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Maritime autonomous surface ships: caught between the devil’s advocate and the deep blue sea

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Maritime Autonomous Surface Ships
Caught Between the Devil's Advocate & the Deep Blue Sea

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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: 24th September 2019

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Acknowledgements

ज्ञानानन्द मयं देवं निर्मल स्फटिकाकृतिं
आधारं सर्वविद्यानं हयग्रीवं उपास्महे

Gnanananda Mayam Devam Nirmala Spatika Kruthim
Aadharam Sarva Vidyanam Hayagrivam Upasmahe

I worship Lord Hayagreeva, who is the very form of knowledge, pure as a crystal,
and who is the support of all knowledge

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Abstract

Title of Dissertation: **Maritime Autonomous Surface Ships: Caught Between the Devil's Advocate and the Deep Blue Sea**

Degree: **Master of Science**

'Maritime Autonomous Surface Ships' (MASS) has gained a lot of attention from the shipping fraternity in the past few years. Faced with economic, efficiency, and environmental concerns, the maritime industry is turning to autonomous ships as the key to the future of sustainable shipping. "Will autonomous shipping become a reality with industry-wide adoption?" is a question everyone in the industry has an opinion on. With many autonomous projects in their final phases, the world may soon witness the technology at work.

However, MASS needs a legality check before such crewless ships can be deployed to service international trade. Maritime law and its legal jargon over hundreds of years have developed to apply to ships with a master and crew. The idea of crewless ships disturbs the entire maritime regulatory landscape, nullifying some fundamental maritime law concepts. In the light of such developments, this research is an examination of some key commercial maritime law concepts namely, seaworthiness, shipowner's liability, and manufacturer's liability with autonomous ship technology, in the context of MASS operations.

The dissertation argues that with MASS, international shipping will witness a key shift of responsibilities and liabilities from the shipowners to the manufacturers of MASS technology. This is essentially due to the nature of the autonomous technology proposed. The seaworthiness obligations with MASS will greatly differ for the shipowner. Such responsibilities need clarification and will see the manufacturers being required to take the forefront in the seaworthiness guarantee. Consequently, the industry may witness a shift from the traditional fault-based liability of the shipowner to the liability of the manufacturer. Thereupon, the dissertation discusses the need for an appropriate extension of product liability into the general maritime law.

The deployment of such sophisticated technology demands an equally sophisticated overhaul of the maritime legal framework.

Keywords: Maritime Autonomous Surface Ships, MASS, Unmanned Ships, Commercial Law, Seaworthiness, Liability, Shipowner, Product Liability, Manufacturer's Liability

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List of Abbreviations

AAWA	Advanced Autonomous Waterborne Applications Initiative
AMV	Autonomous Maritime Vehicle
CET	Consumer Expectations Test
COLREGS	Convention on International Regulations for Preventing Collisions at Sea
EU	European Union
IMO	International Maritime Organisation
ISM	International Safety Management Code
ISPS	International Ship and Port Facility Security Code
IT	Information Technology
LLMC	Convention on Limitation of Liability for Maritime Claims
MASS	Maritime Autonomous Surface Ships
MUNIN	Maritime Unmanned Navigation through Intelligence in Networks
SBO	Shore Based Operator
SOLAS	Safety of Life at Sea Convention
STCW	Standards for Training, Certification, and Watchkeeping Convention
UMV	Unmanned Maritime Vehicle
US	The United States of America

Chapter 1

INTRODUCTION

1.1 Background

The international shipping industry is often characterized as being conservative and slow to adapt to change, relying heavily on established traditional ways. However, the industry over the years has witnessed some significant changes due to the tsunami of digitalization that it is trying to accommodate. With the advent of technologies such as block-chain, big data, and the internet of things, the maritime stakeholders are recognizing the benefits of digitalization, pushing harder than before to achieve greater efficiencies and competitive advantages that such technologies promise. A technology that has gained a lot of interest from the international shipping community, in particular, is autonomous ships which are being lauded as the key to sustainable and competitive shipping. Once an unrealistic abstract idea, is very much an existing reality today. The concepts of autonomy, automation, and unmanned operations, and their other necessary cousins- Big Data, enterprise-grade connectivity, and analytics are steadily rising on the shipping and maritime agenda (Futurenautics & Inmarsat, 2016). The Strategic Plan (2018-2023) of the International Maritime Organisation (IMO) has a key strategic direction to "*integrate new and advancing technologies in the regulatory framework*" (IMO, 2019). In 2018, IMO's Maritime Safety Committee approved a regulatory scoping exercise on Maritime Autonomous Surface Ships (MASS) during its 100th session. Thereupon, in 2019, IMO approved an initial set of guidelines for conducting trials with autonomous ships, validating the industry's enthusiasm for this technology.

The MASS technology exists no more just on paper but in actuality. Astronomical amounts of time, effort, and money have been poured into making the concept of MASS a reality by different companies spearheading innovation in this arena. For instance, Rolls Royce is working hard at bringing the autonomous vessel technology to the commercial shipping industry with its project ‘Advanced Autonomous Waterborne Applications Initiative’ (AAWA). The AAWA project envisages a remotely operated local vessel being in operation by 2020 followed by a fully autonomous unmanned ship in operation by 2030 (Rolls Royce, 2016). On a similar track, the Norwegian shipyard VARD built ‘Yara Birkeland’ is set to become the world’s first fully-electric autonomous containership, ready for launch in 2020 (Konsberg, 2018). Another significant project in the autonomous ship arena is that by the European Commission under its Seventh Framework Programme i.e. the Maritime Unmanned Navigation through Intelligence in Networks project (MUNIN). MUNIN aims to develop an autonomous ship guided by an automated onboard decision system but controlled by a remote operator in a control station onshore (MUNIN, 2016).

In the face of all such specular innovations, the concept of MASS needs a legality check. Simply put, the shipping industry is governed by maritime law. Maritime law in this context is a functional term which encapsulates a whole range of international, national, regional, and local laws on public issues such as safety, security, and environmental protection and civil law issues pertaining to contracts of carriage, liability and compensation for damage, salvage, and rules related to marine risks and insurance, to name but a few (CMI, 2018). The basic prospect of autonomous ships i.e. ships navigating with no master or crew on board challenges major principles of maritime law. The general legal jargon applicable to merchant ships has over the years been developed to apply to ships which have a captain and a crew on board. The existing maritime law has at its core a tripartite apportionment of responsibility between shipowner, flag state, and shipmaster; the absence of a shipmaster disturbs the entire regulatory landscape which has the potential to significantly undermine its effectiveness (Veal & Tsimplis, 2017).

Thus, certain aspects of maritime law will have to undergo significant amendments before MASS navigating our high seas becomes a reality.

1.2 Objectives of the Study

The Maritime Safety Committee of the IMO for the purpose of its scoping exercise identified four degrees of autonomy in MASS (IMO, 2019):

- Degree One: Vessels with automated processes and decision support. Such ships have seafarers present on board to operate and control the ship. It may involve some operations being automated which at some times are unsupervised with the crew taking over whenever required.
- Degree Two: Remotely controlled vessels being controlled and operated from an offshore access point. Such vessel has seafarers present on board to operate and take control of the ship.
- Degree Three: Remotely controlled vessels being controlled and operated from an offshore access point. Such vessels do not have any seafarers present on board.
- Degree Four: Fully autonomous ships with an operating system capable of making decisions and determining actions by itself without any human involvement.

This dissertation focuses on degree three and degree four types of MASS. Therefore, the research is concerned with MASS navigating with no crew on board either being operated remotely or with the help of a software/ pre-programmed algorithm and a sophisticated information technology (IT) system. This is done primarily to consider the ‘human element’ challenge, which is at the centre of most all legal issues.

Based on the above, this research will discuss purely commercial maritime law issues surrounding MASS operations focussing on three topics: -

1. **Seaworthiness in MASS**

The seaworthiness concept needs clarification in the context of MASS. With this new breed of technology, the duties under the seaworthiness obligation will change significantly. This topic is covered in Chapter 2.

2. **Shipowner's civil liability with MASS**

The arguments presented in Chapter 2 provide for a good base for discussions on shipowners liability with MASS. Discussions under this topic highlight the likely shift in the traditional fault-based liability from the shipowner to the manufacturer of MASS technology. This is further discussed in Chapter 3.

3. **Manufacturer's Liability with MASS production**

After highlighting the critical role that the manufacturer will play in the MASS operations and the arguments presented in favour of eliminating the manufacturer's immunity in Chapter 3, the scope of manufacturer's liability or product liability with MASS is discussed in Chapter 4.

1.3 Research Methodology & Sources

The starting point of this research is the idea of autonomous ships and what autonomous operations shall entail as proposed in Rolls Royce's AAWA project white paper and the MUNIN project.

The dissertation uses a range of different research techniques for substantiating the conclusions reached. The primary methodology employed is that of qualitative research. It mainly adopts a legal normative analysis to evaluate the existing provisions using a dogmatic approach; it focuses on primary data such as international conventions, existing laws, statutes, and resolutions. Besides this, the topics covered are further scrutinized based on the existing literature available on them. Some parts of the research also employ comparative law to elucidate the nuances and differences existing in civil and common law jurisdictions in the treatment of a particular concept.

1.4 Limitations & Scope of Further Research

MASS is a relatively new topic. While much academic ink has been spilled on MASS, most research conducted on this topic addresses public international law. During the process of this study, it was observed that not much has been written in the domain of commercial maritime law and MASS. The topics that this dissertation discussed are rather unexplored in the context of MASS. Therefore, in order to form an opinion and base the arguments presented by the researcher, the dissertation had to rely on existing research conducted on the individual topics alone i.e. seaworthiness, shipowner's liability and product liability.

The dissertation considers the MASS technology manufacturer as a singular entity i.e. the pre-programmed algorithm developer or the autonomous software manufacturer. This is done, in order to highlight the supreme role of the programmer. In reality, it is probable that the manufacturing process will require the involvement of many entities. As a result, it would be quite hard to ascertain how liability should be distributed amongst the manufacturers or hold any one of them liable in full.

