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## Safe manning of ships in the era of new and emerging technologies

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**SAFE MANNING OF SHIPS IN THE ERA  
OF NEW AND EMERGING  
TECHNOLOGIES**

**AMNA JAVED**

A dissertation submitted to the World Maritime University in partial  
fulfilment of the requirements for the award of the degree of Master of Science  
in Maritime Affairs 2023

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## Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

(Signature):  .....

(Date): **24.09.2023**

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## Abstract

Title of Dissertation: **Safe Manning of Ships in the Era of New And Emerging Technologies**

Degree: **Master of Science**

The maritime industry is undergoing a profound transformation with the rapid integration of digitalization and automation of ships. While digitalization promises improved safety, efficiency and sustainability, it also presents new challenges in ensuring the safe manning of vessels. This research work is an attempt to analyse the impact of increased digitalization on safe manning of ships, mainly highlighting the concerns of the seafarers in terms of job security, occupational safety and health and a shift in the nature of their digital operational skills and tasks.

This dissertation examines the role of regulatory bodies and maritime stakeholders and how actively they are engaged in revising the policies and training patterns to ensure that seafarers are thoroughly prepared for their future challenges. Although the international, regional and national regulatory framework is working to address these issues, still a lot of work needs to be done to review the regulations and policies. The research work has also attempted to analyse the gap in the existing international regulations on safe manning and has proposed some recommendations that might be considered in future maritime policy review.

Based on the analyses, this research finding indicates that the future merchant ships will be equipped with intense digitalization especially at bridge and engine control room which will highly transform the competencies and responsibilities of the seafarers. A careful consideration must be given to advance digital training, cybersecurity and crew well-being to ensure that seafarers remain adequately prepared to the evolving demands of the modern vessels. Regulatory bodies, industry stakeholders and training institutions must collaborate to overcome the challenges that come along with digital transition and should maintain a strong focus on safety at sea.

**KEYWORDS:** Safe Manning, New technologies, well-being, Just Transition

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## List of Abbreviations

ECR:	Engine Control Room
FAL:	Facilitation of International Maritime Traffic
IACGMA:	International Advisory Committee on Global Maritime Affairs
ICS:	International Chamber of Shipping
ILO:	International Labour Organization
IMO:	International Maritime Organization
ISM:	International Shipping Management Code
ITF:	International Workers Transport Federation
LEG:	IMO Legal Committee
MARPOL:	International convention for the prevention of Pollution from Ships
MASS:	Maritime Autonomous Surface Ships
MLC:	Maritime Labour Convention
MSC:	Maritime Safety Committee
OOW:	Officer on Watch
OSH:	Occupational Safety and Health
PTSD:	Post Traumatic Stress Disorder
RSE:	IMO Regulatory Scoping Exercise
SOLAS:	Safety of Life at Sea
STCW:	Standards of Training and Watchkeeping at Sea
UN:	United Nations
UNCLOS:	United Nation Convention on Law of Seas
VR:	Virtual Reality



## Chapter 1

### Introduction

Shipping, the bloodline of world trade, carries out almost 80-90 % of global trade and seafarers are regarded as the lifeblood of this mighty industry since they play a notable role to keep the economy running (Baumler & Manuel, 2021). The sustainability of the maritime sector includes the well-being and safety of seafarers as they are the backbone of ship operations and the shipping industry. Seafaring in general is regarded as a dangerous profession attributed to hazardous circumstances, poor living and working conditions. Seafarers face numerous challenges while working onboard, such as slips, trips and falls, lifting heavy objects, cargo handling, mooring, exposure to noise, hazardous substances and work-related stress. The Occupational health and safety of seafarers play a crucial role for maintaining sustainable shipping practices as the bulk of problems in the maritime industry are thought to be caused by human error and fatigue is one of the major contributing factors among these. According to an estimate, 75% - 96% of marine accidents are thought to be the result of human error and this can be attributed to the reduced and under manning of most of the ships (Russ, 2018). The significance of the human element in the shipping sector cannot be undermined and needs to be recognised and handled effectively in order to reduce accidents.

Although international legal maritime safety instruments are constantly being upgraded and regulations and guidelines are being issued with the changing trends of the shipping industry, there are still several reports of fatal accidents caused by fatigued and insufficient crew members on ships. For example, a tragic accident onboard the 2,984 GT general cargo ship *Damsterdijk* occurred in the UK port of Ipswich in October 2019, resulting in the sad demise of a cook. The investigating team's report on the incident emphasises the difficulty in managing safety-critical tasks with a minimal number of crew onboard. Investigations revealed that the incident happened due to the false certificate of minimum crew level, hazardous working

conditions, extending working hours resulting in fatigue, barriers to effective communication and lack of supervision and coordination by the chief officer (Nautilus, 2021).

The existing regulations on manning of ships are not adequately addressing the current and upcoming challenges. There is no particular convention which determines the level of manning on various vessels and there are only guidelines on safe manning that are not a mandatory instrument to be complied with. These vague statements are subjected to be exploited by the owners and the shipping companies (Russ, 2018).<sup>1</sup> Officially certified safe manning levels for ships must accurately reflect the reality of operations and confirm that delimited rest hours for crew members and other measures entitled to the well-being of seafarers are to be implemented in true spirit (Exarchopoulos & Zhang, 2023).

This research findings further indicates that the detailed principles listed in International Maritime Organization Resolution A.1047, titled IMO Principles of Minimum Safe Manning for establishing minimum safe manning levels are not observed in most instances. It is also evident that the flag States and operators do not always carry out their responsibilities, nor do they inevitably ensure that shipowners carry out their duties with regards to safe manning of ships. This in turn creates a disproportion between workload and the number of staff available to complete the variety of onboard tasks. The situation is even worsened during the peak working hours especially in port-related activities and operations. The discrepancies in implementation and non-enforcement mechanism give room to ship owners and companies an environment of deviance (Baumler et al., 2021). The research findings also indicate that insufficient crew and noncompliance with the existing safe manning levels are the root cause of seafarer's fatigue and other malpractices.

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<sup>1</sup> Manning levels on many ships often only meet the flag state minimum for that size and type of ship. Often this fails to allow for additional watchkeeping requirements whilst sailing through restricted waterways, port operations, non-routine maintenance requirements and /or off-duty /overtime work performed by seafarers in order to satisfy commercial pressure, particularly on busy, short-haul trading routes.

Presently, the maritime industry is increasingly embracing automation and new technologies to enhance operational efficiency. This includes the development of semi to fully autonomous vessels and remotely operated shore-based centres. These vessels incorporate automation, digitalization, and sophisticated systems to improve efficiency, navigation and cargo operations. For example, countries like Norway, Denmark, Finland, Japan, India and many developed countries are buying the idea of smart shipping in order to increase efficiency and reduce the commercial cost. Norway has exemplified this idea by the invention of the first fully autonomous containership *Yara Birkeland*. The ship has been in commercial operations since 2022 (Yara, n.d.). Similarly, *Maersk*, a leading logistic company of Denmark, launched the first zero greenhouse gas emission container vessel *Laura Maersk* officially named in September, 14 2023. It is the world first container vessel operating on green methanol that is assumed to be commercially operational at the end of 2023 (Maersk, 2023)<sup>2</sup>.

The ongoing rapid transformation in the maritime industry towards digitalization and environmental protection is also presenting a wide range of challenges to the safe manning of vessels. These challenges include skills and competencies of seafarers with respect to advanced technology, increased workload, integration of existing systems with modern systems, job displacement of old and existing seafarers, impact of technology on the occupational health and safety of seafarers due to the continuous exposure and handling of high-tech systems onboard. Some of the challenges are discussed briefly in chapter 3 of this research paper. This paper will also highlight the reduction in the crew size and a transformation to the existing training pattern of the seafarers is one of the major concerns that is coming along with digitalization. Although automation has many benefits to offer in the shipping industry, it can also potentially reduce the size of the onboard crewmembers. Several studies affirm that in the 1950s, the average number of seafarers onboard was about 40-50 which declined

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<sup>2</sup> Equinor and Maersk Partner up to ensure the continued green methanol supply for the world first methanol-enabled container vessel on 8 September 2023. The 172-metre-long ship is the first of 25 methanol-powered container ships. The ship accomplished its maiden voyage from South Korea to Denmark in August 2023.

to an average of 20-30 in the 1980s. Today it is further reduced to almost 17 personnel onboard, while on experimental automated future ships only ten persons onboard are recorded (Stopford, 2009).

It is essential for the shipping industry to strike a balance between reaping the benefits of digitalization and managing the associated risks to ensure the safety of vessel's operations in general and seafarers' welfare in particular. The concerns of seafarers associated with increasing automation of the shipping industry can be addressed through proper training, appropriate crewing level, supportive regulations with the changing technology and comprehensive safety protocols to lessen the risks associated with the reduction of crew size and the well-being of seafarers.

### **1.1 Statement of the Problem**

This research paper attempts to analyse the gap in the existing regulations and guidelines for the safe and efficient manning level by taking into account the upcoming and future challenges with the increased automation of the shipping industry and comes up with the viable recommendations to be considered at the international level. This study also finds out that the lack of a definite convention on the insufficient and decreased manning level and the lack of effective compliance with existing guidelines by the stakeholders, is the root cause of various malpractices onboard.

