executive staff are support level.

Chapters II, III, and IV of Part A of the Code set out the standards of competence in a convenient tabular format while specifying the levels of responsibility and functions.

For the purpose of this study, it is necessary to analyse the training requirements for deck officers at the management and operational levels for Function 2 ("Cargo handling and stowage"). The other two functions applicable to ship officers will not be examined in detail, as the training subject matter covered by them is applicable irrespective of ship type.

A. *Training Standards Under the STCW Code*

All tables of minimum competence standards in the Code are structured uniformly in four columns with the following contents:

- Column 1 "Competence";
- Column 2 "Knowledge, understanding and proficiency";
- Column 3 “Methods for demonstrating competence”;
- Column 4 “Criteria for evaluating competence”.

It is not necessary to consider text in Columns 3 and 4 in this analysis because they are relevant only to the assessment methodology and not to the content of the Syllabus. The tables themselves are conveniently divided by function, which allows the content of Function 2 to be selected and analysed separately and independently of the others.

The minimum competency standards for officer in charge of a navigational watch (OOW) on ships of 500 GT and more are listed in Table A-II/1.

Function 2 for OOWs includes two competencies. The first is related to the knowledge required by deck officers to successfully supervise cargo handling operations and to take due care of cargo during voyage. The overall definitions of knowledge and skills in column 2 are also very general. There are no IMO instruments references. The only type of cargo mentioned are the heavy lifts and their effect on the seaworthiness of the ship and the dangerous and hazardous cargoes. Apparently, the IMO does not consider it necessary to regulate specific mandatory topics concerning rules for the safe handling of different types of cargo. This gives the impression that OOWs can be trained in a methodology that provides them with general knowledge of the principles of ensuring the seaworthiness of the ship and preventing accidents, without going into specifics on how exactly to achieve this for different types of ships. The second competence for OOWs addresses their ability to inspect and report defects and damage to cargo spaces, hatch covers and ballast tanks. This function has been introduced for the purpose of bulk carrier crew inspections under the 2011 ESP Code [21].

The approach taken in Table A-II/2, related to the management level, is quite different. Here, there are three competencies (Table 1), with masters and chief mates required not only to report observed hull damage, but also to be able to independently assess its severity and take appropriate action. In addition, the knowledge regarding handling of hazardous and noxious cargoes is brought out as a separate competency.

Table 1: STCW Code A-II/2 - Knowledge, Understanding and Proficiency Applicability

Competence	Knowledge, understanding and proficiency	Applicable to
Plan and ensure safe loading, stowage, securing, care during the voyage and unloading of cargoes	Knowledge of and ability to apply relevant intcrnational regulations, codes and standards concerning the safe handling, slowage, securing and transportation of cargoes	All Ships
	Knowledge of the effect on trim and stability of cargoes and cargo operations	All Ships
	Use of stability and trim diagrams and stress-calculating equipment, including ADB equipment, and knowledge of loading cargores and ballasting in order to keep hull stress within acceptable limits	All Ships
	Stowage and securing of cargoes on board ships, including cargo-handling gear and securing and lashing equipment.	General Cargo Ships
	Loading and unloading operations, with special regard to the the transportation of cargoes identified in the CSS Code.	General Cargo Ships
	General knowledge on tankers and tanker operations	Tankers
	Knowledge of the operational and design limitations of bulk carrierrs	Bulk carriers
	Ability to use all available shipboard data related to loading, care and unloading of bulk cargoes	Bulk carriers
	Ability to establish procedures for safe cargo handling in accordance with the provisions of the relevant instruments, such as IMDG Code, IMSBC Code, MARPOL 73/78 Annexes III and V and other relevant information	General Cargo Ships Bulk Carriers
	Ability to explain the basic principles for establishing effective communications and improving working relationship between ship and terminal representative	All Ships
Assess reported defects and damage to cargo spaces, hatch covers and ballast tanks and take appropriate action	Knowledge of the limitations on strength of the vital constructional parts of a standard bulk carrier and ability to interpret given figures for bending moments and shear forces	Bulk carriers
	Ability to explain how to avoid the detrimental effects on bulk carriers of corrosion, fatigue and inadequate cargo handling	Bulk carriers
Carriage of dangerous goods	International regulations, standards, codes and recommendations on the carriage of dangerous cargoes, including the IMDG Code and the IMSBC Code	General Cargo Ships Bulk Carriers
	Carriage of dangerous goods, hazardous and harmful cargoes; precautions during loading and unloading and care during the voyage	General Cargo Ships Bulk Carriers

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Unlike the approach taken in compiling Table A-II/1 mentioned above, details for the required knowledge and skills here is much more detailed, with a number of IMO instruments mentioned. As the Syllabus Outline in A-II/2 is much more specified, we can examine the applicability of individual knowledge and skills to different ship types, which is shown in the third column of Table 1.