While this dissertation focussed highlighting the role of manufacturers, there is scope to research the role of classification societies and their liability with regards to certifying the MASS. Also, one prominent issue at present with MASS is its insurance. The confusion that surrounds the risk associated with MASS operations provide an unclear picture of how such ships will be insured keeping in mind the challenges discussed.

As has been proven time and again, maritime law is quite adaptive to technological innovations. There is no doubt that MASS technology has the potential to transform the shipping industry completely revolutionizing not only its economics but also the industry's social aspects at large. With the introduction of MASS, maritime law will branch out considerably to accommodate the very many issues emanating from its introduction. Such issues will become clearer with the wide adoption of the technology and therefore, will serve to keep the researchers busy in the near future.

1.5 Basic Concepts & Definitions in MASS

This section aims to highlight certain MASS operations and unique concepts surrounding it, based on the current autonomous ships projects such as AAWA and MUNIN. It is important to be versed with these concepts as they form the basis for discussions in this dissertation.

1.5.1. Unmanned Maritime Vehicle (UMV) & Autonomous Maritime Vehicles (AMV)

Before we delve into the specific topics, it is important to differentiate between degree three and degree four of autonomous vessels for our discussion. While both types of vessels operate without any crew on board, the primary difference between them, as discussed earlier is that one is being controlled remotely through an on-shore access point while the other navigates on its own with the help of a shipboard system capable of operating autonomously. For the purpose of this dissertation, we will refer to a degree three and degree four autonomous vessel as 'Unmanned Maritime Vehicle' (UMV) and 'Autonomous Maritime Vehicle' (AMV) respectively.

1.5.2. Shore Control in UMV & Shore Based Operator

UMV operations are proposed to involve a Shore Based Operator (SBO). An SBO will be responsible for monitoring the safe operations of the autonomous vessels from an on-shore control centre. Both, the AAWA and the MUNIN introduce this idea by conceptualizing the Remote Control Centre and the Shore Control Centre respectively. The SBO's monitoring and control is made possible with the sophisticated technology at his disposal. For instance, MUNIN introduces various technologies like Remote Manoeuvring Support System and Automatic Sensor Module (Burmeister *et al.*, 2014). The former helps ensure the appropriate relay of situational awareness of the vessel despite the physical distance between the vessel and the SBO while the latter is utilized for the lookout requirements for traffic, any obstacles, and environmental data such as weather conditions. Similarly, the Autonomous Engine and Monitoring Control System monitors and controls the engine components of the UMV to work as a transceiver for the operator (Bruhn, 2015). This sheds light on the extremely high dependency on technology for safe vessel operations.

In the case of UMVs, both projects envision a hybrid of both remote and autonomous technologies being deployed initially i.e. a remotely controlled vessel that will be capable of navigating autonomously during certain stages of the voyage. For instance, the AAWA introduces the concept of 'dynamic autonomy' where how the vessel operates shall depend on the state of the vessel and the voyage being executed; the ship can be expected to be fully autonomous during the high sea stage while during other stages be controlled by an SBO.

Chapter 2

MASS: MARITIME AUTONOMOUS 'SEAWORTHY' SHIP?

2.1 Introduction

This Chapter will focus on seaworthiness, an indispensable concept of maritime law since the merchant marine's inception. Even during the times of 'master next after God', it was always expected that the goods shipped on-board are transported on a vessel fit for its purpose. Much academic ink has been spilled on this topic of imminent interest for marine cargo claims. Interestingly, no single definition of the word 'seaworthiness' exists in any of the legal instruments governing it. But, the principles of seaworthiness remain more or less the same everywhere. To put it simply, a ship to be seaworthy needs to be fit to transport the goods it is carrying, while doing so safely in the face of the marine perils that can be reasonably expected in that voyage. Though straightforward, the nature of the seaworthiness obligation and the failure to provide a seaworthy ship has been the Pandora's box for liability claims for the shipowners for decades. The Chapter first briefly touches upon the history of seaworthiness. It then delves into the seaworthiness obligation under the English common law and under the different contracts of carriage by sea, highlighting the differing nature of the said obligation under such contracts. This helps in understanding what is expected from the shipowner in fulfilling the seaworthy obligations. In the context of such discussions, the challenges in ensuring the seaworthiness of a MASS by a shipowner is discussed.

2.2. The Origins of Seaworthiness

Seaworthiness has never been articulated properly to the extent that there is no explicit definition or reference to the term 'seaworthiness' in any of the historical maritime codes. However, there is enough evidence of the concept of seaworthiness being around since the earliest of times.

In the 'Laws of Oleron', considered to be the foundation of all the European maritime codes, the seaworthiness obligation was stipulated to be an explicit obligation requiring the shipowner to show the condition of the ropes, cordages and the slings to the merchant before the loading commenced (Kampantais, 2016). Furthermore, properly manning the vessel was an obligation. Any deficiencies in relation to such obligations made the shipowner liable for any damages resulting thereof. References to the vessel's fitness can also be drawn from charterparties of as early as the 16th century; for instance, in the 'Charterparty of Cheritie' dated July 3rd 1531, the implied warranty of seaworthiness can be found. It stipulates: -*"And the sayd owner shall warant the sayd shyppe stronge stanche well and sufficyentlye vitalled and apparellyd with mastys sayles sayle yerds ancors cables ropes and all other thyngs nedefull and necessarie to and for the sayd shype during this presentt viage And the sayd owner shall ffynd in the sayd shippe xj good and able maryners"*. As can be inferred, there was an obligation to provide a ship fit for its purpose and to man it properly.

Years later came the body of Marine Ordinances of 1681 by Colbert under the reign of Louis XIV. It is considered to be one of the most important contributions to commercial insurance and maritime law. The Ordinances are said to have laid down the foundation of the warranty of seaworthiness, specifically with the clause: -

"However, if the merchant prove that when the ship put to sea she was unfit for sailing, the master shall lose his freight, and pay other damages and losses". As can be inferred, this imposed an absolute obligation on the shipowner to provide a seaworthy vessel, and any unfitness which exposes her to risks was sufficient to afford a merchant the right to indemnity. Thus, the concept of seaworthiness like the general maritime law was conceived, nurtured, and shaped by the needs of commerce (Chamlee, 1973). It has been an indispensable concept applied to merchant marine since its inception and remains one of the fundamental principles of admiralty law in the 21st century.

2.3. Seaworthiness under Common Law

Seaworthiness under English common law is an absolute duty of the shipowner. Contracts of carriage by sea usually make an explicit reference to the obligation. In the absence of any reference to the seaworthiness obligation, it is treated as an implied obligation for the shipowner arising out of the nature of the contract. While it is not common for such contracts to define seaworthiness, they usually make reference to the vessel being 'strong and staunch' or 'tight and fit' (Girvin, 2017). It is more or less known, what is expected out of the shipowner in fulfilling this duty; the principles of seaworthiness have remained the same under the doctrine of seaworthiness.

2.3.1. Requirements

The seaworthiness obligation extends to three facets of a vessel. The first is the structural integrity of the ship. The vessel must be in a sound physical condition to undertake the planned voyage. As was ruled in the UK case *Kopitoff v Wilson* [(1876) 1 QBD 602], a seaworthy vessel is one which is *"fit to meet and undergo the perils of the sea and other incidental risks to which of necessity she must be exposed in the course of the voyage".* Structural fitness extends to the vessel's equipment including but not restricted to her engine and navigational aids. Secondly, the vessel has to be cargoworthy i.e. she is fit to receive and transport the cargo she has been commissioned for. As was ruled in *Stanton v Richardson* [(1872) LR 7 CP] , *"... the obligation of the shipowner is to supply a ship that is seaworthy in relation to the cargo which he has undertaken to carry"*. The third aspect of the seaworthiness obligation entails manning the vessel with adequate and competent master and crew. Therefore, an incompetent crew or inadequate manning will render the ship unseaworthy, as indicated in *Hong Kong Fir Shipping v Kawasaki Kisen Kai Co Ltd* [(1962) 2 QBD 26].

A fourth factor which is a culmination of the three aspects just discussed is that of relevant documentation. A vessel is required to have a wide range of certificates and documents on-board. The absence of such documents can amount to a breach of the seaworthiness obligation. Having the required documents is a way to evidence the adherence to the other three aspects as well. These documents include but are not restricted to the International Safety Management (ISM) Code or International Ship and Port Facility Security (ISPS) Code documentation, Ship Safety Construction Certificate, Ship Safety Equipment Certificate, Ship's Plan, and Deck Clearance Certificate, etc.

2.3.2. Absolute but Relative

Under the English common law, the duty to provide a seaworthy vessel is an absolute duty, failing which the shipowners are liable regardless of their efforts or precautions taken in doing so; as was ruled in *Steel v State Line Steamship Co.* [(1877) 3 AC 72], "*not merely that they should do their best to make the ship fit, but that the ship should really be fit"*. However, this absolute duty is relative as well. This means that it is not expected from the shipowner to furnish a 'perfect' vessel but rather a vessel that is reasonably fit to undertake the voyage she has been commissioned for, as was ruled in the case *President of India v West Coast Steamship Co (The Portland Trader)* [(1963) 2 Lloyd's Rep 278].

Related to this, Justice Chanell put forward the test of unseaworthiness, citing Carver in *McFadden Brothers and Co v Blue Star Line Ltd* [(1905) 1 KB 697] according to which *"a vessel must have that degree of fitness which an ordinary careful and prudent owner would require his vessel to have at the commencement of her voyage, having regards to all probable circumstances of it"* (Carver, 1982). Therefore, the seaworthiness obligation is relative to the nature of the ship, the particular voyage she is about to undertake, the expected perils reasonably conceivable, and the cargo she is transporting.