### **1.2 Aims and Objectives**

- a) To assess the challenges in formulation of the policy for the adequate manning levels on board vessels by IMO.
- b) To evaluate the level of compliance by managers onboard ships with the existing IMO manning guidelines.
- c) To investigate the relationship between different factors that are preventing the compliance of legal regime with respect to the manning of vessels.

### **1.3 Research Questions**

- a) Why is increased manning not a priority in the IMO policy agenda?
- b) To what extent are the flag states and shipping companies/owners complying with the safe manning of merchant ships?
- c) Are the current regulations adequately addressing the safe manning of ships?
- d) To what extent would the present global manning situations be able to cater for the challenges posed by automation and digitalization of the shipping industry in the near future?

### **1.4 Research Methodology**

This research is based on the analysis of ongoing maritime safe manning practices and legal regime regarding the safe manning of vessels, presenting how regimes are and how they should be in order to achieve a balance between the seafarers and the different stakeholders' interests. The study highlights the issue of reduced crew and challenges posed by ongoing advancement in technology especially in the present and near future. The research is primarily conducted by analysing the data gained through the authentic and appropriate sources, i.e., UN Conventions, IMO's Regulatory Frameworks, reports, books, journalistic articles and newspaper articles taking into consideration the increased automation of the shipping industry.

### **1.5 Limitations of the research**

This research is mainly analysing the current and future challenges regarding safe manning and evaluating the gap in the present regulatory regimes regarding safe manning levels. The research, however, would not be able to analyse the data collection through questionnaire and interview methods due to the time limitation and constraints in physically approaching the target population, such as shipowners, ship managers, flag state administrations and port state authorities.

## 1.6 Division of Study

The research will be divided into five chapters including introduction, recommendations and conclusion.

The first chapter provides the introduction to the underlying problem of safe manning by defining the methods adopted for this research, and the elements that are not touched upon due to certain limitations.

The second chapter provides a literature review by analysing the existing regulatory instruments and challenges posed by the current and upcoming techno-advancement in the maritime industry.

The third chapter discusses the challenges posed to current manning levels by changing technical dynamics of the shipping industry especially in view of the training, occupational safety and health and stress posed by technology on seafarers.

The fourth chapter looks into the deficiencies and inadequacies in the existing regulatory frameworks regarding safe manning level onboard and will analyse the expected changes in the legal regime especially with respect to maritime autonomous ships and shift of the manning situation.

The last chapter concludes the overall topics and makes some recommendations and measures that can be taken into consideration by the statutory bodies in order to overcome the existing and upcoming challenges regarding the safe and efficient manning.

## Chapter 2

### Literature Review

This chapter presents the analysis of the current and future manning situation by taking into consideration the various aspects from the perspective of various stakeholders like flag states, ship operators, port states, seafarers and the role of statutory bodies in effectively regulating the manning situation and its compliance at the global level. The chapter will also discuss the impact of changing trends, especially technology on the health and well-being of seafarers and how current regimes are addressing these challenges. The analysis is made by reviewing the literature from various authentic sources including IMO conventions, books, scholarly articles, dissertations, websites and blogs.

#### 2.1 Risks and Benefits of Crew Reduction

**Risk and Benefits of Crew Reduction and/or Removal with Increased Automation on the Ship Operator: A Licensed Deck Officer's Perspective** by *Elspeth Hannford and Edwid Van Hassel* is qualitative research which describes the scope and limitations of removing crew with the increased automation in shipping.

The Article describes that the development of autonomous shipping technology has increased significantly in recent years. Reduction in the commercial cost and accidents caused by human error are the two major drivers which have motivated maritime organizations, private businesses, governments, and academic institutions towards the adoption of autonomous shipping. Currently there is no agreed-upon timeline or method for implementing autonomous shipping. The goal of this paper is to examine the potential hazards and advantages that autonomous shipping might have for licensed deck officers, with a particular emphasis on their perspective as the ship operator.

The study revealed that the licensed deck officer may be negatively impacted by crew reduction and increased automation. Increased vessel automation would lead to a greater reliance on sensors and reduced situational awareness, as the control centres

would be recreated on land. Moreover, it is believed that less conventional licensed deck officer posts might exist in the future and some modification in their current skills. It is also believed that the traditional positions will still continue and the mariners will adapt them according to the changing requirements and skills.

The paper further elaborates that shipping firms, unions, and Maritime Education and Training (MET) facilities are not sufficiently prepared for changes in the industry; therefore, the usage of inter-institutional platforms is recommended to tap into SME expertise, including licensed deck officers as autonomous shipping technology advances.

Furthermore, it is concluded that more attention would be needed regarding MET because MET will change significantly during the next ten years. Although there have been few discussions about the operator skills essential to fulfil these upcoming criteria, new skills and Standards of Training, Certification and Watchkeeping (STCW) competencies may still be required.

## **2.2 Applicability of STCW Convention to MASS**

**Study on the applicability of STCW Convention to Maritime Autonomous Surface Ships (MASS) and updating Electro-Technical officer (ETO'S) Standard of competence** by *XU Chang Qing*, is a dissertation which tries to find out the gap with STCW Code in view of the automation and digitalization advancement. The thesis also analyses the knowledge and skill gaps that may be needed as a result of the development of MASS technology, and combine those findings with the development trend of green ships and ships' typical flaws. As a result, the current issues and new requirements in technology, operation, and regulation are analysed, and the inappropriate or missing knowledge and skill parts in the STCW Code are identified. The unique aspect of this research is the use of knowledge and skills to reach conclusions on how the STCW Convention will be applicable to MASS. The STCW Convention merely needs to update the STCW Code to reflect updated training and certification standards for remote operators in order to effectively transition to



autonomy levels one and two. New tools may be needed to solve autonomy levels three and four.

The authors recommend that the maritime administration and maritime education institutions should enhance their investment towards policies and resource building in order to provide sophisticated training models, teaching platforms and laboratories. Training in situational awareness, communication skills, preventing maritime pollution, and emergency response skills should all be prioritised. To address the issues of high expense, risk, and difficulty in repeated training, Virtual Reality (VR) technology should be widely used in seafarers' education and training. Moreover, organisations need to offer proper seafarer training and must work closely with educational and training institutes.

### **2.3 STCW Convention's Standards for the Training of Seafarers**

The STCW Convention refers to the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers. The convention is administered by the International Maritime Organization (IMO) and sets the minimum standards for training, certification, and watchkeeping for seafarers on an international level.

The convention aims to promote the safety of life and property at sea by ensuring that seafarers are adequately trained and competent to perform their duties onboard ships. It also establishes a set of minimum standards for the training and certification of seafarers, providing a framework for uniformity in maritime education and training worldwide. The convention emphasises continuous professional development and upgrading the skills and knowledge of seafarers to keep pace with advancements in technology and best practices in the maritime industry.

By providing a standardised certification system, the convention helps to combat fraudulent practices related to seafarer qualifications and promotes higher-quality training programs. In addition, it addresses the issues related to seafarers' hours of work, rest periods, and working conditions to ensure their well-being and prevent fatigue-related accidents. Moreover, the STCW Convention enables seafarers to work

on ships of other countries by recognizing their qualifications and certificates, promoting international mobility within the maritime industry.

Overall, the STCW Convention is a significant legal framework that plays an important role in enhancing maritime safety and promoting a skilled and competent workforce of seafarers globally. However, like any regulatory framework it may have deficiencies particularly in the context of current and upcoming situations of manning in the maritime industry.

#### **2.4 IMO's Principles of Minimum Safe Manning**

IMO assembly in its 20th session in November 1997 adopted a resolution about *factors in manning* to encourage the parties involved in ship operations for increasing focus on human-related activities. The managers and operators of ships were asked to develop and implement a safety and pollution prevention management system. The parties involved were encouraged to consider factors related to fatigue in manning and safety. The stakeholders were also asked to increase focus on human-related activities in the safety operation of ships and the environment protection.

In 1999 at its 21<sup>st</sup> session a resolution on *Principles of safe manning* was adopted and subsequently changed to *Principles of minimum safe manning* in 2003. The objectives of these principles were to warrant that a ship is sufficiently, efficiently and effectively manned and the manning levels are able to provide safety and security of the vessel. These principles are meant to avoid fatigue and to ensure safety of navigation, safe operations at sea and port, prevention of human injury, loss of life and damage to the environment.

The guidelines on fatigue were approved in 2018 and covered issues such as fatigue and the company, and fatigue and the seafarer. These guidelines primarily focus on managing and mitigating the fatigue-related risks in order to ensure the well-being of seafarers and safe operations of vessels. The guidelines are not legally binding but serve as valuable recommendations for the maritime industry.

IMO is presently supporting the Maritime Just Transition Task Force involving International Chamber of Shipping (ICS), International Transport Workers'

Federation (ITF) and International Labour Organization (ILO) to look into the skills needed for a people-centred just green transition.

Like other regulatory bodies IMO's Principle of Safe Manning still has certain deficiencies but the positive thing is that efforts are being made at the international level to continuously update and review the manning standards in line with the changing needs of the maritime industry. This includes taking into account the advancement in technology, human factors and operational practices to maintain the balance between the safety and efficiency of the shipping industry.