Fig. 1 illustrates how many of the thematic knowledge and skills set by the IMO for the management level are applicable to individual ship types. If a topic is intended for more than one ship type, it is reported for each ship separately, except for all ships, which are mentioned cumulatively. Only the main types of cargo ships are mentioned. It is understandable that pure passenger ships are not covered by any of the requirements of Function 2.

Four of the fourteen topics are applicable to all types of ships. The number of topics related to bulk carriers is particularly large. It is followed by general cargo ships and tankers. There is no single specialised topic on container ships or Ro-Ro ships. In the context of the statistics presented in Section III on the composition of the world fleet, the role of container shipping in global trade, the casualty rate of container ships the absence of any specialised topics related to container ships is puzzling. In this regard, it is particularly important to note that although container ships are classified within the wider family of general cargo ships, the handling technology and methods of cargo securing, planning, and control of cargo operations differ significantly from those of the classic general cargo ships and their modern modification - the multipurpose ships.

Fig. 1, also shows that only one specialised tanker topic is included in the management-level syllabus of Function 2. This seems strange on the face of it, given the risks associated with operating this type of ships. However, the IMO has adopted a different approach to ensure that tanker crews are sufficiently trained.

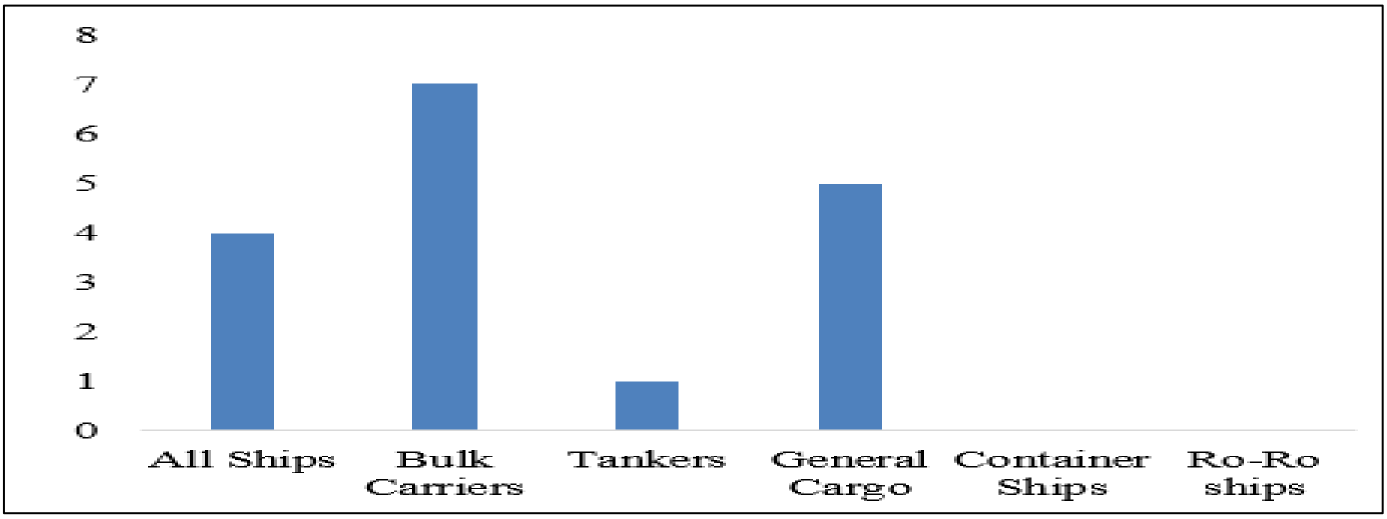

Fig 1: Number of Topics from the Syllabus Outline Applicable to Different Types of Ship

Part A of the Code includes Chapter V, which deals with so-called "special training" for crews on certain types of ships. Crews of the following types of ships are subject to such training.