2.3.3. Time Period

The absolute obligation attaches itself to the shipowner at two points: the commencement of the loading operations and at the commencement of the voyage. At common law, the seaworthiness obligation that attaches at the commencement of the voyage is not a continuing one. The loading stage requires the vessel being fit to receive the cargo and fit to encounter any ordinary perils that can be expected during the loading operations. Once the loading operations end with the cargo on-board, the obligation ends and the vessel must now be seaworthy for the next stage which will be the commencement of the voyage. As ruled in *McFadden Brothers and Co v Blue Star Line Ltd* [(1905) 1 KB 697], "..*there is no continuing warranty after the goods are once on board that the ship shall continue fit to hold the goods during that stage and until she is ready to go to sea, notwithstanding any accident that may happen to her in the meantime"*.

Also the case *Maxine Footwear Co Ltd v Canadian Government Merchant Marine Ltd* [(1959) AC 589 (PC)] made it clear that the shipowner cannot argue that the vessel was seaworthy when the goods were shipped on board but she became unseaworthy after that. The voyage commences when all the hatches are battened down and orders from the bridge are given so that the vessel starts moving from the mooring place (Tetley, 1988). At the commencement of the voyage, the vessel must be structurally fit, sound in condition, manned properly, and supplied well to undertake voyage and face the ordinary perils expected.

2.3.4. Breach of the Obligation

Under English Law, the consequences of a breach in the seaworthiness obligation depend on the type of contract, the severity of the breach, and the time it will take to rectify it. While the obligation is referred to as a warranty of seaworthiness, maritime law classifies it seaworthiness as an 'innominate obligation'. A breach of warranty entitles a party to claim damages, and a breach of a condition may give the authority to a party to repudiate the contract. However, as held in the Hong Kong Fir Shipping Case [(1962) 2 QBD 26] "*the legal consequences of a breach of such an undertaking, unless provided for expressly in the contract, depend upon the nature of the event to which the breach gives rise and do not follow automatically from a prior classification of the undertaking as a condition or a warranty*".

2.4. Seaworthiness in the International Conventions on Carriage of Goods by Sea

The applicable laws regarding seaworthiness under contracts of carriage by sea were originally subject to common law, later becoming subject to the Harter Act 1893 followed by the International Convention for the Unification of Certain Rules of Law relating to the Bills of Lading i.e. the Hague Rules (HR), and later the Visby amendments to the HR i.e. the Hague-Visby Rules (HVR). The contracts of carriage may also be subject to the United Nations Convention on the Carriage of Goods by Sea (Hamburg Rules) if a State is a party to it.

Another Convention which governs carriage by sea is the United Nations Convention on Contracts for the International Carriage of Goods Wholly or Partly by

Sea (Rotterdam Rules); it is a relatively new Convention adopted in 2008. We will not be discussing the Rotterdam Rules as it has not yet entered into force.

2.4.1. The Hague & Hague-Visby Rules

HR/HVR are crucial to the carriage of goods by sea. More than 80 countries adhere to them covering 90% of the global shipping tonnage (Djadev, 2017).

Article I (b) of the HVR makes the rules applicable to all contracts of carriage evidenced by a Bill of Lading or a similar document of title. Consequently, where the HVR apply, the absolute obligation under common law is replaced by one of exercising due diligence. Article III (1) of HVR stipulates- *"The carrier shall be bound before and at the beginning of the voyage to exercise due diligence to: (a) Make the ship seaworthy; (b) Properly man, equip and supply the ships (c) Make the holds, refrigerating and cool chambers, and all other parts of the ship in which goods are carried, fit and safe for their reception, carriage and preservation".* The HVR borrow the principle of 'due diligence' from the Harter Act.

William Tetley defines the term 'due diligence' as a *"genuine, competent and reasonable effort of the carrier to fulfil the obligations set out in subparagraph (a), (b) and (c) of Art III of the Hague or Hague-Visby Rules"* (Tetley, 1988). The standard of exercising due diligence remains the same as under common law; it has been interpreted by courts as the duty to exercise reasonable care in the case *Riverstone Meat Co. Pty Ltd v Lancashire Shipping Co Ltd (The Muncaster Castle)* [(1961) 1 QB 536]. Also, the lack of exercising due diligence can be translated into negligence of the shipowner as was held in the case *Papera Traders Co Ltd v Hyundai Merchant Marine Co Ltd* [(2002) 1 Lloyd's Rep 719].

2.4.2. The Hamburg Rules

Unlike the HVR, Hamburg Rules leave out the provision of ‘due diligence to make the ship seaworthy’. Instead, seaworthiness in the Hamburg Rules is included more generally in Article 5.1 which stipulates “*The carrier is liable for loss of or damage to goods … from fault or neglect on part of the carrier, his servants or agents … unless the carrier proves that he, his servants or agents took all measures that could reasonably be required to avoid the occurrence and its consequences”.* Thus, the cargo interested parties in order to hold the ship-owner liable need to establish that the damage occurred when the cargo was in the custody of the carrier. At this point, the carrier will prima facie be liable for the failure to provide a seaworthy vessel. The carrier must then prove that he took measures to avoid the occurrence and its consequences, in the context of reasonable foreseeability. It is important to note that seaworthiness under the Hamburg rules is a continuing obligation throughout the voyage and is not restricted to just at the beginning and start of the voyage. Furthermore, while there is a mention of the carrier’s servants or agents, there is no express stipulation regarding the manning of the vessel. None of the Articles make reference to the carrier’s duty to man the vessel with sufficient and competent crew.

2.5. Seaworthiness under Charterparties

Most charterparties are based on standard forms and provide an expressed duty stipulating the obligation to provide a seaworthy vessel (Todd, 2016). In the absence of an express clause, the seaworthiness obligation is implied. The nature of the duty depends on the wording of the charterparty clauses, stipulating whether it is one of exercising due diligence or absolute. If the seaworthiness obligation is implied in the absence of an express clause, the duty is absolute. Furthermore, the parties to a contract may choose to incorporate the HVR or the Hamburg Rules by incorporation of the said Rules into a Paramount Clause; thereafter, the duty to render a seaworthy vessel becomes subject to the rules mentioned. The time at which the duty attaches depends on the type of the charterparty and the wording of the clauses.

We will now look at the seaworthiness obligation under the most commonly used voyage and time charterparties which shall be the basis for our arguments in their application to MASS, later in the Chapter.

2.5.1. Voyage Charterparties

The leading voyage charterparty is the GENCON 1994 form (Girvin, 2017). A mention of the seaworthiness obligation can be found in the 'Owner's Responsibility Clause' which stipulates that: - "*the Owners are to be responsible for loss of or damage to the goods or for delay in delivery of the goods only in case the loss, damage or delay has been caused by personal want of due diligence on the part of the Owners or their Manager to make the Vessel in all respects seaworthy and to secure that she is properly manned, equipped and supplied, or by the personal act or default of the Owners or their Manager".* As it can be inferred, the required standard of seaworthiness is one of due diligence and not an absolute one. The principles of seaworthiness remain the same as are under the common law regime i.e. provision of a structurally fit, cargoworthy and properly manned vessel.

2.5.2. Time Charterparties

The NYPE 93, though outdated is the most heavily used time charter party (Girvin, 2017). The seaworthiness obligation in it is absolute and attaches at the time of the delivery of the vessel. Borrowing the common law seaworthiness principles, it requires the vessel to be "*tight, stauch, strong and in every way fitted for service, having water ballast, … and with full complement of officers, seamen, engineers and firemen for a vessel of her tonnage".* None of the clauses in the BALTIME make any reference to the manning obligation. However, it is stipulated that the vessel needs to be *"fitted for ordinary cargo service"* which encapsulates a manning obligation; in 'the case *Cheikh Boutros Selim El-Khoury v Ceylon Shipping Lines Ltd (The Madeleine)* [(1967) 2 Lloyd's Rep 224] it was held that "*in every way fitted for* *ordinary cargo service"* makes reference to the implied warranty of seaworthiness. Thus, the shipowner is under the obligation to man the vessel with sufficient and competent crew.

2.6. Seaworthiness and MASS

The UMVs shall be controlled by a Shore Based Operator (SBO) from another location, obsoleting the need to have seafarers on-board. It is anticipated that UMVs ships will follow 'dynamic autonomy' and could navigate on a fully autonomous mode during the 'high seas' length of its voyage, with the SBO monitoring it. The AMVs will be having a fully autonomous operating system that will make decisions and determine actions itself with the help of decision algorithms and sophisticated on-board technology.

2.6.1. Seaworthy Software

Ensuring the seaworthiness of MASS would require the shipowner to check all facets of the autonomous ship. The said obligation will include checking the software on which the MASS relies so heavily for autonomous operations. Consequently, the seaworthiness obligations in MASS will differ drastically from the ones that exist for the conventional manned ships.

AMVs are designed for autonomous navigation independent of any human involvement. This is done with the help of pre-programmed algorithms/ software coded by a programmer. Such technology is essentially intangible. This makes the practical discharge of any due diligence obligation onto the shipowners challenging, except for delegating software maintenance obligations such as that of updating it regularly. It is relatively easy to ensure the seaworthiness of a ship in relation to, for instance, its hull, hatches, vents, engines, and generator; such things can be visually inspected inter alia other inspection methods to ensure their integrity. However, to ensure the soundness of something invisible would be quite challenging as such a system cannot be examined for defects by the usual system of codes, checks, and procedures. Similarly, in UMVs, to ensure the soundness of the IT system or the software which enables the remote operations and vessel operations in high seas would need a different kind of expertise altogether. The problem seems more pronounced with an absolute warranty of seaworthiness; the absolute duty would be far more demanding than that of exercising due diligence or that of exercising due diligence before and at the commencement of the voyage.

The traditional shipowner is unlikely to have the expertise for checking the software for any troubles. The shipowners in what would appear as the obvious solution will delegate external surveyors or contractors with the expertise needed to inspect the automated ship to fulfil the seaworthiness obligation. The researcher opines, such duties will be delegated to the software manufacturer/ supplier in most cases. With the advent of automated systems, suppliers of such technology will play a critical role in the ship operations. Such manufacturers would be in the best position to check the software for any defects and take any corrective action for rectifying the same. Nevertheless, as was ruled in *McFadden Brothers ad Co v Blue Star Line Ltd* [(1905) 1 KB 697], the due diligence obligation is an overriding obligation; shipowners cannot escape liability if they choose to delegate the duty to a third party. Regardless of who the shipowner delegates the obligation of exercising due diligence, s(he) is liable for any negligence by those contracted, and cannot argue that s(he) did not have the expertise to check the work of the contracted party. Thus, this becomes a catch-22 for the shipowner.