## **2.5 Adjustment of Seafarers Rest and Work Hour Records Onboard**

**Ship first: Seafarers' adjustment of records on work and rest hours** by *Raphael Baumler, Bikram Singh Bhatia, and Momoko Kitada* investigates how seafarers keep track of the application of their work and rest hour laws. It specifically takes into account the drivers behind seafarers' attempts to conceal their violations through record-keeping.

The article emphasises that frequent infractions are caused by the imbalance between workload and staffing levels, notably during port-related operations and for seafarers on the 6 On/6 Off watch schedule. The study reveals that practically all seafarers tend to alter work and rest hour records in order to conceal their violation and seem to be in compliance. The primary motivation behind such record-keeping adjustments is concern over the consequences of non-compliance during third-party inspections. Seafarers often put the interests of the ship first because of their concerns over their employment and fear of losing their jobs. Violations and modifications appear to be ignored by the flag State, port State, and shipping corporations. As a result, updating records appears to be a low-risk choice for seafarers. The International Safety Management (ISM) Code and its audit mechanism, however, appear to have failed when records are adjusted systematically. Many times, mariners put up with terrible working circumstances and adopt the "ship first" philosophy. This investigation provides proof that seafarers violated the necessary rest periods and altered shipboard

logs to cover up their transgressions. Such compliance strategies are in doubt given the importance of changes. This article makes the case that seafarers are caught between operational requirements on board and a weak regulatory framework. This study also supports Hughes' description of a schizophrenic state. Due to the fact that inspectors infrequently evaluate the accuracy of records, adjusting records has been identified by seafarers as the unsatisfactory but only realistic alternative. While it is clear that enforcement agencies now have great skills for evaluating the reliability of oil records, there are currently no reliable methods for confirming rest hours. This viewpoint is surprising because nations like the United States of America identified inadequate manning, which led to fatigue, as a significant factor in their worst ship-related oil disaster, the Exxon Valdez, as one of the causes. This work would be complemented and expanded by additional studies on the enforcement of work/rest hours.

The research finally concludes that there are questions about the current utility of the ISM Code and its audit system given that they do not appear to be able to resolve the issue. For shipping to enhance its organisational performance and safety, the development of a "just culture" based on trustworthy connections that guarantees quality feedback and responses is greatly required. It is also essential to improve shipping safety and bridge the distance between land and ships. By encouraging seafarers' feedback and considering their perspectives on safety will be advantageous to bridge the gap between land and sea and improve the overall safety of the shipping industry.

## **2.6 Safe Manning of Highly Automated Vessels**

**Can a ship be its own captain? Safe manning of autonomous and uncrewed vessels** by *Barbara Stepień* is about the autonomous and unmanned ships, which is a new development in marine technology, are already positioned to transform the shipping sector. The fact that they are essentially unregulated by the maritime rules in place, however, poses serious safety and social effect concerns. The writer questions whether

significant changes to current laws or the adoption of new international legal instruments need to be made in order for them to be incorporated into the marine legal system, or may this be accomplished through a policy choice by the international community. For the optimum solution to digitalization and automation of shipping, the writer suggests that embracing the new, specified convention or a particular code designed for those vessels seems to be a convenient solution. Based on the analysis done, it can be said that the primary issues with these new types of vessels complying with the laws now in place have more to do with their uncrewed nature than with their operational autonomy. Therefore, the primary regulatory obstacles result from the need to ensure the physical presence of a master and crew members on board (as required in particular by the UNCLOS, STCW, and MLC Conventions) and from the safe crewing standards.

The author further goes on describing that despite the fact that the IMO, MSC stated in the RSE that a policy choice must be made in regard to the appropriate terminology (particularly the definition of a master, seafarer, and shore-based operator). Despite this, the IMO Regulatory Scoping Exercise must be seen as a significant step forward in allowing autonomous and unmanned vessels to operate within the current legal framework because it identified the main regulatory obstacles resulting from the IMO instruments. It was also the first worldwide attempt to create a definition that would apply to maritime autonomous surface ships (MASS), which despite being far from perfect, established the groundwork for subsequent discussion. At the end, the writer concludes that there is an urgent need to secure interim solutions that would allow the initial functioning of the autonomous and unmanned vessels and their coexistence with conventional ships until a permanent solution to this problem is created.

## **2.7 Analysis of Seafarers' Education and Training Regulatory Framework**

**The Evolution of Seafarer Education and training in international law** by *Michael Ekow Manuel and Raphael Baumler* is a chapter which is derived from the book, *Maritime Law in Motion*. The chapter discusses the regulatory framework for the

education and training of seafarers under the context of public international law. The chapter has briefly described the history of education and training of seafarers linking it to the present situation and challenges for future developments in the maritime industry. The authors have critically analysed shortcoming in the international regulatory system vs the national approach of the states in respect of their sovereignty, which is a major contributory factor in the non-compliance of international law in this global sector. The main focus is on the STCW Convention 1978, as amended today along with the challenges it faces in the current regulatory framework. The authors have successfully presented the International Law approach along with the challenges which it could encounter in the upcoming future and finally the chapter concludes with some recommendations which might be considered in the future amendments of international law regimes.

## **2.8 MLC, 2006 as Bill of Rights of Seafarers**

**The Maritime Labour Convention 2006 in human rights context: An appraisal** by *Yen-Chiang Chang and Muneeb Khan* evaluates the role of the Maritime Labour Convention from the perspective of human rights and argues how successful it has been in preserving the rights of seafarers. However, MLC has been considered as the “Bill of Rights” of seafarers and its concept of zero favourable treatment to states has provided the level playing field to prevent biases in the protection of seafarers’ right. The author further goes on that the triparty structure of MLC and monitoring by three parties i.e., flag State, port State and labour supplying state has increased its credibility but nonetheless the non-mandatory nature of MLC guidelines have made the standards non-uniform globally. The author concludes with the suggestion that the guidelines should also be made mandatory in order to observe uniformity in MLC compliance at an international level.

## 2.9 Seafarer's Welfare Under MLC 2006

**Seafarers' welfare: A critical review of the related legal issues under the Maritime Labour Convention 2006** by *Georgios Exarchopoulos, Pengfei Zhang, Nicola Pryce-Roberts, and Minghua Zhao* elaborates that the living and working conditions of seafarers have significantly improved as a result of the implementation of the Maritime Labour Convention of 2006. Nevertheless, the welfare of seafarers is still jeopardised in many ways, including social isolation, exhaustion, stress, and their line of work may be criminalised and targeted in numerous locations throughout the world. Exarchopoulos et al try to critically examine a number of significant concerns regarding the wellbeing of seafarers under the MLC 2006 regulatory framework. The authors state that regardless of many positive impacts the MLC 2006 has on seafarers' welfare, there are still many gaps that are preventing the advancement of seafarers' wellbeing. The psychological needs of seafarers, such as loss of sense of connection with friends and family, work stress and isolation, are more closely related to these factors. Despite the fact that many MLC 2006 laws are concentrated on and imprecisely suggest all these areas, the issues connecting seafarers' mental health, wellbeing, and even basic labour rights have not yet been efficiently addressed. The article comes to the conclusion that maritime regulation needs to be revised periodically in order to reduce the happenings of maltreatment and misuse of seafarers' rights.

## 2.10 Impact of Stress Posed by Technology to the Health of Seafarers

**Technostress at sea: A case study of Danish Flagged vessels** by *Dr. Khanssa Lagdami* is a report in **Transport 2040: Impact of Technology on Seafarers - The future of Work**. In this report the author has argued that the rapid advancement in technology, especially in the maritime sector, is impacting the occupational safety and health of seafarers in a profound way. The writer states that, because of the speed at which technology is being incorporated into shipping, seafarers are under growing pressure to learn new skills and competencies quickly, which has major negative

effects on their mental health and wellness. The burden of technological advancement is specially felt by sailors, who are at the forefront of marine operations. Seafarers must keep up with the increasing pace of new technology development, which is known to lead to work-related stress, termed by the author as “Technostress”. The writer further elaborates that despite the awareness of this stress and its impacts on the mental health of seafarers, there is still no regulation in the international, regional, national or in the industries regarding technostress. The author emphasises that seafarers must be sufficiently trained for new technologies before joining the ships and they must be made aware of the seriousness of this stress that can further deteriorate their physical and mental health. The author concludes that there is a need to raise awareness among seafarers regarding this issue which can be done through multiple platforms i.e., seminars, conferences, meetings, and media. The involvement of different stakeholders in the whole process can also play a major role as they will be made aware of the technical challenges faced by seafarers in their routine work.



## **Chapter 3**

### **Factors Affecting the Safe Manning of Merchant Ships**

This chapter critically analyses the current situation of sufficiently and efficiently manning of ships and the challenges posed by the changing trends in the shipping industry especially on the automated and super digitalized ships and ports. The chapter further anticipates the future impacts of technology on the number, occupational safety and health (OSH) and training of seafarers.

#### **3.1. Manning of Ships**

Manning can be defined as “The minimum number of people required to safely operate a ship in accordance with the legal, management and technical requirements. The manning level varies from ship to ship depending upon the type, age and technology of the ship” (Li & Wonham, 2000).

