FACULTY OF LAW
Lund University

Hannes Gosch

Legal analysis of Collision Liability in the context of Unmanned Shipping

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Supervisor: Olena Bokareva

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Summary

The aim of this graduation thesis *Legal analysis of Collision Liability in the context of Unmanned Shipping* is to examine how the implementation of commercial unmanned ships will interact with the legal framework for collision liability. New technological advancements have proven that the notion of an unmanned ship might become a reality in the near future. For this reason, the author decided to examine selective parts of the maritime regime governing liability for collisions at sea in order to describe their suitability with the notion of unmanned ships. Since the unmanned ship is characterised by advanced technology, this thesis additionally discusses whether the product liability regime could be utilised for distributing liability.

Chapter 2 highlights the technical characteristics in unmanned ships with the purpose of familiarising the reader with similarities and differences in regard to traditional shipping. The legal status of unmanned ships under public and private international law is examined in Chapter 3. Additionally, the chapter ascertains that the unmanned ship will be imposed duties as well as being able to enjoy rights and privileges derived from the international conventions to the same extent as their manned counterparts. Chapter 4 and 5 provide an overview of the liability regimes and identifies potential problems in relation to unmanned shipping. Chapter 6 addresses the identified problems when applying the existing liability regimes to the notion of unmanned shipping. Final conclusions are drawn in Chapter 7.

The results show that while the technical knowledge could enable deployment of unmanned ships, there are legal barriers presented by international maritime law that must be overcome before such deployment. The complete lack of human presence on board the ship is especially troublesome since the regulations governing collision liability are founded on the basic premise that humans are present on board the ship. There are, furthermore, indications that concepts derived from the product liability regime could find application or act as a complement to the maritime law. Thus, expanding the traditional scope of entities that may accrue liability.

The author recommends a further review of the legal framework for collision liability on an international level, followed by amendments to accommodate the peculiarities of unmanned shipping.

Sammanfattning

Syftet med examensarbetet *Legal analysis of Collision Liability in the context of Unmanned Shipping* är att undersöka hur det rättsliga ramverket för kollisionansvar hanterar och kan komma att påverkas av implementeringen av obemannade handelsfartyg.

Flera internationella forskningsprojekt har påvisat att det teknologiska kunnandet inom en snar framtid har nått en sådan nivå som möjliggör implementering av obemannade handelsfartyg. Dessa projekt har även slagit fast att det obemannade handelsfartyget kan komma att medföra en mängd förbättringar inom transportverksamheten, däribland ökad effektivitet, kostnadsbesparingar och ökad säkerhet.

Av denna anledning har undertecknad valt att undersöka huruvida utvalda delar av sjörättens regler för kollisionsansvar är adekvata i kontexten av obemannade handelsfartyg. Eftersom obemannade handelsfartyg utmärks av den avancerade teknologin som skeppen är utrustade med, utforskar examensarbetet även om regelverket för produktansvar kan användas för att fördela ansvar vid kollisioner.

I kapitel 2 följer en redogörelse för likheter och olikheter mellan bemannade och obemannade fartyg, med fokus på de tekniska egenskaper som utmärker obemannade handelsfartyg. Det obemannade handelsfartygens rättsliga status enligt internationell offentlig och privat rätt avhandlas i kapitel 3. I detta kapitel slås det fast att det obemannade handelsfartyget åtnjuter samma rättigheter och är föremål för samma skyldigheter under internationella konventioner som deras motpart, det bemannade skeppet. Kapitel 4 och 5 tillhandahåller en översikt av ansvarsregelverken och identifierar potentiella problem i förhållande till obemannade handelsfartyg. Dessa potentiella problem analyseras ingående i kapitel 6. I kapitel 7 behandlas examensarbetets slutsatser.