A solution to this issue could perhaps be the issuance of Letters of Indemnity by the contracted parties to exercise due diligence to make the vessel seaworthy in relation to its IT system. This may be difficult, but it seems rather probable that programmers of the vessel technology issue letters of indemnity as proof of the software being in a sound condition before every voyage. Such a practice is more likely in the case of due diligence required at the beginning and at the commencement of the voyage since the absolute duty or a continuous obligation will need greater responsibility and commitment with more exposure to liability. Offering Letters of Indemnity guaranteeing the safety of performance will help the manufacturers market their product better as well. This will further eliminate any hesitance of the shipowner to adopt such technology, increasing its rate of adoption. With increased dependence of the shipowner on such technology and their manufacturers, the manufacturers will have to assume greater responsibility. Manufacturer's expertise and experience with their products validate holding them accountable; this is discussed further in Chapter 3.

2.6.2. The Latent Defect Argument

Another scenario that can possibly complicate legal procedures is that of latent defects in the context of HVR. A 'latent defect' in maritime law can be defined as a defect that is not discoverable by a person of a competent skill and using ordinary care (Tetley, 1988). Under common law, the shipowner is liable for a defect which renders the ship unseaworthy even if it was not discoverable by reasonable inspection. However, Article 4(2) of the HVR exempts the shipowner from any liability arising due to latent defects. Charterparties too sometimes exempt shipowners from any liability arising because of latent defects.

The use of automated systems may lead to a situation where the shipowners increasingly rely on this exemption. If a defect exists in the autonomous software, it would be quite hard to ascertain that the competent skills of the software producers or the authority delegated could have found out any software malfunctions rendering the ship unseaworthy; it could be an error in the software not detectable or a technical malfunction which was not present and discernible when the vessel sailed. After all, we are talking about an unparalleled automated system which will be a culmination of many other systems (Komianos, 2018). Furthermore, the lack of case law involving such situations and technology would be an impediment for the courts to conclude any cases in this regard. Most cases brought before courts that involve latent defects deal with defects existing in the structure of the ship (Tetley, 1988). Even such cases have not been quite straightforward; the judgment on whether the said defects can be considered latent or not are often critiqued.

As a potential solution to this problem, perhaps an analogy can be drawn from aviation law, specifically from the concept of 'Extraordinary Circumstances' and 'Hidden Manufacturer's Defect'. An Extraordinary Circumstance in aviation law is a force majeure situation that forces the airliner to cancel or delay the flight. As per European Regulation No 261, an airline cannot be held liable for compensation for delay or cancellation of a flight due to an extraordinary circumstance [Council Regulation (EC) 261/2014]. A 'Hidden Manufacturer's Defect' is a technical problem which establishes grounds for extraordinary circumstances. However, technical problems under Hidden Manufacturer's Defect have to be differentiated from any normal technical problems. The difference between the two is mainly whether the defect in question is inherent in the normal exercise of the carrier's activity. For instance, some of the aircraft's components might fail while under warranty and/or at an earlier stage of the product life cycle than anticipated by programmed maintenance schedules. The Civil Aviation Authority (CAA) holds that neither of these circumstances will fall under the exemption of hidden manufacturer's defect, as these can be expected to occur. The Court of Justice of the European Union (CJEU) has ruled that only safety critical defects identified by the manufacturer or other competent authority will fall under the exemption [C-257/ 14, C van der Lans v Koninklijke Luchtvaart Maatschappij NV, ECLI:EU:C:2015:618].

Therefore, a technical defect can be considered a Hidden Manufacturer's Defect only if it is revealed or accepted by the manufacturer of the aircraft or by another competent authority.

Possibly, a condition similar to that of 'hidden manufacturer's defect' can apply to the concept of 'latent defect' in autonomous vessels. If the manufacturers of the autonomous technology have to disclose such defects for it to be considered latent, the standards and reliability of the software fundamentally improve; any disclosure on the part of the manufacturer will hurt his/ her reputation and thus decrease the occurrence of such defects.

2.6.3. Safe Manning Level: A "Competent" SBO and Software

One of the biggest impediments to the operation of UMVs and AMVs is the absence of a master and a crew on-board the proposed ships. Many international instruments, given effect by domestic legislations, make reference to safe manning levels. Furthermore, manning a vessel appropriately is an implied obligation under common law.

According to Article III 1(b) of the HVR, the carrier in order to provide a seaworthy ship must 'properly man' her. A straightforward interpretation of the clause makes it clear that a vessel is not seaworthy and due diligence has not been exercised if the ship is either insufficiently manned and/or if the crew is incompetent (Tetley, 1988). The same can be observed in charterparties as was seen in our previous discussions. NYPE and GENCON make an express reference to the vessel being properly manned. Under BALTIME, manning is an implied obligation captured by the requirement of it being fit to receive cargo.

The question then becomes, what complement of the crew constitutes as being sufficient or 'proper' to make a ship seaworthy. The sufficient manning of a vessel is evidenced by a 'Minimum Safe Manning Certificate' issued by its Flag State. Article 94 on *'Duties of the Flag State'* of the United Nations Convention on the Law of the Sea (UNCLOS) makes a Flag State responsible for making sure that the crew on board a ship flying its flag, is sufficient in number and qualified, taking into consideration the ship's type, size, machinery, and equipment. The Safety of Life at Sea Convention (SOLAS) Chapter V Regulation 14 further outlines the Administration's role in the issuance of a Minimum Safe Manning Certificate. Importantly, IMO Resolution 1047 (27) '*Principles of Minimum Safe Manning'* in Annex 2 lays down the guidelines for determination of minimum safe manning; it mentions factors to be taken into account for determining the minimum safe manning, of which automation is a contributing factor (IMO, 2011). Thus, a Maritime Administration's view on the number of on board personnel required is subjective to its satisfaction with a ship's operational and navigational capabilities. If the Administration is convinced about the safety of the onboard technical arrangements of a UMV and AMV i.e. that the vessels require no crew on board, the minimum manning prescribed for them could be brought down to zero.

In relation to the above argument, it becomes important to point out that under Article 94 (4) of UNCLOS, the Flag States must make sure that each ship is in charge of a master and officers, who are qualified for the same. Fulfilling this obligation will be particularly challenging in the case of AMVs. In the case of the UMV being controlled from the shore, the question arises whether the shore-based vessel operator can in the current state of maritime law be regarded as the master, or more broadly, the commander of the ship and whether his/ her colleagues are crew members (Hooydonk, 2014).

The word 'master' is not defined explicitly in any of the international maritime conventions. That being said, the meaning of 'master' was always implied in the maritime vernacular. The position points to the person at the highest level of command of the crew stationed on board (Veal & Tsimplis, 2017). All definitions of a master contain expressed or implied elements of *"(1) a natural person who (2) is responsible for a vessel (3) and all things and persons in it and is (4) responsible for enforcing the maritime laws of the flag state"* (Cartner *et al.*, 2009). An important inference drawn from this is that there is no reference to the master being on-board the ship while being in command. Therefore, as long as the SBO can fulfil all the requirements of a master's role from a shore based centre, s(he) can still fulfil the criterion of Article 94 (4) even if s(he) commands the ship from a control centre. However, some States in their national legislations make specific reference to on board presence of a master while describing his/ her duties and will require amendments (Veal & Tsimplis, 2017).

Not just sufficiency, but the competency of the crew is of paramount importance to the seaworthiness of a vessel too. Most cases brought before courts surrounding manning, deal with the competency of the crew, inter alia questioning their sufficiency (Tetley, 1988). Thus, the question which needs to be addressed is how will the competency of an SBO be examined, if s(he) can be considered a master at all. The way in which most shipowners exercise due diligence in recruiting the seafarers is by examining whether they hold the valid certificates/ licenses required to serve on board. Before being certified, seafarers have to undertake the required education and training based on the guidelines set out in the Standards of Training, Certification, and Watchkeeping (STCW) Convention, 1978, as amended, which needs to be adhered to by the maritime education and training institutes of the contracting States. But, the STCW 1978 Convention applies only to seafarers serving on board a vessel[1]. Thus, the STCW principles and guidelines of training cannot apply to an SBO. However, it is important to remember that UMVs shall be operating alongside their conventional manned counterparts. Therefore, it is only logical to expect the SBO to have navigational and operational knowledge of the conventional manned vessels as well. The AAWA project expects that SBOs will be master mariners with years of seagoing experience. This would be a step in the right direction towards ensuring the competency of the SBO. The shipowner may evidence the competence of

[1] Article III *'Application'* of the STCW Convention stipulates that *"The Convention shall apply to seafarers serving on board seagoing ships entitled to fly the flag of a Party except to those serving on board.."*

a master as an SBO, by providing proof of his master's license. But, as was seen in *Papera Traders Co Ltd v Hyundai Merchant Marine Co Ltd (The Eurasian Dream)* [(2002) 1 Lloyd's Rep 719] a master's competency is judged in relation to the vessel and voyage it is supposed to undertake. In this context, the role of a master operating of a UMV remotely from an onshore point is not similar to that of operating a conventional vessel; therefore, it can be questioned.

Moreover, if the standard of competence for an SBO will similar to that of a master, the standard over time will become very challenging to meet with more ships getting automated resulting in the pool of people with the requisite skill shrinking (Carey, 2017).