Manning of ships is the process of determining the number of qualified and trained staff required to maintain a vessel safely and efficiently during its voyage and operation. Manning requirements are influenced by various factors such as the size and type of ship, nature and amount of cargo, and intended voyage and port intervals. Sufficiency and efficiency are two terms that are very inter-related when related to the term manning of ships. While the latter is covered by the STCW Convention, the former is related to the "Safe Manning Document" under SOLAS (Chowdhury, 2008).

#### **3.2. Efficient Manning of Ships**

Efficient manning implies making sure that the appropriate number of crew members with the required training and credentials are allocated to the ship while taking into account the elements like vessel size, type, operational needs, and legal compliance (Macdonald, 2006). A thorough grasp of the ship's operational requirements, personnel capabilities, and regulatory environment is necessary for efficient ship staffing. Ship operators can improve operational efficiency, uphold safety standards, and manage expenses by optimising crew makeup, qualifications, workload distribution, and use

of technology (Russ, 2018). Therefore, efficient manning may be described as the practice of staffing and organising a ship's crew in a way that maximises operational effectiveness while minimising costs is known as efficiently manning ships (Stepien, 2023).

Efficient manning involves assessing the ship's size, type, and operational needs to determine the optimal number of crew members required. Factors such as the vessel's complexity, automation level, trading area, work and rest hour regulations play a role in determining the crew size (Russ, 2018).

The objective of efficient manning is to strike a balance between having enough personnel to perform necessary tasks and ensuring cost-effectiveness. It also considers the skills and expertise required for different positions on board. It involves identifying the necessary qualifications, certifications, and experience levels for each crew member to effectively perform their assigned duties (Stepien, 2023). This includes roles such as deck officers, engineers, electricians, navigators, and catering staff, among others. Matching the crew's skill sets with the ship's operational demands helps optimise efficiency (Stepien, 2023).

With the increasing use of automation in the maritime industry, efficient manning ships also involves integrating technology and automated systems effectively with the human crew. It requires assessing the level of automation onboard and determining the tasks that automation can handle versus those that require human oversight or intervention. This ensures that the crew's roles and responsibilities are aligned with the ship's automated systems, maximising operational efficiency. It also takes into account safety considerations and regulatory requirements. It ensures that there are enough crew members to maintain a safe working environment, handle emergencies and comply with international maritime regulations. This includes maintaining proper watchkeeping, adhering to rest hour regulations, and ensuring sufficient personnel for firefighting, lifesaving, and security duties (Stepien, 2023).

A ship's efficiency in manning significantly impacts its safety, performance, and profitability, making it essential for seamless operation. Optimising operational performance, crew workload, and safety while considering elements like vessel type,

size, technology, and regulatory requirements are the goals of efficiently manning ships. To strike the ideal balance between and efficient crewing, it is necessary to carefully evaluate the operational requirements of the ship and the crew's capabilities.

### **3.3. Safe Manning**

A contentious issue in the global discussion is the safe staffing of cargo ships. All ships must be securely staffed by international laws, and the Minimum Safe Manning Document (IMO 1999), which specifies the minimum personnel requirements for each ship. A ship can only set sail if the required minimum staffing is fulfilled. Safe manning signifies the number of skilled and qualified seafarers required to preserve the environment, the safety of the ship, crew, passengers, cargo, and property. The conditions connected to the training, work and rest hours, safety at workplace, health and hygiene, and the adequate availability of food all affect seafarers' capacity to satisfy the criteria (Alpapetite & Kozine , 2017).

The shipping sector is currently engaged in a fierce international rivalry where even modest margins matter. All ship owners who operate in the same markets have the same operational costs for things like fuel and port fees. The only more significant variable costs are staffing which vary greatly from nation to nation. As a result, these costs have emerged as a crucial factor in the competition, making staffing optimization crucial. (Tyson, 2006).

A ship's crewing can be considered an optimization problem with the goal function "minimum staffing expenses" or "minimum number of crewmembers" and the constraint that the crew must ensure the ship is operated safely over the long term. The size of the crew, the number of qualified crew members, the automation of some jobs, the relocation of some tasks to land, the presence of a dual-officer on board, the length of the watch shift are few aspects of this multidimensional problem. Although the effects of some of the above-mentioned variables on safe operation are quite evident, quantifying such effects is more difficult. Nevertheless, some quantifiable factors are proven to have a direct impact on operational safety. The workload is one of the key factors. Inadequate safety on board is largely caused by an excessive workload, a lack of rest, and as a result weariness (MacDonald, 2006).

The minimum hours of rest required on board are outlined in both international (EC 1999) and national rules (DMEBA 2002) in acknowledgment of this fact. The smallest number of breaches of the rest restrictions, as specified by the relevant legislation, is the primary objective function of this optimization issue. Almost 90 % of the ship accidents are caused by human error and fatigue is one of the major factors. In order to carry out all tasks correctly and safely, the better the personnel, the less is the deviation of the rest regulations and fewer chances of human error onboard (Baumler et al., 2021).

However, in addition to fatigue, motivation, morale, training, experience and working conditions are the various elements that constitute the human element. One must conduct a thorough examination of the tasks performed throughout each phase the ship goes through (sea travel, arrival, departure, cargo handling, and anchoring) in order to solve the sufficient staffing problem (Alapetite & Kozine, 2017).

### **3.4. Factors Affecting Safe Manning**

Historically, manning in the shipping industry has been influenced by various factors such as economic conditions, technological advancements, regulatory changes and global trade patterns. Factors such as long working hours, extended periods away from home, and concerns about safety and security have influenced the availability of qualified personnel (Russ, 2018). Furthermore, the shipping industry is faced with challenges in reducing and retaining the skilled seafarers (Hannaford & Hassel, 2021) The factors which are impacting the safe manning can be broadly divided into three categories, such as technical, individual, organisational and social respectively. All of these are briefly discussed below.

#### **3.4.1 Technological Factors**

To improve operational efficiency, the maritime sector is embracing automation and technology more and more. Full automation, however, is still in its infancy and must overcome legislative, safety, and technological obstacles. Furthermore, seafarers are confronted with unique challenges in human- machine interaction as such,

*3.4.1.1 Fear of Cyber Attacks.* The fear of cyber-attacks can also have a negative impact on seafarers' psychological health causing distress and anxiety. Further, the lack of privacy due to a apprehension of data access by shore controlled centres may intensify the present stress onboard. The crew on board may feel that they are being continuously monitored and can feel insecure. Seafarers may experience increased stress and anxiety following a cyberattack. The breach of their ship's systems or the theft of sensitive data can create a sense of vulnerability and uncertainty. The fear of potential consequences, such as accidents or compromised safety, can contribute to heightened stress levels and anxiety among seafarers. If a cyberattack results in the theft or exposure of personal data, seafarers may experience emotional distress. In severe cases where a cyberattack leads to significant disruptions, accidents, or life-threatening situations, seafarers may develop post-traumatic stress disorder (PTSD). The traumatic experience of a cyberattack, combined with potential physical dangers and the aftermath of the incident, can have long-lasting impacts on mental health (Akpan et al., 2022).

*3.4.1.2 Information Overload and Technostress.* The increase in information due to automation has led to overburden of information for seafarers. To process and prioritise this huge amount of data can be challenging and may lead to perplexity and confusion. In addition to digital performance, seafarers also have to manage and monitor various systems. Monitoring digital and manual work simultaneously will also increase the workload, which will ultimately lead to fatigue reducing their ability to perform onboard tasks effectively (Sauer et al., 2002).

Technostress is the term coined to the stress that comes from the excessive use, exposure and management of technology. In the maritime industry, technological stress has not been thoroughly investigated. Technostress, as the term is used, refers to workplaces that are heavily reliant on technology (Concha et al., 2021).

The technostress experienced by seafarers in context to technically sophisticated ships and MASS indicates the emotional and psychological anxiety stemming from the introduction and use of smart technologies in the maritime industry. Information and communication technology (ICT) professionals exhibit high levels of computer

anxiety, feeling uneasy, frustrated, and stressed. They expect disastrous results from mistakes when utilising computers and the Internet. The stressors that people encounter can be divided into a number of categories known as "technostress-stressors" (Lagdami, 2023).

**Techno-overload** may result from workers being unable to handle the information overload brought on by modern technologies. Moreover, ICT is not the only factor contributing to technostress. Other technological stressors include the information flow and the perception of always being linked and approachable, which results in a sense of invasion of personal time and space. **Techno-complexity** can also result from workers having to spend time and money learning how to grasp the complexity of the technology and undergoing challenging learning curves. **Techno-insecurity** is a stressor caused by someone's worry or threat of losing their job as a result of others becoming better at using technology (Lagdami, 2023).

Additionally, workers experience dissatisfaction and anxiety due to the frequent changes and improvements in technology, a syndrome termed as "**Techno Anxiety**". The term "**techno-anxiety**" refers to a user's worry, nervousness, and agitation when using computers or other ICT devices. This comprises unease when a person must use ICT to complete an action (such as clicking a button) and a corresponding concern of information loss. These elements, together known as techno-stressors, add to the extent of the effect that technostress has on workers' occupational health and safety, or techno-strains. These are described as the psychological, bodily, and behavioural reactions of a person to stressors (Lagdami, 2023).