- oil tankers – tables A-V/1-1-1 and A-V/1-1-2;
- chemical tankers – tables A-V/1-1-1 and A-V/1-1-3;
- gas carriers – tables A-V/1-2-1 and A-V/1-2-2;
- passenger ships – A-V/2, A-V/2-1 and A-V/2-2;
- ships subject to the IGF Code [22] – tables A-V/3-1 and A-V/1-2;
- ships operating in polar waters – tables A-V/4-1 and A-V/4-2.

Special training is compulsory for all crew members on tankers, passenger ships and those subject to the IGF Code, in accordance with their position. For ships operating in polar waters, only deck officers are covered by the special training requirements.

In addition to the training standards set out so far, seafarers also undergo what is known as "additional training". The knowledge and skills included depend on the position held on board and the type of ship. The training includes training for emergency situations such as fire, abandon ship, survival at sea, lifeboat management, first aid, medical care, security duties, etc. Additional training is provided for passenger and Ro-Ro passenger ship crews. All crew members should be given knowledge of maintaining safety on board, with training at levels depending on the position on board.

Fig. 2 shows a summary table of the specific knowledge and skills required in the training of deck officers on different types of ships, considering the three streams of training: main competence, special training, and the additional training. For each type of ship, it is determined if there is a topic in the respective training specifically aimed at the particularities of its operation.

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The IMO has not made any provision for deck officers to undergo type-specific training if employed on container ships and Ro-Ro vessels, although for both types of ships the cargo handling technology is strictly individual and does not coincide with that for general cargo. According to the CSS Code, in Ro-Ro ships the cargo is stowed and secured using a semi-standardized securing system. For cellular container ships, the standardized one is applied. General cargo ships use the non-standardized system. The stowage and securing methodology for this type of cargo is well developed in CSS Code Annex 13. In contrast, there are practically no specific lashing methods provided in the Code for cellular container ships, for which they rely solely on the rules of the classification societies approved by the administrations.

Ship type	Section A-II/2 Requirements	Special Training	Additional training Section A-VI
General cargo ship	✓		
Tanker	✓	✓	
Bulk carrier	✓		
Container ship			
Ro-Ro ship			
Passenger ship			✓
Ro-Ro passenger ship			✓

Fig 2: Summarized Ship Specific Training Requirements for Deck Officers as per STCW 2010 Code

B. IMO Model Courses 7.01 and 7.03 - Applicability to Container Ships

Since the adoption of STCW 78, several IMO member governments have advocated for model training courses to enhance the implementation of the STCW and facilitate the transfer of knowledge on new maritime technologies. These courses aim to harmonize global training standards, serving as a flexible guide rather than a strict curriculum. Training institutions can adapt them to their needs while ensuring compliance with STCW standards. Model courses are periodically updated alongside STCW amendments, with state administrations responsible for overseeing compliance.

For container ship deck officers, IMO does not provide dedicated training beyond general model courses. The relevant courses, 7.01 (for masters and chief mates) [23] and 7.03 (for watch officers) [24], were last updated in 2014 to align with STCW 2010. However, an analysis of their content reveals significant gaps in container ship specific training.

Model Course 7.03 covers cargo handling and stowage at the operational level, including ship stability, cargo securing, and various cargo types. However, container ships specific training is limited to two lessons (two hours), covering topics like vessel layout, slot numbering, loading/unloading practices and securing methods. Given the complexity of container operations, this time allocation is quite insufficient.

Model Course 7.01, intended for management-level officers, dedicates 139 hours to cargo operations but again lacks a specialized focus on container ships. Instead, it includes 16 hours on tanker-specific topics, despite officers already undergoing extensive tanker training in previous courses. This results in an imbalance where container ship officers receive minimal specialized training, while tanker officers undergo over 116 hours of targeted training accounting the main competence training and the special training.

This discrepancy likely stems from the reactive nature of training updates, often influenced by major incidents or external pressures. The absence of container safety topics in STCW training, alongside similar gaps for Ro-Ro ships, highlights the need for a comprehensive revision of ship-type-specific education standards.