There may come a time when a professional who is specifically trained for the purpose of navigating and operating the unmanned vessel operates a UMV. Will then the prevailing seaworthiness criterion and competency requirements be fulfilled? Here, it becomes important to mention the seaworthiness test put forward by Lord Channell citing Carver, in McFadden v Blue Star Line, would an ordinary, careful, and prudent owner allow his vessel to sail under the command of someone who has no seagoing experience or has no experience in operating such a technology? In the opinion of the researcher, the answer to this can be found within case law. In the case *Papera Traders Co Ltd v Hyundai Merchant Marine Co Ltd (The Eurasian Dream)* [(2002) 1 Lloyd's Rep 719], *"the standards of seaworthiness needs to be judged by the standards and practices of the industry at the relevant time, but at least so long as those standards are reasonable"*

In light of the technological advancements being made with the advent of MASS operations, it is evident that the practices of the industry will undergo a major overhaul. In such a case, the role of an SBO performed by a master or a trained professional may become the common practice and such people being trained on for instance simulators, may become the industry standard. Whatever the case, there is a clear need to define the standards and training procedure for the SBOs according to which they can be judged on their competence. Thus, in deciding maritime law cases on seaworthiness whether in common law or under HVR, it will be important for the courts to take into consideration the prevailing industry standards in the context of such technology.

Chapter 3

MASS & SHIPOWNER'S LIABILITY

3.1. Introduction

With the shipping business fraught with risks, the shipowners become the liability nexus for the operation of their ships (CORE Advocatfirma & Cefor, 2018). As the primary party capable of including risk in their operations by obtaining insurance, shipowners need to be well informed of their risk exposure in order to spread it effectively. A shipowner's civil liability in most cases depends on the contractual relationship that s(he) engages in. These contracts can include numerous parties including the shipbuilder, the crew employed, cargo interested parties, charterers, salvors, and any liability arising thereof is settled according to the terms of the contracts established. However, non-contractual liabilities of a shipowner can lead to significant liability exposure as well. Such liabilities include instances of pollution caused by the vessel, bunker-spills, a collision or an allision.

Shipowners can be held liable either strictly or based on fault and negligence. Furthermore, a shipowner is vicariously liable for any faults made by his crew or any third parties that he contracts in relation to his vessel operations, who ultimately are his employees or agents respectively. Applying such liability regimes to the MASS operations poses significant challenges. The idea that an SBO can be considered an employee of the shipowner seems straightforward. But, who assumes the responsibility of the software controlling the autonomous ship given that shipowners will have limited control over its operations? Can the software be considered a shipowner's employee? In the situation where the software controls the vessel, it will be difficult to assess the fault of the ship-owner. Hence, the application of the traditional fault-based liability in MASS cases becomes challenging. Alternatively, holding the shipowner strictly liable for MASS becomes unjustifiable if we consider the rationales of strict liability.

This Chapter is a discussion of the present legal regimes applicable to a shipowner and the challenges involved in their application to autonomous vessels. The discussions highlight the increased role of the autonomous software manufacturer in ensuring safe MASS operations and argue in favour of the need for such entities to assume liability.

3.2. Liability Regimes for the Shipowners

3.2.1. Vicarious Liability

The doctrine of vicarious liability lies at the heart of all common law systems of tort. The civilian systems generally refer to this type of liability as 'liability for the acts of others'. Principles of both the system remain more or less the same. Such a liability makes the defendant liable for the torts committed by others under his employment (Giliker, 2010). The master and crew of the ship are employees of the shipowner. Therefore, as in any business, a shipowner is vicariously liable for the negligence of the master or the crew, and any damage caused by such negligence. In most jurisdictions, the word 'negligence' or the factors which constitute negligent behaviour are defined in the same way. As was ruled in the landmark case *Donoghue v Stevenson* [(1932) UKHL 100], negligence can be best defined as a "*breach of a recognized duty of care owed to a person who might reasonably be foreseen to suffer* *loss as a direct result of the breach".*

Discussions of such a liability regime are centred around the principal-agent theory; if a principal orders to his agent, the principal becomes liable for any tortious acts performed by the agent in the course of carrying out his order (Laski, 1916). Where an independent contractor (cases such as those involving salvage where a salvor is an independent contractor) is employed to work for the shipowner, liability will only arise if it is established that the shipowner failed to take reasonable care in choosing the contractor (Baughen, 2012). Also, the importance of control that an employer has over those employed and contracted is quite important. Therefore, it can be said that the shipowner has a strict liability towards all incidents caused by his vessel due to the applicability of the vicarious liability regime (Ulfbeck, 2014).

3.2.2. Strict Liability and Fault-Based Liability

There are mainly two standards of liability that exist in sharp contrast to each other, namely, strict liability and fault-based liability. The strict liability standard is marked by the belief that a defendant is prima facie liable for any harm caused by him/ her with no requirement for proof of intent or negligence. Shipowners are held strictly liable in specific severe cases of oil pollution, hazardous and noxious substances pollution, and wreck removal.

The second standard i.e. fault-based liability, allows a claimant to recover damages from a defendant only where the defendant intended to harm the claimant or was negligent in taking reasonable steps to avoid inflicting the harm (failure to account for reasonable foreseeability). The application of such a system can be seen in cases involving collisions between vessels at sea; such cases lead to several claims which frequently end up in litigation (Marsden & Gault, 2003). Collisions are governed by the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) 1972. The cause of action pleaded in every collision case is that of negligence and the decision of the court is based on apportionment of blame or contributory negligence (Institute of Maritime Law, 2008). Consequently, the shipowner is liable in proportion to his vessel's fault.

3.3. MASS and Liability

3.3.1. Challenges to the Application of Vicarious Liability to MASS

As was conferred in Section 3.2.1, vicarious liability has the principal-agent relationship at its centre. While applying vicarious liability standard to the shipowner of a typical manned vessel is straightforward, the same is not true in the case of MASS.

A UMV is under the command of an SBO who is employed by the shipowner and there will be a contractual employment agreement in place. Thus, the notion that shipowners shall be held liable for acts of negligence by an SBO performing his/ her duties for the shipowner, makes sense. However, things get complicated in the case of AMVs and also when the software takes control of the UMV. Will the shipowner be vicariously liable for any damages due to the failure or fault of the software system guiding the vessel? Answering such questions involves ascertaining whether the software controlling the vessel can be considered an employee/ agent of the shipowner.

3.3.1.1. The Control Test

A discussion on vicarious liability would be incomplete without mentioning the 'control test'. In determining the employer-employee relationship in cases involving vicarious liability, the fundamental reasoning used by courts is that of 'control' i.e. whether the employer could control or exert authority over the employee. Such a test seems to be persistent in most jurisdictions because it plays a dual role; it not only determines for whom the defendant will be liable but also why (Atiyah, 1967).

The control test does not prove to be particularly useful when one takes into account the modern working styles that prevail at present. In the earlier times, when such a test seemed to offer a plausible direction in court judgments, the cases usually involved employees possessing no technical or specialized knowledge. Such employees had to rely on the instructions of their master for the directions on how to best complete their tasks. The technological and economic developments of all industrial societies have nullified such assumptions (Kidner, 1995).

In today's era, employees possessing specialized and technical knowledge can make their own decisions and work with no supervision or direction. It is not expected out of employees to be constantly seeking advice on how to perform their jobs. One cannot expect a master of a vessel to seek advice from the shipowner on how to command the ship, even if s(he) is an employee of the shipowner.

The inapplicability of the control test to modern employment is evident. In response to this, common law has come to consider 'control' as only one of the factors in the identification of the employment relationship. Similarly, civil law has adopted a more flexible way of interpreting employment relationships. However, scholars argue that such modifications and other tests still lead to the same complications (Giliker, 2011). The 'control' factor, even though regarded as a contributing factor, still remains key.

Purely in the context of having control over AMV operations, the shipowner being held vicariously liable for the fault of the software does not seem credible. The operations of the AMVs will be governed by the decisions it determines itself through pre-programmed algorithms and a sophisticated IT system relinquishing all human control. There is not an operator ashore deciding the next action, but computers, sensors, and navigation systems that make sure the ship follows the planned route within its allowed deviations (MUNIN, 2016). So, when does one assume that the shipowner has control over the AMV? The idea that the shipowner will instruct the voyage plan to the system at the beginning of the voyage can contribute to the idea of having control over the vessel inter alia other factors. However, holding the shipowner liable based on this idea is not very rational.

The two objectives of vicarious liability are deterrence of any dangerous conduct and compensation for any damage caused (Shavell, 1992). Ultimately, the idea in autonomous robots is the use of specific algorithms and codes that instruct machines to make specific decisions and act in a specific manner. Any decision made by the machine can be traced back to the instructions given by the designer (Lemley & Casey, 2019). Holding the owner vicariously liable will not deter the dangerous activity because of his inability to change the algorithm of the software. This will have to be done by the manufacturer.

There is also the problem of different stakeholders that could be considered the potential principal/ owner to the software. There could be a conflict between the company that designs, the company that distributes, or ultimately the shipowner who operates it. To make things even more complicated, one could argue the differentiation between the vessel and the software programme i.e. the algorithm and code which makes the vessel autonomous, being two completely different things.

With UMVs, the SBO shall be in control of the vessel and will have the option of operator intervention. Therefore, the SBO will be in control and naturally, any acts of his/ her negligence shall render the shipowner vicariously liable. But, it is important to consider that the SBO shall totally depend on the technology not only for the various required functions to sail with safety but also a series of updates related to the condition of the vessel at sea; the functionality of the IT system will be key for the SBO to monitor the integrity of the ship (Komianos, 2018).

In a situation where a glitch in the software processes the data incorrectly or poorly, which ultimately leads to a wrong decision by the SBO during a marine peril, will the shipowner be vicariously liable for the SBO’s fault? The role of technology will increase a lot and with that manufacturers of this technology cannot stay immune to any liability. Manufacturers will have to bear the bigger chunk of liability if it is a defect in the product that leads to damages. This is under the scope of product liability which is discussed in Chapter 4.

3.3.1.2. Lack of Agency

The most basic concept in legal liability is that it governs the behaviour of the people and that liability can only be attributed to a person demonstrating the capacity to act as a purposive agent (Rachum-Twaig, 2019). Even though the software, in the end, is executing the will of the shipowner, the software is not human. Scholars have however appealed to the principles of agency law to determine how to assign liability for the behaviour of the autonomous programmes (Chopra & White, 2009). It is likely that autonomous programmes may be considered an agent of the person employing it in the future. But, at present, the software lacks agency and cannot be considered an ‘agent’ or an employee of the shipowner.