Despite much research and concerns over technostress, seafarers are experiencing technological stress. Studies revealed that in Denmark one in every four employees are facing the consequences stress posed by technology. Despite these suffering the crew members would be reluctant to admit these dissatisfactions due to the fear of losing job or out of faithfulness towards the shipowner (Lagdami, 2023).

*3.4.1.3 Noise Related Health Impacts.* Contemporary ships contain a variety of alarms for controlling and monitoring the complex operations of the autonomous and semi-

autonomous vessels. Constant exposure to numerous alarms can desensitise individuals causing them to become less alert or ignore serious alarms which in turn potentially compromise the safety. Excessive noise levels can hinder effective communication among crew members, particularly in emergency situations where clear and timely communication is critical. Loud alarm sounds can make it difficult to hear and understand spoken instructions or relay important information, potentially impeding coordinated responses and increasing the risk of accidents or errors (Graham et al, 2023).

Excessive exposure to noise and alarms can interfere with concentration and cognitive performance. High levels of background noise can make it challenging to focus on tasks, process information accurately, and make critical decisions. This can have implications for the safe and efficient operations of semi and fully automated ships (Graham et al., 2023).

### **3.4.2 Individual and Organisational Factors**

The following are the factors which are affecting safe manning at individual and organisational levels.

*3.4.2.1 Reduced Understanding of Situational Awareness.* Considerable dependence on technology may lead to the lack of understanding the situational awareness causing inability to sense and respond to the potential safety hazards. On automated ships, there is a concern that seafarers may experience a reduced understanding of situational awareness. Situational awareness refers to the perception and comprehension of the current circumstances, conditions, and events in the environment and their potential impact on the ship's operations and safety (Bajwa, 2022).

Automation will limit seafarers' exposure to direct sensory information from the ship's environment. For example, on a traditional ship, crew members can rely on their senses, such as sight, sound, and touch, to assess the vessel's motion, weather conditions, and potential hazards. However, on an automated ship, seafarers may have limited or no physical presence on board, relying solely on digital displays and remote monitoring systems. This detachment from direct sensory feedback can impede their ability to develop a complete and intuitive understanding of the situation (Hannaford

& Hassel, 2021).

Automation can also handle numerous tasks and processes without direct human intervention. As a result, seafarers may have less involvement in decision-making and problem-solving, leading to a diminished sense of situational awareness. When automation takes over critical functions, seafarers may become disconnected from the decision-making process and may not fully comprehend the rationale behind certain actions or system outputs. Maintaining situational awareness is crucial for seafarers to effectively respond to emergencies, make informed decisions, and ensure the safety of the ship and its crew (Hannaford & Hassel, 2021).

*3.4.2.2 Skills and Competence.* Learning and acquiring new technologies alongside the routine operations can be challenging for seafarers, especially those who are habitual to conventional shipboard operations. Techno-complexity is evidenced by the fact that engineers must spend time and effort to become familiar with various interface designs and the meanings of technical abbreviations. Engine control rooms (ECRs) with software-based computerised systems that use push buttons to start and run the machinery were also found to exhibit techno-complexity. Especially the ship engineers would have to deal with the complexity of numerous interfaces being used on various monitoring systems. The engineers could be subjected to stress easily since they had trouble accessing the necessary information due to the excessive use of acronyms, misspellings, and complicated menu items (Lagdami,2023).

Additionally, the complexity of ships with digitalized ER and ECRs also presents ergonomic issues. The effort to make ECR operations more efficient, according to engineers, has brought about difficulties with regard to poorly built monitors, which are typically too small to read and very sensitive to damp or dirty fingers, making it exceedingly difficult for engineers to carry out their responsibilities. Due to the nature of the control software operating in the background, it is also frequently exceedingly challenging to identify, troubleshoot, and resolve issues in the systems. All of these problems make engineers feel frustrated, doubtful, and anxious while also creating technological ambiguity (Lagdami, 2023).



### 3.4.3 Social Factors

The social elements affecting the safe manning due changing demands of the maritime industry are listed below.

*3.4.3.1 Job insecurity and Reduced Performance.* With the shift towards more technically advanced and semi-autonomous ships, jobs are decreasing quickly in the shipping business as a result of technology. The incorporation of autonomous technologies could make seafarers apprehensive about the future of their employment. They may anticipate that they will be replaced by automation systems in the future, leading to job insecurity and stress about their livelihoods. Apart from this, too much reliance on technology and reduced crew size may jeopardise the overall safety and security of the ship and cargo in general. This may be justified as reduced crew size may also limit the availability of personnel with the necessary skills to conduct manual interventions or repairs. This could lead to delays in addressing issues, potentially compromising the safety of the ship, cargo, and crew (Hannaford & Hassel, 2021).

With fewer crew members, the remaining personnel may experience increased workloads and longer working hours. They may need to handle multiple tasks, including operational duties, maintenance, and emergency response. The additional responsibilities and potential fatigue can impact the crew's performance, concentration, and decision-making abilities, potentially increasing the risk of human error. This in turn may lead to unemployment, lethargy and other associated health issues for seafarers (Hannaford & Hassel, 2021).

*3.4.3.2 Social Isolation.* Smart shipping may decrease the number of onboard staff, which may create the feeling of loneliness and social isolation for seafarers. The requirement for permanent physical presence on board a ship declines as autonomous ships increasingly rely on cutting-edge technologies for navigation, monitoring, and control. A remote monitoring centre on land where several autonomous vessels are being managed simultaneously may be where seafarers find themselves in the future. The sense of belonging, camaraderie, and shared experiences that come along by working closely with a crew might be missed by seafarers. The lack of these interpersonal ties can significantly affect the psychological health of seafarers such as

depression, anxiety and stress might result from social isolation and detachment (Lagdami, 2023).

**3.4.3.3 Trust and Reliability.** Seafaring has a lengthy history, and many seafarers have learned their trade through conventional instruction and years of experience. They might be worried that new technologies might eventually replace their knowledge or make their skills outdated. For people who value their traditional abilities, trusting technology involves giving up some control and relying on automated processes, which can be a considerable transition from their traditional skills (Lagdami,2023).

Trusting and relying on autonomous systems can be a source of stress for seafarers. They may have concerns over the reliability and safety of the semi-autonomous and autonomous systems, especially during critical situations or emergencies. While modern technology has many advantages, it is not impervious to errors or faults. If they heavily rely on the technology for navigation, communication, or other crucial tasks, seafarers may be concerned about the possible repercussions of a technological failure at sea. Being anxious about entrusting their lives to technology that can malfunction can induce anxiety in them (Lagdami, 2023).

### **3.5. Just Transition and the Manning of Seafarers**

The transition of the maritime industry towards the development of highly advanced ships termed as “Smart Ships” has brought about a number of modifications in the onboard working environment, offering new challenges for the occupational health and safety and overall well-being of seafarers. The future maritime operations are expected to be more sophisticated with the introduction of alternative fuels and green technologies onboard and in the shipping industry (“Philippines and Indonesia”, 2023).

The necessity for a more flexible task organisation has increased due to the internationally networked economy and other factors, such as the COVID-19 pandemic. This has led to new working practices, such as the use of virtual platforms. As a result, OSH regulations are challenged by digital technology and new responsibilities in their operations. The maintenance of a ship's machinery relies highly

on seafarers. Ships operations and all of their activities such as work, rest, and play take place in the same setting. The nature of their work exposes them to challenging situations for months. While the engineers diligently run, oversee, mend, and sustain numerous ship systems, the watch-keeping officers at the bridge are required to follow intense navigational procedures to avoid collisions and further incidents (Lagdami, 2023).

With the maritime transition of shipping, there is a need to prepare the maritime workforce and revise the STCW Convention according to the changing dynamics of the maritime industry. Several advanced maritime nations such as Norway and Finland are adjusting their systems and port facilities according to the future demands of the industry. In addition to that, the major crew supplying nations such as Indonesia and the Philippines, which constitute almost 21 % of global seafarers, are providing platforms to train their seafarers to acquire the skills needed for decarbonization of the shipping industry (“Philippines and Indonesia”, 2023). The Philippines established a tripartite International Advisory Committee on Global Maritime Affairs (IACGMA) in January 2023 to take the necessary steps to ensure worldwide competitiveness of its seafarers with the changeover of the maritime industry (“Philippines and Indonesia,” 2023). Similarly, Indonesia has also started a training Program entitled Skills for Prosperity conducted in collaboration with ILO to upskill its seafarers with the future demands of the maritime industry (“Philippines and Indonesia ", 2023).

The aim of these platforms and programs is to streamline their maritime training and education systems with the changing requirements of the industry. The maritime nations especially with strong maritime workforce must sustain their position with the evolving demands of the global maritime industry. To ensure this, maritime nations could also develop this kind of programs and strategies to make informed decisions to shift their education and training systems with the future green operations.