Examensarbetets resultat påvisar att även om det tekniska kunnandet har nått en sådan utveckling som möjliggör obemannade handelsfartyg, inrymmer den

internationella sjörätten rättsliga hinder som behöver bemästras. Den totala avsaknaden av mänsklig närvaro ombord det obemannade handelsfartyget utgör en av de främsta svårigheterna vid tillämpningen av det existerande regelverket. Detta grundar sig i att sjörättens regelverk för kollisionsansvar är utformat efter att det finns en mänsklig närvaro ombord på fartyget, vars agerande kan vara vållande till kollisionen. Vidare påvisar examensarbetet att det finns indikationer på att regelverket för produktansvar kan komma att få större inflytande på sjörättens traditionella regler för ansvarsfördelning. Detta skulle medföra en utökning av den grupp av aktörer som kan bli föremål för ansvar vid en kollision.

Undertecknad rekommenderar att det genomförs ytterligare granskning av det rättsliga ramverket för kollisionsansvar på en internationell nivå, samt att denna granskning åtföljs av tillägg för att ackommodera de egenskaperna hos obemannade handelsfartyget.

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Abbreviations

AAWA	Advanced Autonomous Waterborne Applications Initiative
AMS	Advanced Sensor Module
Arrest Convention	International Convention Relating to the Arrest of Sea-Going Ships
CJEU	Court of Justice of the European Union
CMI	Comité Maritime International
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea
ESMA	European Maritime Safety Agency
GPS	Global Positioning System
IMO	International Maritime Organization
LLMC	Convention on Limitation of Liability for Maritime Claims
MASS	Maritime Autonomous Surface Ship
MARPOL	International Convention for the Prevention of Pollution from Ships
MAXCMAS	Machine Executable Collision regulations for Marine Autonomous Systems
MSC	Maritime Safety Committee
MUNIN	Maritime Unmanned Navigation through Intelligence in Networks
NFAS	Norwegian Forum for Autonomous Ships
ROR	Rules of the Road
SA	Situational Awareness
SCC	Shore Control Centre
SOLAS	International Convention for the Safety of Life at Sea
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers

UNCLOS	United Nations Convention on the Law of the Sea
1910 Collision Convention	Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, 1910

1. Introduction

1.1 Background

Shipping as one of the world's oldest modes of transport is ongoing a technological transformation. Several sectors of the industry are subject to digitalisation where intelligent systems are considered to be at the very edge of these advancements.

The process of making ships unmanned, either by remote control or by autonomous systems[1], has attracted much attention and interest from a wide range of stakeholders. The centre of attention is on the several research and development projects that have been launched in recent years.[2] The conducted research has proven that in the near future we may have reached a point in technological knowledge that allows for a large-scale deployment of unmanned ships in the area of commercial shipping. As an example, the Yara Birkland project predicts that they will have developed a fully autonomous ship which is able to navigate the Norwegian waters by 2020.[3]

Similar technology is already being used today, both within the military and the civil sector.[4] However, the introduction of unmanned ships in the commercial sector is yet mostly limited to research projects comparable with the one mentioned above.

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[1] These concepts will be elaborated upon under the technical description in Chapter 2.

[2] For information about a selection of projects see: MUNIN "About MUNIN – Maritime Unmanned Navigation through Intelligence in Networks" <http://www.unmanned-ship.org/munin/about > accessed 19 February 2019; Kongsberg "Autonomous ship project, key facts about YARA Birkeland" <https://www.km.kongsberg.com/ks/web/nokbg0240.nsf/AllWeb/4B8113B707A50A4FC125811D00407045?OpenDocument.> accessed 26 February 2019; Advanced Autonomous Waterborne Applications Initiative (AAWA) "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016) <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.

[3] Kongsberg "YARA and KONGSBERG enter into partnership to build world's first autonomous and zero emissions ship" (2017) <https://www.kongsberg.com/maritime/about-us/news-and-media/news-archive/2017/yara-and-kongsberg-enter-into-partnership-to-build-worlds-first-autonomous-and/> accessed 12 April 2019.

[4] Eric Van Hooydonk "The Law of Unmanned Merchant Shipping: An Exploration." (2014) 20 The Journal of International Maritime Law 403, p. 404.