V. CONCLUSION, VALIDATION AND RECOMMENDATIONS

This study analysed the need for specialized professional training for seafarers responsible for cargo operations on container ships to ensure compliance with IMO regulations and reduce accidents caused by human error. Despite the importance of container ships in global trade, investigations revealed that many accidents resulting from non-compliance with mandatory cargo stowage and securing requirements, often due to human error. The study reviewed statistical data on container ship accidents, compared training standards for different vessel types, and examined current IMO regulations related to container ship crew training. The analysis shows that human error is the largest contributing factor to accidents, and a significant proportion of safety recommendations are related to cargo handling and transportation. However, the STCW Code and IMO model courses lack specialized training for container ship deck officers, in contrast to the extensive training provided for tanker officers. The study highlights the need for a comprehensive revision of ship-type-specific education standards to address this gap in container ship crew training.

To verify the findings of this study, a survey was conducted among 4th year students at the NVNA who spent their first contract as junior cadets on board container ships.

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They were asked the following question: “Do you consider that ship type-specific training for container ships could have helped you to better adapt to the working environment on board and would have contributed to your overall safety when joining vessel?”.

The students were given the opportunity to answer on a 5-point scale: 1. Very useful; 2. Moderately useful; 3. Neutral; 4. Not very useful; 5. Not useful at all. Totally 53 students completed the survey. Most of them (51 %) gave answer 1 - “very useful” and 34% answered with “moderately useful”.

The survey results confirm the findings of this study and raise an important issue. Cadets that joined container vessels for the first time missed ship type-specific training for container ship cargo operations. This observation can be extended to other ranks that join container ships for the first time. Taking into account the opinion of the students the NVNA has provided in its curriculum of Cargo Handling and Stowage 8 academic hours of specialized classes for container ships. Unfortunately, these curriculum topics are taught to students in their final year and they can only benefit from this knowledge during their second contract as senior cadets.

In conclusion, it may be recommended for the IMO to review the current training standards for container ships and consider the introduction of type-specific training for all crew-joining container ships, not just deck officers. Training standards may include competency levels similar to the current tanker special training included in A-V/1 - Basic Training (for all crew) and Advanced Training for Cargo Operations (for master and responsible officers).

REFERENCES

[1]. Raunek, “Top 22 World’s Biggest And Largest Container Ships in 2024,” *Marine Insight*, 2024, [Online]. Available: https://www.marineinsight.com /know-more/top-10-worlds-largest-container-ships-in-2019/

[2]. Chen Yang, “27500 TEU!! Here comes the world’s largest container ship!,” Xinde Marine News. [Online]. Available: https://www.xindemarinenews. com/m/view.php?aid=56265

[3]. J. Ge, M. Zhu, M. Sha, T. Notteboom, W. Shi, and X. Wang, “Towards 25,000 TEU vessels? A comparative economic analysis of ultra-large containership sizes under different market and operational conditions,” *Marit Econ Logist*, vol. 23, no. 4, pp. 587–614, Dec. 2021, doi: 10.1057/s41278-019-00136-4.

[4]. R. J. Sánchez, D. E. Perrotti, and A. G. P. Fort, “Looking into the future ten years later: big full containerships and their arrival to south American ports,” *J. shipp. trd.*, vol. 6, no. 1, p. 2, Dec. 2021, doi: 10.1186/s41072-021-00083-5.

[5]. B. Musso, “The Evolution of Maritime Container Transportation,” in *Analytical Decision-Making Methods for Evaluating Sustainable Transport in European Corridors*, vol. 11, I. M. Lami, Ed., in SxI - Springer for Innovation / SxI - Springer per l’Innovazione, vol. 11. , Cham: Springer International Publishing, 2014, pp. 33–43. doi: 10.1007/978-3-319-04786-7_3.

[6]. International Maritime Organization, Ed., *Casualty investigation code: code of international standards and recommended practices for a safety investigation into a marine casualty or marine incident*, 2008 ed. in IMO publication. London: IMO, 2008.

[7]. IMO, “Revised harmonized reporting procedures – Reports required under SOLAS regulations I/21 and XI-1/6, and MARPOL, articles 8 and 12.” International Maritime Organization, 2014. [Online]. Available: https://wwwcdn.imo.org/localresources/en/OurWork /MSAS/Documents/MSC-MEPC3/MSC-MEPC.3-Circ.4%20Rev%201%20%20Revised%20harmonize d%20reporting%20procedures%20-%20Reports%20required%20under%20SOLAS%20 regulations%20I21.pdf

[8]. B. Li, J. Lu, H. Lu, and J. Li, “Predicting maritime accident consequence scenarios for emergency response decisions using optimization-based decision tree approach,” *Maritime Policy & Management*, vol. 50, no. 1, pp. 19–41, Jan. 2023, doi: 10.1080/03088839.2021.1959074.