3.3.2. Challenges to the Application of Strict & Fault-Based Liability to MASS

Fault-based liability requires proof that the defendant was negligent in his actions and therefore any damage caused thereof is due to his fault (Posner, 1972). Connected to this, is the duty of care which requires the defendant to take adequate steps to avoid any causation of harm, while reasonably foreseeing the damages that can be caused through the activity being undertaken.

The concept of duty of care seems to be broad and can vary extensively depending on the nature of business in question and in regards to the different steps that need to be taken as a precaution. However, the interpretation of the duty of care has been kept straightforward in the application by courts.

The landmark case *United States v. Carroll Towing Co.*, [159 F.2d 169 (2d. Cir. 1947)] . expressed the standard of care ruled by Judge Learned Hand which co-incidentally involved a maritime matter (Epstein, 1973). The Hand Formula takes a cost-benefit formulation of negligence. The formula specifies that a breach of duty of care exists if the cost of prevention of harm was lower than the probability of the harm occurring[2].

The formula has the element of foreseeability embedded into it, which is where the challenge for its application to the owner of a MASS lies. While the perils at sea are reasonably foreseeable, there is some amount of unpredictability attached to the AMV operations itself. What happens if the AMV responds incorrectly on a collision course? What is the probability of such an incident occurring? What are the preventive measures that are being taken as a precaution for the same? Answers to such questions would require proof, which would be difficult to determine.

There is the problem of establishing which of the stakeholders would be better informed about the elements in the question and take suitable measures. The sophistication of the manufacturers of the programme, their access to data, and their familiarities with the programme makes them better adept at assessing the risk and taking the necessary precautions. Holding the shipowner accountable for the algorithm which failed to foresee a peril and inadequately responded to it would not be fair. This would keep the manufacturers of the programme hidden from any liability even when it is the programmer who is priming the software for operations at sea.

Assessing negligent behaviour with UMVs would be relatively easy. Fault-based liability should apply if the accident or damage has occurred because of a

[2] If ‘P’ is the probability of harm occurrence, ‘L’ is cost of injury, and ‘B’ is the burden of adequate precautions, then breach of duty occurs when $B < P \times L$

production defect in the software that could have been rectified by the shipowner exercising due diligence. But, this takes us back to an argument presented in Chapter 2 highlighting the difficulties of bestowing the due diligence responsibility on the shipowner. Similarly, with AMVs, it could be difficult to assess or find fault on the part of the shipowner unless the shipowner has failed to exercise due diligence in operating the MASS or in relation to maintenance or software updates. Perhaps establishing standards of duty of care for the shipowner can prove as a starting point in proving negligence. Such standards of care for the programme and MASS operations should be set high. If such standards are unmet, liability can be triggered, and if met, the burden of proof shall shift onto the claimant in proving the shipowner's negligence and its causal relationship to the damage. Also for AMV, the data recorded will have to be carefully examined. However, this might significantly increase the administrative costs of the courts.

It would be hard to ascertain the fault of the software and therefore, the application of a theoretical fault-based liability may de facto may lead to a strict liability standard for shipowners (CORE Advocatfirma & Cefor, 2018). As discussed previously, strict liability does away with the need to prove negligence or fault. Therefore, with MASS, strict liability can capture the unpredictability of the software or any product deficiency without having to judge where the fault lies. This is certainly a strong point in favour of applying strict liability to MASS shipowners.

From an economic viewpoint even though shipowners in the face of strict liability may face huge costs, they can significantly reduce their liability exposure by obtaining insurance. The ability of the shipowners to use contributory negligence defences combined with the exceptional safety of the MASS will prevent the total immunity of the manufacturers and reduce the insurance premiums respectively (Beale, 2018). In the end, it is ultimately the shipowner who places his trust in such a technology. Such a decision is economically motivated by the prospects of savings on crewing costs and an increase in operational efficiency. Therefore, shipowner's responsibility should increase as well.

The predominant scholarly belief is that strict liability should apply to the party in the best position to analyse the cost and benefits, between the cost of damages and cost of avoidance, and therefore has the ability to act accordingly (Garbessi & Hirschoff, 1972). Arguing which stakeholder would be best suited to analyse the costs and risks associated with MASS operations makes the idea of holding the shipowner strictly liable weak.

The arguments presented for justifying the application of strict liability to shipowners can reasonably be extended to the manufacturers of the programme. The manufacturers are in the best position to assume the risks involved with MASS operations and produce a safer programme, thereby protecting all stakeholders involved. While shipowner's ability to obtain insurance is a valid point, the manufacturer of the product can engage in cost spreading as well. Manufacturers can adopt pricing reflecting the costs/ risks alleviating the individual who is harmed of bearing the loss and fill manufacturer's coffers, giving them funds necessary to satisfy potential judgments (Owen, 1990). However, such a step may deter innovation with manufacturers not willing to engage in an activity that increases their liability exposure.

The researcher opines that, the shipowner of a MASS should be vicariously liable with the right to take recourse against the manufacturer if he believes the damages were caused by the contributory negligence of the software on-board. Such a system ensures fast justice to an innocent party claiming damages who does not have to enter into lengthy legal battles with either party on the causation side. Such compensation will in most cases be made by the shipowner's insurer who then can initiate a case against the manufacturer through subrogation or a statutory right. Also, as can be imagined, since both parties involved thereafter i.e. the shipowner's insurer and the manufacturer can be expected to share a similar stature, the case can be tried effectively and fairly.

3.4. An Analogy to No-Fault Mandatory Insurance

No-fault mandatory insurance is a widely adopted insurance scheme in the automotive industry. It is adopted as a means to address the court's burden in judging fault and negligence in the very many cases of car accidents. Such an arrangement makes it is mandatory to purchase first-party insurance and restricts the right to sue any injurer; the assured gets recompensed for any injuries or damages sustained without having to prove fault or negligence. Such an insurance scheme helps to reduce the administrative costs of the courts while producing fairer outcomes with all victims getting compensated regardless of their ability to prove negligence or fault (Liao & White, 2002). No-fault mandatory insurance is in place in many countries such as Sweden, Israel, Canada, and New Zealand (Schellekens, 2018). There is a mix of both, civil as well as common law States which have adopted such a scheme.

The European Parliament recently recommended the European Commission to deliberate over the adoption of a mandatory insurance scheme concerning robotics and Artificial Intelligence (AI). The white paper published comprises of five general principles: - (i) establishing a compulsory insurance scheme for specific categories of robots requiring the producers of the robots to purchase such insurance; (ii) establishing a compensation fund guaranteeing compensation if the damage for damages of the robot, if not covered by the insurance; (iii) limiting the liability of robot producers if they contribute to a compensation fund and purchase insurance; (iv) selecting between general compensation funds or sector-specific funds for every robot category; (v) establishing a robot registry that will establish a valid link between a robot and the fund with which it is associated; and (vi) creating a specific legal status for the robots in the long run [Council Resolution (2018/C252/251)]. Such recommendations are proof of the advent of autonomous technology and how stakeholders are actively navigating the legal impediments associated with the adoption of it.

Similar to the strict liability regime, no-fault mandatory insurance with its ability to negate the concepts of fault, negligence, foreseeability, personhood, and liability, makes its application look promising. But, there are significant hurdles to the application of such a scheme to international shipping in general and MASS in particular. Shipping has no boundaries in the sense that ships travel all around the world, visiting different ports; they switch legal regimes based on the State whose territorial waters they are in. That being said, the manufacturer, operator, and owner of the vessel can be situated in different parts of the world. In this context, a mandatory insurance scheme that is meant to supersede the general tort system will demand unitary ratification by all stakeholders across all jurisdictions. This is a politically daunting task and will perhaps require a Convention similar to that of the Convention on Limitation of Liability for Maritime Claims (LLMC).

Chapter 4

MASS & MANUFACTURER'S LIABILITY

4.1. Introduction

The manufacturers of MASS technology will play an integral role in not just the MASS operations but also in guaranteeing the safety of such operations. In the previous chapters, it was argued that the manufacturers are in the best position to guarantee the safety of the technology deployed, whether it is the technology which aids the SBO in discharging his/ her duties, or the pre-programmed algorithm installed onboard. Currently, a major chunk of marine liability lies with the shipowner. However, with MASS technology, the future may witness a major shift in the onus of liability towards the manufacturers and an increase in product liability disputes. Usually, any product liability claim is subject to the traditional law of torts. However, most countries have adopted a product liability regime which prescribes strict liability for defective products, supplanting the traditional tort theory.

This Chapter is primarily discusses the challenges that surround the application of the general product liability rules to the MASS technology. The discussions keep at their centre the European Product Liability Directive and the product liability regime of the United States of America (US) governed by the Restatement (Third) of Torts. The differing concepts of a 'defect' under the two jurisdictions are examined, highlighting the bigger problem i.e. the absence of a uniform approach in product liability. Also, it is important to consider how a particular regime defines a 'product'.

The US and European Union (EU) regimes do not apply to intangible products. Hence, such regimes are inapplicable to the intangible autonomous software. However, with the evolution of autonomous technology, perhaps policymakers need to rethink the entire product liability space in the context of maritime law.

4.2. The European and American Product Liability Regime

Before any specific legislation on product liability existed, such cases were subject to the Doctrine of Privity i.e. they were solely decided based on the contracts in place. Therefore, a defective product manufacturer was liable for any damages caused by such a product only if s(he) was in contractual privity with the plaintiff.

Following the system of privity led to cases being tried unfairly and was deemed ineffective. Products follow a series of channels to finally reach the end consumer, and it is only seldom that a consumer will enter into a contract with the manufacturer (Liivak, 2018). Faced with criticism for the ineffective rule of contract, the courts moved away from such practice. This was seen for the first time in the US in the case *MacPherson v Buick Motor Co.* [(1916) 217 NY 382, 111 N.E. 1050]. where the manufacturer was held liable against the proof of negligence for manufacturing a defective car whose wheels on collapsing caused injuries to the claimant; the claimant had a contract only with the dealer and not the manufacturer. In Europe, the issue of manufacturer's liability was not addressed until the 1960s (Reimann, 2003). The European courts relied on applying certain tests relying on existing tort regimes.