## Chapter 4

### Gap Analysis in the Legal and Regulatory

#### Framework of Safe Manning

The maritime industry is very crucial to the world economy, but it frequently presents workers and seafarers with a variety of human rights issues, such as unsuitable working conditions, exploitation, and violation of seafarers' right including extended working hours, insufficient rest and recreational intervals, and insufficient health and safety conditions (International Transport Workers' Federation, 2021). There are many conventions that are designed under the international legal framework in order to protect the rights of seafarers onboard and the maritime sector in general. The International Convention for the Safety of Life at Sea (SOLAS), The International Labour Organization (ILO), Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) and Maritime Labour Convention (MLC) are among the important conventions that are examined in this chapter. The study goes on to show that the IMO and the ILO have separate but connected tasks and responsibilities. Although maritime labour is a significant area for the ILO, it is important to refer to the proper IMO standards or guidance when using the legal instruments, which IMO has established to address marine security and wellness. Together, the two groups are seeking to protect seafarers' basic legal rights and well-being (Chang & Khan, 2023).

The current international legal and administrative framework represents minimum criteria in the maritime sector. The legal mechanism could be considered as the base from which jurisdictions should grow rather than the standard to be desired. They represent the minimum criteria to which all parties may agree. While in a global setting like the IMO, this minimum may be the only practical or realistic requirement. It does not require that the minimum standards should be equated with the optimum standards or best practices. Many nations also have their own laws and rules aimed at preserving the welfare and human rights of seafarers in addition to these international agreements.

The maritime sector must make sure that these rules and laws are truly followed and that seafarers get the protection to which they are entitled to under both national and international law. The welfare and human rights of seafarers are also promoted by a number of non-governmental organisations (NGOs) and business associations. These groups assist and advocate for seafarers while also bringing attention to the difficulties they are confronting in this sector.

The IMO in essence not a de facto enforcement body, it faces many challenges in the creation and application of sanctions. Any enforcement powers it may have across board are resultant from the sovereign states, who compose its membership. States are usually reluctant to withdraw from sovereign control of activities that occur in their jurisdictions. This chapter will examine that despite the existence of thorough legal frameworks, there are certain gaps in the existing legal regime that make it difficult for effective compliance of these rules

#### **4.1 SOLAS 2020**

Regulations for the safe manning of ships are included in SOLAS (International Convention for the Safety of Life at Sea). These rules are designed to make sure that ships have an enough crew of trained personnel to run the vessel safely. Chapter V of SOLAS contains the specific rule pertaining to safe manning. Regulation 14 of SOLAS Chapter V, "Safety of Navigation," addresses "Safe Manning." Taking into account elements including the nature and size of the vessel, its equipment, and the trading region in which it works, this regulation specifies the standards for the minimal number and credentials of crew members on board ships to maintain safe operations.

The main objective of SOLAS Regulation 14's are as follows:

- To make sure that ships are properly manned in order to guarantee constant navigation and safe operation.
- To prevent the crew members from fatigue and overtime, which can pose serious safety issues.

- To encourage the crew's efficient cooperation and communication during both emergencies and routine operations.

The safe manning criteria are based on the kind and size of the ship, the machinery and equipment on board, the intended trading region, and the nature of the ship's operations. The regulation also takes into account the requirement for adequate rest periods and watchkeeping schedules in order to prevent fatigue (SOLAS, 2020).

#### 4.1.1 SOLAS and Safe Manning Levels

Despite the fact that SOLAS Regulation 14 on Safe Manning is a thorough and significant set of rules intended to ensure the safety of ships and their personnel, there may be certain gaps or potential weaknesses of which an undue advantage can be taken. These loopholes may appear due to various variables, such as implementation, enforcement, and changing practices in the maritime industry. Some of the potential loopholes which are also identified by *Stepien* are listed down below.

- The effectiveness of SOLAS regulations greatly depends on the willingness and capability of flag states (the countries where ships are registered) to enforce and monitor compliance with the regulations. Some flag states might have limited resources or lack rigorous enforcement mechanisms, which could lead to poor implementation of safe manning requirements.
- While SOLAS specifies minimum crew qualifications, some crew members might obtain certificates from less stringent flag States or certification authorities. This could result in individuals holding positions for which they are not adequately trained or experienced, compromising the overall safety of the crew and vessel.
- In certain cases, flag States may grant waivers or exemptions from specific safe manning requirements, citing operational or economic reasons. While there might be legitimate reasons for such waivers, there is a possibility of abuse if not carefully scrutinised.

- Even though SOLAS includes provisions to address crew fatigue, it may still be challenging to ensure full compliance, especially on long voyages or when unforeseen operational demands arise.
- Advances in technology and automation may impact the traditional interpretation of safe manning requirements. Ships with advanced automation might have reduced crew sizes, potentially leading to concerns about the adequacy of human oversight in critical situations.
- SOLAS is an international convention, and while it sets general standards, some regional variations in interpretation and enforcement might occur, leading to disparities in safe manning practices between different areas of the world. Some shipowners might employ crewing agencies that could take advantage of loopholes or misinterpretations of regulations to cut costs or bypass certain requirements (Stepien, 2023).

#### **4.2 IMO Principle of Minimum Safe Manning**

The IMO Current Principle of safe manning adopted in 2011 in the resolution A.1047 (27), defines safe manning as “Safe Manning is the Function of the number of qualified and experienced seafarers necessary for the safety and security of the ship, crew, passengers, cargo and property and for the protection of the marine environment”.

The IMO principle of minimum safe manning is based on the understanding that every ship should have an appropriate number of qualified and competent crew members to safely operate the vessel and handle emergency situations effectively. The aim of the resolution is to strike a balance between this crewing number and the navigational and operational safety of the ship and the marine environment.

While the principle of minimum safe manning is designed to enhance safety, there are certain challenges associated with its implementation.

#### **4.2.1 Interpretation of the Definition of Safe Manning**

The lack of clarity in the term "minimum safe manning" may lead to varying interpretations among ship operators and flag States. Uncertainties in the term could arise from various perspectives, and contextual factors. For example, different types and sizes of vessels and complexity of vessel operations such as its trade routes, cargo types and navigational challenges can influence crew requirements. For example, a ship which trades on frequent ports after short intervals may need more crew members for ship and port operations than a ship sailing on a long route and fewer ports. The nature and operation of a ship has an important role in determining the manning level on board in order to ensure that the ships' crew is properly rested in compliance with the legal requirement of MLC and STCW Convention. The reports from various investigating authorities e.g., MAIB indicates fatigue as a major cause for accidents. If a vessel is engaged in short voyages and has frequent port calls, this will mean enhanced mooring and cargo operation time, resulting in higher working hours to ensure safety of the vessel, cargo and environment. (This is evident in the case of vessels engaged in transshipment of oil cargo from mother vessels to the nearest port from the transshipment area). On the other hand, vessels which have long voyages may not have similar increased requirements of working hours. Additionally, emergency situations, such as accidents, extreme weather, or equipment failures, may create additional demands on the crew. The vessel's operating environment, such as high-risk areas for piracy or adverse weather conditions also poses a great workload and readiness of response on the crew. Thus, there is a difference in manning the vessel with minimum level and manning it efficiently and effectively to ensure compliance with the safety requirements (Alapetite & Kozine, 2017).



#### **4.2.2 Non-Compliance with the Requirement of Manning Level by the Maritime Operators**

Most of the flag States have their own interpretation and national regulation regarding Minimum Safe Manning and are exercising such interpretation for their own interest.. Some operators may attempt to escape minimum safe manning regulations, and if enforcement and inspection mechanisms are inadequate, it could undermine the effectiveness of the principle (Exarchopoulos, 2018). As the certificates of training and competencies are given by flag States, uncertainties and variations may arise in determining the specific qualifications and training needed for various crew positions. As shipping is a cost-driven business, economic pressures and market demands are encouraging shipowners to prioritise short-term profitability over long-term safety, leading to decisions that do not prioritise minimum safe manning adequately. Evolving industry practices, changing trade patterns, market trends, rapid automation and new operational procedures, are also considerably affecting the crew requirement leading to the downsizing of crew members. Defining a one-size-fits-all approach may not adequately account for these variations (Fenstad et al., 2016).

In order to address these possible gaps and difficulties and guarantee the safety and security of maritime operations, it is crucial for the maritime sector, flag States, and international organisations like IMO to regularly examine and adjust the principle of minimum safe manning.

### **4.3 ILO C147 - Merchant Shipping (Minimum Standards) Convention, 1976 (No. 147)**

In order to safeguard the welfare and human rights of seafarers, the International Labour Organisation (ILO) has created a number of treaties and recommendations, including:

The ILO (International Labour Organization) Convention No. 147, also known as the Merchant Shipping (Minimum Standards) Convention, 1976, is an international treaty adopted by the ILO in 1976. Its purpose is to establish minimum standards for working and living conditions for seafarers on board.

The main goal of the Convention is to ensure decent working conditions and protect the rights of seafarers, who often work in a challenging and potentially hazardous environment. It covers various aspects related to seafarers' employment and living conditions, including their recruitment and placement. Fair employment practices and minimum requirements employment agreements should be insured. Provisions related to wages, repatriation, standards for the accommodation, quality and quantity of food provided, health protection, medical care, social security, hours of work and rest ensuring that they have safe and adequate living conditions onboard should also be included. The Convention promotes the provision of appropriate welfare and recreational facilities for seafarers' well-being during their time on board. It also emphasises the provisions for ensuring seafarers' safety on board ships and the implementation of appropriate safety measures (ILO,1976).