Thus, what are the advantages to be gained by the automatisation of the shipping and having unmanned ships? The ongoing research projects claim that there are numerous benefits which include economical drives linked to the possibility of saving costs through better navigation, decreased labour costs and fuel efficiency. Additionally, the improved navigation and the reduced labour force on board the ship could also generate significant environmental benefits.[5] Lastly, one of the major incentives in the development of this technology is to reduce the risk of human error. Statistics for maritime accidents between 2011-2017, provided by the European Maritime Safety Agency (EMSA), evidence that erroneous human action could be contributed to 58% of the accidental events reported by the EU Member States.[6] Moreover, *Rothblum* from the U.S. Coast Guard Research & Development Center found out, when examining a broader scope, that human error was involved in 80% or more of all maritime shipping accidents.[7] While there is no possibility to give a definitive answer to whether the unmanned ship will be able to reduce the number of accidents caused by human error, a study directed by *Kujala*[8] concludes that the implementation of unmanned ships is "likely to reduce the number of navigation-related accidents like collisions or groundings".[9]

Considering these major technological advancements, it is important to ask whether the existing shipping regulations are sufficient. While the Maritime Safety Committee (MSC)[10] examined the concept of automated ships as early as 1964, it is not until recent years that they have started work on developing a framework specifically targeting ships that implement advanced automatisation.[11] The International Maritime Organization (IMO) is currently conducting a regulatory scoping exercise in order to assess the impact and potential challenges the

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[5] Bernard Eder, "Unmanned Shipping: Challenges Ahead" (2017) Lloyd's Maritime & Commercial Law Quarterly 47, p. 50.
[6] ESMA: "Annual Overview of Marine Casualties and Incidents 2018" (2018), p. 8. <http://www.emsa.europa.eu/news-a-press-centre/external-news/item/3406-annual-overview-of-marine-casualties-and-incidents-2018.html> accessed 12 April 2019.
[7] Anita M. Rothblum et al., "Improving Incident Investigation through Inclusion of Human Factors" (2002) United States Department of Transportation - Publications & Papers 32, p. i.
[8] Pentti Kujala: Professor of Marine technology, Aalto University, Finland.
[9] Pentti Kujala et al., "Towards the assessment of potential impact of unmanned vessels on maritime transportation safety" (2017) 165 Reliability Engineering & System Safety 155, p. 164.
[10] The MSC is a body of the IMO concerned with a wide range of issues relating to IMO´s work on maritime safety and security.
[11] IMO: MSC 8th session (1964) Agenda.

implementation of these technologies might present, vis-á-vis the regulatory framework for international maritime safety.[12]

The IMO is at the very centre of developing the international regulations governing shipping and ensuring safety at sea. Four of the most prominent instruments that have been adopted by the organization, and which are said to constitute the very pillars of IMOs safety regulations, are the *International Convention for the Safety Of Life At Sea* (SOLAS), the *International Convention on Standards of Training, Certification and Watchkeeping* (STCW), the *International Convention for the Prevention of Pollution from Ships* (MARPOL) and the *Convention on the International Regulations for Preventing Collisions at Sea* (COLREGs). History has evidenced that these regulations to a certain degree have an inherent flexibility and ability of adapting to the incorporation of advanced technology into commercial shipping.[13]

It is, however, widely recognised that several of the international conventions are based on the basic premise that a ship has a crew on board the vessel. It is therefore essential to determine the applicability of the legal regimes onto unmanned shipping, in order to avoid legal gaps. Such potential legal uncertainty could have a hindering effect on both financial investments as well as on the willingness to pursue further technological advancements within the shipping industry.[14]

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12 IMO: MSC 99th session (2018) Briefing. <http://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx> accessed 26 February 2019; IMO: MSC 100th session (2018) Meeting Summary. <http://www.imo.org/en/MediaCentre/MeetingSummaries/MSC/Pages/MSC-100th-session.aspx> accessed 27 February 2019.

13 IMO "About IMO" <http://www.imo.org/en/About/Conventions/Pages/Home.aspx> accessed 7 Mars 2019. See also "Legal principles of interpretation" in Danish Maritime Authority, "Analysis of regulatory barriers to the use of autonomous ships" Final Report (2017), p.11. <https://www.dma.dk/Documents/Publikationer/Analysis%20of%20Regulatory%20Barriers%20to%20the%20Use%20of%20Autonomous%20Ships.pdf> accessed 27 February 2019.