Despite the dying out of the contractual privity, proof of negligence of the manufacturer was still crucial in both the US and Europe. However, such proof of negligence was a rather demanding condition to be fulfilled by the claimant. As a result, the US judicial system saw the application of strict liability for the first time in *Henningsen v. Bloomfield Motors Inc* [32 N.J. 358, 161 A.2d 69 (1960)]. The ruling was based on the implied warranty that a manufacturer guarantees the safety of the product if s(he) places it in the market (Alvey, 1982). Another landmark case in strict liability was *Greenman v. Yuba Power Products Inc*. [27 Cal. Rptr. 697, 377 P.2d 89 (1963)] which discarded the law of contract warranties held in the Henningsen case; the court in the Greenman case ruled that the liability for a defective product is to be governed by strict liability in torts. Consequently, the American Law Institute drafted the Restatement (Second) of Torts which was eventually replaced with the Restatement (Third) of Torts governing product liability.

The European courts had a rather fragmented approach in product liability suits with each State resorting to its own jurisprudence and legislation in the 1970s. It was the aftermath of the Thalidomide disaster[3] which led the European Union (EU) to deliberate and adopt Council Directive 85/ 374/ EEC i.e. the EU Product Liability Directive on 25th July 1985, harmonising the governance of the liability of manufacturer for damage caused by defective products.

4.3. The Differing Concept of Defects

The EU Product Liability Directive governs the product liability regimes of the EU Member States. Article 6 of the EU Liability Directive establishes liability without fault and stipulates the conditions for a defective product. It stipulates that *"A product is defective when it does not provide the safety which a person is entitled to expect, taking all circumstances into account, including (a) the presentation of the product;*

[3] Thalidomide was a pharmaceutical drug and also the only non-barbiturate sedative available in Europe at its time. Marketed as completely safe for pregnant women, it was available as an over the counter medicine used to treat insomnia, morning sickness, etc. However, its consumption lead to the unanticipated and adverse reactions with numerous women delivering babies with serious bodily deformities.

(b) the use to which it could reasonably be expected that the product would be put; (c) the time when the product was put into circulation".

The Directive has at its core the 'Consumer Expectations Test' (CET). The CET takes into account the general expectations of the consumers from the product and not just the subjective expectations of individual consumers or consumer groups (Shapo, 1993). Based on the expectations developed, the test reaches a conclusion whether the product in question can, in fact, be considered as defective when it worked contrary to the belief or expectation of how it should have worked. This test was first adopted by the US judicial system in its Restatement (Second) in 1977. The CET was subject to heavy criticism for being vague, overbroad, and ambiguous (Masters, 2006). Therefore, it was later abandoned in the Restatement (Third) which incorporates a three-way approach to the concept of a defect.

The Third Restatement taking a rather mixed approach towards the concept of a defect divides a defect into three categories namely manufacturing defects, design defects, and defects due to inadequate warnings or instructions.

Manufacturing defects have to do with the manufacturing process itself in the sense that if the product turns out to be different than what was originally intended, any damages caused by such a product makes the manufacturer strictly liable. Establishing a manufacturing defect is fairly straightforward in comparison to proving a design defect. While a manufacturing defect puts to question the final design against the intended one, a design defect questions the original design of the product itself. In such cases, the plaintiff has to prove that the manufacturer failed to take into account an alternative design which was available when the production was initiated, and which if adopted, would have reduced the product's usage risk. In deciding the validity of such a claim, the courts have adopted the 'risk-utility test'. The risk-utility test takes into account all the relevant information such as the advantages and disadvantages of the alternate designs, the costs related to its adoption, consumer expectations, and warnings and instructions given. The reasoning behind the risk-utility test is that risk in any product design is counterbalanced by elements of utility, safety, and cost (Owen, 1996). Lastly, the product is considered defective if the manufacturer does not give reasonable instructions and warnings to the users for their safety. This is based on the concept of asymmetrical information and failure to warn. Since manufacturers have a better knowledge of the product and any risks attached to its usage, they need to adequately caution consumers about any such dangers by instructing them for its proper usage. Furthermore, it is not just the manufacturing phase that the manufacturer is responsible for; the duty of care extends throughout the distribution phase.

The nature of the defects in Third Restatement has been aptly put forth by David G. Owen who on analyzing the three types of defects says *"while true strict liability has been adopted for manufacturing defects; a reasonableness standard properly applied by courts in design and warning cases is simply negligence, wrapped in a strict liability shroud"* (Owen, 1996). Therefore, proving negligence is still an important prerequisite imbedded into the Third Restatement.

4.4. Rationale behind a Product Liability Regime

Is the application of a product liability regime to MASS technology justified? The answer to this question becomes very clear if we discuss the rationales behind a product liability regime and why it is applied.

As discussed earlier, product liability was based on privity of contract before it was scrapped to hold the manufacturer responsible without the need to prove a contractual relationship, in order to help the innocent claimant. Thus, the one main rationale behind such a liability system is compensation for a victim which stems from the corrective justice principles A defendant is required to make right the wrongs which s(he) responsible for (Chagal, 2018). This is further substantiated by the EU Liability Directive which stipulates that *"protection of consumers requires that all* *producers involved in production process should be made liable, in so far as their finished product, component, part or any raw material supplied by them is defective".* This takes us back to the arguments presented for holding the manufacturer liable in Chapter 3.

A manufacturer is the primary party who is capable of guaranteeing the safety of the product he puts in the market. A shipowner places his trust in the autonomous technology guaranteed by the manufacturer and uses it. With the complex technicalities of the software, the manufacturer of the algorithm owes a general duty of care to all the stakeholders involved in ship operations. Therefore, strict liability for manufacturers would be the only way to adequately address the risks inherent in such a technology. Thus, any damage sustaining user should have the right to take recourse against a manufacturer who failed to provide a safe product.

The other main rationale behind a product liability system is deterrence and promotion of safety (Goldberg, 2002). This is a rationale that stands to create an example out of bad practices and deters manufacturers from adopting substandard production practices. If there is a threat of being held strictly liable, manufacturers automatically uphold best practices to improve the safety of their products. Having the best knowledge about the production practices involved, MASS technology manufacturers can ensure the best inspection and quality control mechanisms.

4.5. Policymaking Considerations

Product Liability is inherently a policy driven body of law (Reutiman, 2012). The autonomous technology was perhaps not conceivable at the time the regimes in question were originally penned down. But, in the light of the potential legal disruption that the autonomous ships bring with them, policymakers should consider the appropriate changes to product liability.

4.5.1. Is it an Algorithm or a Product?

The EU Product Liability Directive in Article 2 defines a product as a 'movable'. A movable can be understood as something tangible. The only intangible thing that Directive applies to by mentioning explicitly is electricity. Similarly, the Third Restatement of the US defines a product as 'tangible personal property'.

In MASS, the application of the two regimes is possible to hardware i.e. things like sensors, cameras, computer systems, and other tangible technology which make the autonomous ship operations possible. However, the pre-programmed algorithm which has been the source of much discussion in this dissertation isn't physical or tangible. The autonomous programme created by a manufacturer is essentially information that s(he) feeds into a system to help the machine (a ship) perform pre-determined tasks autonomously. The question then becomes whether such information can be treated as a commercial product. Systems based on information are subject to much legal debate primarily because they lack tangible form. This is the first challenge to the application of the EU and US product liability regimes to MASS. If claims regarding damages caused due to defective software fall outside the scope of the product liability regimes, they will lose the benefit of strict liability and will have to be subject to fault under negligence or breach of an implied or express warranty (Kraus, 2019).

There has been much legal debate about whether the courts should consider any commercially sold defective information liable under a product liability regime. Courts are reluctant to hold defective information as a basis for liability for its wider implications on the general free flow of ideas (Reutiman, 2012). But, the advent of autonomous ships calls for the extension of product liability to such technology. It must be pointed out that the autonomous programme is a non-severable aspect of the ship. The software programme is essentially what makes the autonomous ship different from its manned counterpart and what the shipowner pays for. Therefore, any defect in such a design should allow the shipowner to take recourse against the manufacturer of such a programme. Ultimately, it is the shipowner who takes the risk of being held liable but any damage which was not a result of his/ her wrongdoing should lie with the responsible party.

4.5.2. The Advantages and Disadvantages of Extending the Product Liability Regimes

While the EU Product Liability Directive is inapplicable to any intangible software, it has certain key advantages that can lead to significant merits if its application is extended to MASS. Article 6 of the Directive applying CET may seem ambiguous in the sense of what level of safety is a person entitled to expect while questioning ‘consumer expectations’. However, considering the maritime industry’s experience with the conventional ships for years, it would not be difficult to determine the industry’s expectations from such a technology operating in our seas. Furthermore, the fact that reference needs to be made to the presentation of a product i.e. the way it is marketed in product liability cases, adds to the responsibility of the MASS technology manufacturers. While discussing the advantages of the MASS technology, most projects tend to point towards statistics on accidents at sea due to human error. The MASS technology is being marketed as an inherently safe option promising to eliminate marine accidents due to human error. As a result, any accident which is caused due to the failure of such technology leaves little to no room for the manufacturers to brush aside their responsibilities. Therefore, manufacturers who enter the arena of autonomous technology need to tread carefully while effectively managing the expectations of the general public and the maritime stakeholders. Such a system fulfils the condition of manufactures being utmost liable with the threshold to escape liability being placed high. A sense of what is being said here can be drawn from an analogy to the autonomous car industry. In 2015, Volvo the Swedish car making giant expressed its intent of accepting liability for anything wrong with their autonomous cars clearly stating that- "*We are the suppliers of this technology and we are liable for everything the car is doing in autonomous mode … If you are not ready to make such a statement, you shouldn't try to develop an autonomous system*" (AIG, 2017).