The Merchant Shipping (Minimum Standards) Convention, 1976 (No. 147), aims to provide a framework for international cooperation in ensuring that seafarers are treated fairly and have decent working and living conditions (ILO, 1976).

#### **4.3.1 Inadequacies in ILO C147 Convention with respect to Compliance by Various Stakeholders**

While the ILO C147 - Merchant Shipping (Minimum Standards) Convention, 1976 (No. 147) is a significant step towards improving the working and living conditions of seafarers, like any international convention, it may have some potential gaps and challenges in its implementation. Some of these loopholes include the following:

- *Flag of Convenience*: One of the significant challenges in enforcing the Convention is the practice of "flag of convenience." It refers to the registration of ships in countries with lenient regulations and enforcement, allowing shipowners to exploit loopholes and avoid complying with international labour standards (Oses & Sanabra, 2014).
- *Enforcement and Inspections*: The effectiveness of the Convention greatly depends on individual countries' commitment to enforcing its provisions and conducting regular inspections of ships to ensure compliance. Inadequate resources or political will in some countries may result in a lack of proper enforcement and inspections (Oses & Sanabra, 2014).
- *Seafarers' Recruitment and Placement*: The convention sets principles for fair recruitment and placement of seafarers, but there may still be devious recruitment agencies or practices that exploit seafarers, especially in regions with weak labour regulations (Oses & Snabra, 2014).
- *Seafarers' Rights and Remedies*: Despite the provisions of the Convention, seafarers may face challenges in asserting their rights or obtaining remedies in case of violations. Access to justice and effective complaint mechanisms can be limited, especially when disputes arise in international waters or involve multiple jurisdictions (Oses & Snabra, 2014).
- *Working Hours and Rest Periods*: The ILO in 1919, developed a reference system for workers, based on an 8-hours work day and 48 hours work per week. The present maritime regulation enforces the 14-hour workday and 72 hours work per week for seafarers. The difference of maritime standards from the land-based standards shows that industrial interests predominate over labour rights and are in contradiction of the human nature of the seafarers. While the Convention establishes standards for working hours and rest periods, still there could be instances where seafarers are forced to work longer hours due to unforeseen circumstances or emergencies, compromising their well-being (Baumler, 2020).

- *Enforcement in International Waters:* The enforcement of labour standards on ships in international waters can be challenging, as there is no single jurisdiction responsible for their oversight. Lack of coordination and cooperation between flag States, port states, and other stakeholders is a major setback in addressing this issue (Baumler et al., 2021).
- *Crew Replacement and Repatriation:* Seafarers sometimes face difficulties in being repatriated after completing their contracts, especially during emergencies or unforeseen circumstances like the COVID-19 pandemic. The change of crew, repatriation and recognition of seafarers as essential workers were the major challenges the shipping industry faced in the past years of the pandemic. Although IMO and ILO issued guidelines and protocols to facilitate crew changes while safeguarding public health, the interconnectedness of global trade highlighted the need for concerted efforts on part of all stakeholders including the flag State, port State, labour supplying companies and operators. Bringing all the actors on the same page for the safe repatriation and well-being of seafarers is a major challenge to be addressed (Chang & Khan, 2023).

In order to close these gaps and overcome these difficulties, international collaboration must be maintained, the enforcement system must be enhanced, and there has to be more awareness of and advocacy for the rights and welfare of seafarers. The working and living circumstances for seafarers around the world can be improved by initiatives to ratify and implement the most recent ILO conventions, such as the Maritime Labour Convention, 2006 (MLC, 2006), which was updated and built upon C147.

#### **4.4 MLC 2006: a Landmark Convention for the Rights of the Seafarers**

The Maritime Labour Convention (MLC), 2006 adopted by the International Labour Organization (ILO) is an international convention that aims to establish comprehensive rights, standards and protections for seafarers. The Tri-Party nature of the Convention for compliance and monitoring on the principle of “No Favourable Treatment” by three authorities make it more credible and it is also rendered as the

“Bill of Rights of Seafarers.” (Chang & Khan, 2023). The Convention consists of Preamble, 16 articles and 5 codes which are mandatory to comply with for the signatory countries. One of the important aspects covered by MLC 2006, which is also highlighted in the Regulation 2.3 – *Hours of Work and Hours of Rest for Seafarers* and Regulation 2.7 - *Safe Manning Levels*, which relates to the minimum number of qualified seafarers required to operate a ship safely and effectively, by emphasising to ensure the implementation of, minimum age, training and fitness certificates, working and minimum rest hours of the seafarers for the smooth operations of ships. In MLC special emphasis is made on the rest hours of seafarers so that the seafarers are not exhausted and fatigued. The Convention specifies that ships should be adequately and effectively manned, taking into account the above-mentioned considerations (Exarchopoulos et al., 2018).

#### **4.4.1 Gaps in MLC, 2006 Regarding Effective Compliance by the Maritime Industry**

While MLC addresses many aspects of seafarers’ rights especially with respect to (w.r.t) to their employment and working conditions, there are still some gaps regarding the safe manning of ships that need to be addressed. These gaps may be addressed through national regulations and industry standards but it is noteworthy that MLC itself provides a broad framework with room for interpretation and adaptation. Therefore, these deficiencies may be addressed in the future revisions or amendments to the Convention. Some of the inadequacies in MLC are as follows:

- The structure of MLC-2006 consists of articles, codes and guidelines in which codes and regulation standards are compulsory for the states to follow while guidelines are just recommendations and they are non-binding on the signatory parties. This discretion of non-binding guidelines, provides opportunity to member states to escape the enforcement mechanism and enforce these guidelines in their national legislations. Therefore, a lack of uniformity start arising from this stage which is a great hurdle to enforce the same standards

globally. The ILO must make all of the MLC-2006's articles mandatory, exactly like the norms and regulations of the code, in order to guarantee the safety and wellbeing of seafarers. This would necessitate that member states follow both the non-mandatory articles and guidelines in addition to the mandatory code provisions. Doing so would establish a more thorough and consistent framework for seafarer protection (Chang & Khan, 2023).

- The analysis demonstrates that the current regulation is insufficient to address the issues and support initiatives that meet the psychological requirements of seafarers. The way that the current maritime industry is structured creates new problems that endanger the mental health of seafarers, and the MLC 2006 falls short of addressing even core labour and human rights issues for seafarers like the criminalization of their line of work (Exarchopoulos et al., 2018).
- Since shipping is an economic activity, deriving its demand from trade, it is evident that ship owners are competing to save operational expenses, and current technological advancements allow for further crew reduction. Additionally, because of fewer crew members onboard, seafarers today work for long hours and become worn out and restless and even the rest time restrictions are not complied with, in the true sense resulting in the fatigue of seafarers. (Exarchopoulos et al., 2018).

This investigation provides proof that seafarers are adjusting the necessary rest periods and altering the shipboard logs to cover up the gap in their rest hour periods. As seafarers are caught helpless between the operational requirement of the ship and weak regulatory framework, the only feasible but undesirable solution for seafarers is to tamper with the records. This is also happening because when the ship calls a port, the port operators hardly detect the tampering of the records. Finally, there are questions about the current utility of the ISM Code and its audit system given that they do not appear to be able to resolve the issue (Baumler et al., 2021).

- The level of safe manning often complies with the flag State minimum requirements depending on the type and size of the ship. Usually, it does not

take into account the need for additional watch keeping while travelling through constrained waterways, during port operations, during non-routine maintenance, and/or the off-duty and overtime work done by seafarers to meet the commercial requirements especially on busy, short-haul trading routes (Russ, 2018).

Moving forward, MLC 2006 should be modified in order to adequately handle more complicated issues relating to seafarers' welfare, aside from the fundamental rights of seafarers.

#### **4.5 STCW: A Benchmark Convention, Setting the Standards of Training and Certification of Seafarers**

An important turning point in the history of the International Maritime Organisation was the adoption of the International Convention on Standards of Training, Certification, and Watchkeeping in 1978. It is evident that no amount of development or refinement in design, material, construction, and equipment would have reached the ultimate goal of safety until or unless its crew members are trained to safely and effectively run the ship and its equipment. The Convention since its inception has undergone significant amendments till date including the 1995 amendment and the Manila amendment 2010 in order to fill the gap in response to technical advancement and changing demands of the industry. The Convention emphasises the continuous professional development and upgradation of knowledge and skills of seafarers in order to ensure their competency with the modern shipping requirements and to sustain best practices in the maritime industry. The STCW Convention as reformed today is the fundamental international legal instrument for the training and certification of seafarers along with other relevant instruments described above.

#### 4.5.1 Areas of Concerns in the STCW Convention Regarding Training of Seafarers in View of the Enhanced Digitalization of Maritime Sector

While the Convention has been periodically updated to keep pace with changes in the maritime industry, there are still some gaps and challenges when it comes to addressing the digitalization of ships and training of seafarers in this context. Some of these are discussed below.