[9]. X. Ma, W. Deng, W. Qiao, and H. Lan, “A methodology to quantify the risk propagation of hazardous events for ship grounding accidents based on directed CN,” *Reliability Engineering & System Safety*, vol. 221, p. 108334, May 2022, doi: 10.1016/j.ress.2022.108334.

[10]. S. Fan, Z. Yang, J. Wang, and J. Marsland, “Shipping accident analysis in restricted waters: Lesson from the Suez Canal blockage in 2021,” *Ocean Engineering*, vol. 266, p. 113119, Dec. 2022, doi: 10.1016/j.oceaneng.2022.113119.

[11]. J. Weng and D. Yang, “Investigation of shipping accident injury severity and mortality,” *Accident Analysis & Prevention*, vol. 76, pp. 92–101, Mar. 2015, doi: 10.1016/j.aap.2015.01.002.

[12]. B. Navas De Maya and R. E. Kurt, “Marine Accident Learning with Fuzzy Cognitive Maps (MALFCMs): A case study on bulk carrier’s accident contributors,” *Ocean Engineering*, vol. 208, p. 107197, Jul. 2020, doi: 10.1016/j.oceaneng.2020.107197.

[13]. J. Chen, W. Bian, Z. Wan, S. Wang, H. Zheng, and C. Cheng, “Factor assessment of marine casualties caused by total loss,” *International Journal of Disaster Risk Reduction*, vol. 47, p. 101560, Aug. 2020, doi: 10.1016/j.ijdrr.2020.101560.

[14]. L. Gucma, A. Androjna, K. Łazuga, P. Vidmar, and M. Perkovič, “Reconstructing Maritime Incidents and Accidents Using Causal Models for Safety Improvement: Based on a Case Study,” *JMSE*, vol. 9, no. 12, p. 1414, Dec. 2021, doi: 10.3390/jmse9121414.

[15]. J. Chen, W. Bian, Z. Wan, Z. Yang, H. Zheng, and P. Wang, “Identifying factors influencing total-loss marine accidents in the world: Analysis and

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25mar1675

evaluation based on ship types and sea regions," *Ocean Engineering*, vol. 191, p. 106495, Nov. 2019, doi: 10.1016/j.oceaneng.2019.106495.

[16]. D. Chen, Y. Pei, and Q. Xia, "Research on human factors cause chain of ship accidents based on multidimensional association rules," *Ocean Engineering*, vol. 218, p. 107717, Dec. 2020, doi: 10.1016/j.oceaneng.2020.107717.

[17]. U. Yıldırım, E. Başar, and Ö. Uğurlu, "Assessment of collisions and grounding accidents with human factors analysis and classification system (HFACS) and statistical methods," *Safety Science*, vol. 119, pp. 412–425, Nov. 2019, doi: 10.1016/j.ssci.2017.09.022.

[18]. F. Paolo *et al.*, "Investigating the Role of the Human Element in Maritime Accidents using Semi-Supervised Hierarchical Methods," *Transportation Research Procedia*, vol. 52, pp. 252–259, 2021, doi: 10.1016/j.trpro.2021.01.029.

[19]. Anish Hebbar, Clever Tugume, and Jens-Uwe Schroeder-Hinrichs, "A statistical overview of containerships casualties." World Maritime University, 2024. [Online]. Available: https://docs.imo.org/Shared/Download.aspx?did=150891

[20]. IMO GISIS, "GISIS: Marine Casualties and Incidents 2015-2025." 2025. [Online]. Available: https://gisis.imo.org/Members/MCIR/Search.aspx

[21]. IMO, Ed., *International code on the enhanced programme of inspections during surveys of bulk carriers and oil tankers, 2011: 2011 ESP code*, Fourth edition, 2020 edition. in IMO publication. London: IMO, 2020.

[22]. IMO, *IGF Code: international code of safety for ships using gases or other low-flashpoint fuels*, 2016 edition. in IMO publication. London: International Maritime Organization, 2016.

[23]. IMO, *Master and chief mate*, Rev. ed. 2014. in Model course, no. 7.01. London: IMO, 2014.

[24]. IMO, Ed., *Officer in charge of a navigational watch*, 2014 ed., rev. Ed. in Model course, no. 7.03. London: IMO, 2014.