Similarly, the prospect of applying the Third Restatement of Torts to MASS technology looks promising. It would be challenging for a plaintiff to investigate a defective product and prove negligent manufacturing techniques or to prove the existence of alternative safer ways of approaching the software design. Nevertheless, the application of defect under alternative reasonable design could help hold manufacturers accountable. Section 2 of the Restatement allows circumstantial evidence to be used as a potential 'end run' around the reasonable alternative design requirement (Schwartz, 1998). Section 2 stipulates the conditions for a defect to be inferred by circumstantial evidence as when a defect - "*(a) was of a kind that ordinarily occurs as a result of product defect; (b) was not, in the particular case, solely the result of causes other than the product defect existing at the time of sale or distribution"*. Therefore, any accident that occurs not due to the negligence of an SBO in the case of a UMVs, would be due to the technology installed onboard. Similarly, in the case of AMVs, applying both the statements of (a) or (b) can contribute towards strong circumstantial evidence for the software being defective. To put it simply, in the absence of any other potential trigger, if a MASS does not operate the way it is supposed to, there has to be something wrong with the technology.

The European and US systems have certain limitations as well. Article 9 of the Directive stipulates that it is applicable to damages to property intended for 'private' use. Also, the Restatement (third) does not apply to damages to property deployed in commercial activities and applies only to tangible personal property. Such limitations of regimes need to be taken into account for their effective implementation to MASS technology.

Also, while our dissertation focuses on just the MASS technology, each product in the autonomous product kingdom differs in its characteristics and the level of autonomy. In such a context, extension of product liability regimes to the autonomous technology while balancing the policy goals and the free exchange of ideas would be challenging. A ‘one size fits all’ approach would not be very fruitful in solving any liability issues.

4.5.3. An International Product Liability Regime?

The arguments presented in the previous section suggest that the application of product liability regimes will increase the manufacturer's liability considerably. While this may have its advantages, policymakers will have to consider the other side of the picture as well; manufacturer’s protest against a strict regime will need to be addressed.

In this context, there is a dire need for industry standards and regulations and/ or best practices in manufacturing MASS technologies. With respect to design and construction, industry and select classification societies have produced bespoke guidance documentation for unmanned marine systems, which is a positive step forward (Veal *et al.,* 2019). However, there is still the need to address the other salient features of the technology like the software.

Compliance with industry standards and regulations is a very strong defense against any liability claim both in common law and civil law jurisdictions. A manufacturer adhering to industry standards and regulations is prima facie not negligent (in common law jurisdictions) or non-compliant (in civil law jurisdictions).

Furthermore, unlike the extensive liability applicable to shipowners which informs them about their liability exposure, the product liability regime is not an international one. Therefore, its application can vary quite dramatically from one jurisdiction to another. Also, this makes this arena quite ripe for the prospects of forum shopping. The maritime policy makers should consider a prospective international product liability regime applicable to the MASS technology. This will help establish the necessary industry standards which answer the questions in the context of the consumer expectations or the risk utility test. Specific thresholds can be made applicable to the manufacturers. This ensures less ambiguity about what the manufacturers of the MASS technology need to do. Also, such a regime can deal with the differing autonomy levels deployed adequately and cater exclusively to international shipping.

Chapter 5

CONCLUSION & RECOMMENDATIONS

5.1. Rise of MASS Blocked by Maritime Law

The digitization revolution influenced by the many technological innovations is on its way to transforming ‘the once upon a time’ traditional shipping industry. The MASS technology is one which has made a lot of buzzes. The concept that once existed in sci-fi storylines is being tested out in actuality today. Many of the autonomous ship projects are in their final phases, and the world may witness the technology at work soon. However, the shipping industry finds itself in a divide between experts who have contentious opinions about on the accommodation of MASS into the *lex maritima.*

This dissertation explored some key commercial maritime law concepts and highlighted their mismatch with the MASS technology. The topics discussed included seaworthiness, shipowner’s liability, and manufacturer’s liability in chapters 2, 3, and 4 respectively.

5.2. The Infamous Pre-programmed Algorithm/ Software and Increased Manufacturer’s Role

The research was confined to degree three (UMV) and degree four (AMV) autonomy levels, focusing specifically on MASS with no crew on-board. Particular attention was paid to the idea of MASS navigation aided by a pre-programmed algorithm/ software capable of making its own decisions with no human interaction.

The general theme of the dissertation was to highlight the critical role of MASS technology manufacturers whose liability must increase with the increased complexity of the onboard system and its decision-making capabilities. Manufacturers with their increased access to data and patent expertise will play a paramount role in not only controlling MASS operations but also guaranteeing its safety. With this, the maritime industry might witness a shift from the traditional fault-based liability of the shipowner towards the liability of the manufacturer of MASS technology.

5.3. Seaworthiness extends to Autonomous Software

The first chapter examined the current seaworthiness legal framework and its incapability to apply to MASS technology. The seaworthiness duties for a MASS owner require clarifications, as they will differ drastically from the ones performed for conventional manned ships. Essentially, to fulfil the seaworthiness obligation with MASS, the shipowner will have to guarantee the soundness of the software installed onboard which helps the ship navigate autonomously. In this context, the research highlighted the high complexity and the intangibility of the software. Consequently, extending any seaworthiness responsibility to the shipowner for guaranteeing a defect-free software becomes challenging. In a situation where the MASS navigates independent of any human decision-making, it will be difficult to assess the fault of the shipowner except in situations where s(he) fails to maintain the software or update it timely.

Taking into account the expertise of the MASS software manufacturers, it is expected that the duty to guarantee the soundness of the software is delegated to them. With manufacturers taking the forefront in ensuring the soundness of the MASS software, the use of Letters of Indemnity is suggested. On a similar note, the likelihood of shipowners increasingly relying on the exemption of 'latent defect' under HVR is anticipated. As a solution to this, the research discusses the application of the concept of 'Hidden Manufacturer's Defect' borrowed from aviation law. Application of a similar concept fundamentally improves the safety and reliability of MASS technology.

5.4. Safe Manning Level and Competency of SBO

The critical problem of having no crew on-board is discussed as a challenge in fulfilling the manning principle of the seaworthiness obligation. The automation potential along with IMO's Safe Manning Principles will play an essential role in influencing the maritime administration's discretion in determining the manning requirements. If a Safe Manning Certificate prescribing zero seafarers required on-board is issued by a Maritime Administration for MASS, it puts to rest any crewing concerns.

Nevertheless, there is a pressing need for establishing training techniques to guarantee the competency of the SBO or any crew who might be employed for autonomous ship operations. While the STCW Convention will not apply to any crew not serving on board, SBOs would still need to have the knowledge of it, at least until MASS operates alongside the conventional manned vessels. That being said, MASS and their conventional manned counterparts differ in their operations significantly, and therefore would require different training and certification standards. Perhaps, the way IMO envisaged a sister Convention of STCW for the fishing industry i.e. the SCTW-F Convention, it can put in place a Convention for standards for training and certification for crew operating the autonomous vessels.

5.5. Shift from Shipowner's Liability to Manufacturer's Liability

With the increased role of the manufacturers, the maritime industry might witness a shift from the traditional fault-based liability of the shipowner towards the liability of the manufacturer for the MASS technology. This idea is reinforced by highlighting the inapplicability of the present liability regimes namely, vicarious liability, fault-based liability, and strict liability to a MASS owner.

While the shipowner can be held vicariously liable for the acts of omission by an SBO, a situation where s(he) is held vicariously liable for the software seems implausible. This is mainly because of shipowner's lack of control on the software and the lack of agency/ personhood of the software. Furthermore, taking into account the two main rationales of vicarious liability i.e. deterrence of any dangerous conduct and compensation for any damages caused thereby, the idea of holding a shipowner vicariously responsible seems unconvincing.

Similarly, strict liability is most effective when it lies with the party in the best position to weigh the costs and benefits, between the cost of damages and the cost of avoidance of the risk, and therefore is in the best position to act accordingly.

In summary, it is, in fact, the manufacturer who fulfils every criterion for being held liable for the software, and not the shipowner. Therefore, it makes sense to eliminate the manufacturer's immunity while making sure s(he) does not become the scapegoat in every situation.

A regime where the shipowner is held vicariously liable but may take recourse against the manufacturer if the damage caused was because of contributory negligence is suggested. Also, a system similar to that of no-fault mandatory insurance for shipowners and/ or a compensation fund for the manufacturers seems logical. However, such practices and systems will need a unified global application requiring intervention by the IMO. Also, adoption of such systems seems workable only when all ships operating in our seas are autonomous.

5.6. The Application of the Product Liability Regimes to the MASS Technology

Holding a MASS manufacturer liable will involve product liability claims that are dealt with under the traditional law of torts. However, a majority of the countries today have a product liability regime in place. Such regimes mostly prescribe a strict liability for the manufacturer to protect the safety of the consumers and to deter any negligence and substandard practices on the manufacturer's side.

Though the application of product liability regimes to the MASS technology makes sense, doing so has considerable hurdles. In this context, the challenges of holding a manufacturer liable under the EU Product Liability Directive and the American Restatement (Third) of Torts on Product Liability, were highlighted. While applying the product liability regimes to any hardware installed onboard MASS seems relatively straightforward, applying it to the software is difficult mainly due to its intangibility.

The European and American systems define a product as something that is tangible. Also, a defective software is essentially defective information that a programmer feeds into the system. There is a general reluctance to hold manufacturers liable defective information as it might lead to the suppression of innovative ideas. However, the importance of the autonomous programme being a non-severable aspect of the ship makes it a critical component of it. Therefore, it becomes essential to extend the product liability regime to the MASS technology.

Taking into account the rationales of product liability provides compelling evidence for the extension of such regimes to the MASS technology. Also, extending the EU Product Liability Directive and the United States Third Restatements onto the MASS technology looks promising in keeping a high threshold for the manufacturer to escape liability. That being said, the different ways in which the two jurisdictions treat the concept of 'defect' points towards a bigger problem i.e. the non-existence of a unified approach towards product liability with each Sate resorting to its own treatment. This also increases the prospects of forum shopping. Thus, a need for an international product liability regime for MASS technology is highlighted along with its advantages.

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