- There seems to be an unbalanced amount of interest in the maritime industry in the development of seafarers' competence, training, and motivation, which may hide the relative importance of other issues like manning levels, resource allocation by shipowners, seafarer participation in safety, and their job security. While discussing the human element, education, the complex and dynamic nature of ship operations and management should also be given equal consideration to maximise the safety and environmental protection (Bhattacharya, 2009)
- The difficulty of regulating, evaluating, monitoring, implementing, and controlling educational activities and its outcomes at a national level is considerably worsening by their raise to an international level, especially in the context of public international law. Despite the noteworthy efforts undertaken by the international maritime community to set standards for the education, training assessment and certification of mariners, there is still a wide range at national level to uphold the best legal and administrative framework and adhere to international standards. The IMO struggles greatly with creating and enforcing penalties because fundamentally it is not a *de facto* enforcement authority. Any enforcement authority it may have globally, derives from the sovereign states that make up its membership. States are hesitant to surrender their sovereignty over actions that take place within their borders. The challenge still persists as to how to avoid overregulation and prescriptiveness and how international law may overcome the resistance posed by sovereign



states without jeopardising their sovereignty, integrity and their right to self-determination (Manuel & Baumler, 2020).

- The scope of STCW Convention is narrowed down in a way that its focus is only on the task related to ship safety, security and pollution prevention. While the occupational health and safety and overall welfare of seafarers who are the backbone of shipping operations are barely touched. Even the fitness for duty of the seafarers is regarded as a competency requirement in order to ensure ship's safety (Dubious & Rothwell, 2004). Moreover, the level of competence assumed by this Convention is mainly on intellectual and psychomotor abilities of seafarers while it does not give much weightage to the norms, ethics, professionalism, cultural consciousness, environment awareness and teamwork which falls under the affective domain of learning (STCW, 2010).
- The reactive nature of the maritime regulatory framework, which is quite evident from the evolution of SOLAS and MARPOL, is yet another important factor which undermines its effectiveness. With the changing dynamics of the maritime industry especially in terms of technology and digitalization, it is not far to admit that maritime autonomous ships (MASS) with varying degree of autonomy will be the future of the shipping industry in upcoming years. This revolution in technology undoubtedly provides new opportunities but it will also bring challenges in social, legal and technical aspects. The foundation of the current maritime paradigm is on the notion that ships are operated by humans. However, it raises serious concerns about the placement, education and training of such crews in the future when they will not be physically present on autonomous ships (Legal and Liability Analysis, 2013).

## Chapter 5

### Conclusions and Recommendations

Even though the shipping industry is becoming increasingly advanced and digitalized, the importance of seafarers in the maritime industry cannot be denied. It is suspected that with increased automation the demand of seafarers and their workload will be increased with certain changes in their training and job requirements.

In order to develop the occupational safety and health of seafarers for the upcoming future with more digitalization of the shipping industry, there is a need to develop an environment that could promote the human-machine interaction, give guidance and support on management of fatigue and information overload. There is also a strong requirement to develop a mechanism to counter or minimize cyber-attacks and other challenges which come along with the advanced technology. With the changing demands and trends of the maritime industry there is a dire need to for the retraining and suitable job alternatives of the existing seafarers and modified training programs for the future seafarers.

All this can be ensured by facilitating a comprehensive dialogue among all stakeholders of the maritime industry. It will help to analyse and better understand the different potential and positions of the partners involved. Special attention should be paid towards the strong labour supplying states such as the Philippines, Bangladesh, India, and others so that they could be aware of the current and future challenges and requirements of this global industry. The IMO member states can develop a unanimous mechanism to facilitate the reception of MASS and comply with the MASS Code at flag and port states with mutual consensus on proper planning and workable strategies (Lagdami, 2022).

Efforts have already been made to analyse and evaluate the challenges posed by increased digitalization at international and national levels. IMO led a governing scoping exercise on Maritime Autonomous Surface Ships (MASS) to evaluate present IMO instruments in 2021, which progressed into a goal-based mechanism controlling

the operation of MASS. Technical and legal aspects were considered including the role and responsibility of master and the crew.

Making progress on the IMO MASS Code, a symposium was held by IMO in May 2023 to investigate the latest advancements in autonomous shipping and to create a network for global collaboration. The Joint MSC-LEG-FAL Working Group on MASS will have its third session from September 11–15, 2023 to understand the consequences, difficulties, and prospects of MASS operations for ports and public bodies. There has been an effort by the IMO to investigate the effect of MASS on IMO Conventions including SOLAS, STCW and other codes; however, the work appears to be continuing as the regulatory framework is still in the making. The finalisation of the MASS Code will impact the manning levels on board and a far-reaching change will appear on the minimum safe manning of the vessels in view of the changed roles and responsibilities. IMO has also developed some free online courses that could be helpful to enhance the knowledge of the operations of the energy efficient shipping. These training programmes are available on the UN Climate Change Learning Partnership Website.

To sum up, manning of merchant ships in the future is expected to involve a combination of technical developments, regulatory changes, and improvements in training. Technologies for automation and remote monitoring will help maximise the use of crew members while maintaining the effectiveness and safety of maritime operations. Despite the development of increasingly advanced technology, the maritime sector will continue to rely on the human element for maritime operations. Even though they will not necessarily fit the frame of the conventional and modern seafarer, the mariners of the future will still be in operational control of the vessel, whether on ship or on land. To address the changing needs of the sector, efforts should be made to attract, develop, and maintain a qualified workforce of the future.

Therefore, seafarers, whether offshore or onshore, must be educated and trained according to the changing dynamics of the maritime industry. Efforts must be made to

continue to focus on and improve seafarer education and training in order to gain international attention (Baumler & Manual, 2020). The international community and the international maritime legal frameworks will remain the most effective forum for debating and generating regulations to monitor the operations of this global enterprise. The maritime industry will remain significant and should be modified according to the increasingly globalised and technological world, through international legal instruments that help regulate it. However, if the regulatory framework fails to perform as expected, then it will be greatly controlled by the national and regional actors to influence it accordingly.

Based on this research, some recommendations may be considered at the national, regional and global policy formulation levels for the adequate and efficient manning of vessels. Few of the recommendations are listed below.

### **5.1 Amendments in International Policy Regarding Manning Regulations & Social Welfare of Seafarers**

The following measures can be adopted while considering the amendments in the current regulations regarding safe manning:

There is a need to devise a policy regarding increased, sufficient and efficient manning of ships at the international maritime governance level which may clearly indicate the manning level regarding each type of vessel and implementation of this mechanism. In order to ensure the safe and efficient manning, and for the protection of human rights in the maritime industry, a variety of actions are required to address these issues and guarantee the efficient application of the legislative framework. These measures include better interstate collaboration, more effective enforcement measures, and increased efforts to address the gaps and improve the safety and efficiency of seafarers and the ships. The regulatory environment has a significant impact on how merchant ships must be manned. The International Maritime Organization (IMO) establishes minimum safe staffing numbers as well as crewing rules and guidelines. These laws must be periodically examined and revised to reflect shifting market demands and technical developments. The incorporation of new technologies and safety concerns

may need to be balanced in future rules.

- i. Even while technology development may be advantageous, it is crucial to think about the moral and humanitarian ramifications of reducing crew sizes or switching to autonomous vessels. To achieve a sustainable and ethical transition, problems including job loss, social isolation, and the protection of seafarers' rights must be addressed globally.
- ii. Important concerns pertaining to the fundamental rights of seafarers to be principally addressed, there is a requirement of considerable amendments to international maritime law. While there are still significant gaps in the existing regulations regarding the fundamental human and labour rights of seafarers, the maritime community cannot presume that seafarers' welfare issues cannot be improved. In order to bring improvements for the well-being of seafarers, the current conventions should be revised in the future to address all of the irregularities and contradictions pertaining to fundamental employee rights and their training and to eliminate distinctions between shore-based employees' opportunities and seafarers' entitlements.

## **5.2 Responsibilities of Stakeholders towards the Manning of Vessels and Training**

Measures that can be adopted by stakeholders towards safe manning are listed as follows:

- i. Apart from the global level, owners and ship operators need to make sure that the crew is "sufficiently safety-aware and safety-competent to avoid accidents onboard" and that the ship is "crewed and prepared in such a way that all onboard tasks should be carried out safely. It demands that suggestions for minimum safe manning be evaluated for their viability in connection to the work to be done, the type of ship, safety and emergency procedures. Additionally, it is essential for ship owners and operators to make sure that

their vessels are registered under the flag of a nation that is a signatory to the pertinent international agreements and that they abide by its terms.

- ii. The lack of qualified seafarers is one of the major issues for the safe manning of vessels that the shipping industry has been dealing with for some time. The retirement of seasoned seafarers, a lack of training opportunities, and the appeal of alternate career pathways are some of the causes of this shortfall. In order to overcome these difficulties, efforts must be undertaken at the national, regional and global levels to enhance the working conditions, by offering training programmes, and competitive pay to attract and keep seafarers.

### **5.3 Training Requirements in view of Advancement of Technology**

Modern networking and communication technology would enable onboard processes to be remotely monitored in real time. Onboard crew members would get advice and troubleshooting assistance from shore-based experts, which would eliminate the need for extra staff aboard the ship. This pattern is anticipated to last, allowing for a more effective use of the crew's limited resources. The expertise needed for maritime operations will alter as technology advances. To guarantee that mariners have the skills and knowledge required to use and maintain complex systems, training programmes must be modified. Additionally, emphasis should be given on digital literacy and cybersecurity awareness in view of the integration of digital platforms and data-driven decision-making.

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