14 Robert Veal and Michael Tsimplis "The integration of unmanned ships into the lex maritima" (2017) Lloyd's Maritime & Commercial Law Quarterly 303, p. 304.

1.2 Purpose and Research Questions

The aim of this thesis is to examine how collision liability will be assigned in the context of unmanned shipping. Since the governance of ship navigation and regulations for preventing collisions at sea are predominantly based on the assumption of human presence and control on board the ship, the thesis will also attempt to answer how compatible the existing liability rules for manned ships are in the context of unmanned shipping.

Furthermore, apart from limiting the discussion to the traditional actors such as the shipowner and ship masters, the thesis will also investigate the possibility for shipbuilders[15] to accrue liability based on the notion of product liability. Due to the legal uncertainty in this field of law, it is the author's aspiration that this thesis can be used as guidance and as a knowledge base for further discussion and research.

Therefore, the thesis will examine the following questions:

- What is meant by unmanned shipping?
- Is the regulatory framework concerning collisions at sea compatible with the notion of unmanned shipping?
- If legal gaps can be found, can and should the division of liability be based on product liability?

1.3 Delimitations

This thesis will only address collision liability in the context of unmanned shipping in civil commercial shipping. Moreover, only non-contractual liability towards third parties derived from damage to property will be examined. It is not this thesis ambition to provide an exhaustive analysis covering every aspect of the legal framework for collision liability. Thus, only selected parts of the regulatory framework will be addressed. The process of selecting what regulations to examine is based on findings produced by legal scholars as well as the authors own considerations.

[15] For the purpose of this thesis "shipbuilder" will include other actors such as manufacturers of individual components in the ship and software developers. Differentiation between the actors will be made when needed.

The examination of the product liability regime will be based on the EU Product Liability Directive.[16] The rationale for applying this approach is because several legal scholars have previously ascertained the Directive´s potential relevance when determining collision liability for unmanned ships.[17] It is important to bear in mind that the Directive at present is only applicable when a defective product causes personal injury or physical damage to property intended for *private use*, which thereby excludes the type of damage to commercial property discussed in this thesis.[18] However, a revision of the Directive is relevant since legal scholars have argued that the Directive possibly could be amended in a way that the scope of application encompasses damage to commercial property.[19] This thesis will, therefore, examine selected articles and concepts in order to determine their applicability in the context of unmanned shipping.

1.4 Method and Material

The research in this thesis will be conducted by applying a theoretical legal dogmatic method. This means that the liability for collisions first will be described through examining international instruments. With reference to international conventions the thesis principal focus is directed at the 1910 Collision Convention, COLREGs, SOLAS and the STCW Convention. Moreover, the EU legislation and case law of the Court of Justice of the European Union (CJEU) will be analysed, primarily concerning the Product Liability Directive.

Domestic law will only be addressed to a limited extent, especially in regards to case law from the United Kingdom. The rationale behind adopting this approach is

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[16] Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products.
[17] AAWA "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016), pp. 52-53. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019; Danish Maritime Authority "Analysis of regulatory barriers to the use of autonomous ships" Final Report (2017), p. 87. <https://www.dma.dk/Documents/Publikationer/Analysis%20of%20Regulatory%20Barriers%20to%20the%20Use%20of%20Autonomous%20Ships.pdf> accessed 27 February 2019.
[18] Emphasis added. The Product Liability Directive 85/374/EEC, Article 1, 9.
[19] CORE Advokatfirma "Maritime autonomous surface ships - Zooming in on civil liability and insurance" (2018), p. 12. <https://cefor.no/globalassets/documents/industrypolicy/news/mass---zooming-in-on-civil-liability-and-insurance---10-december-2018.pdf> accessed 7 Mars 2019.

that English courts traditionally have been the jurisdiction of choice for settling maritime disputes. It is thus possible to ascertain that courts of the United Kingdom exercise great influence regarding application and development of the international maritime law. It is, additionally, important to emphasise that there is at present no case law directly concerned with collisions and unmanned shipping. The case law examined in this thesis, therefore, serves the purpose of depicting existing law and providing a foundation for the discussion regarding its compatibility in the context of unmanned shipping. This thesis will, furthermore, make use of the legal doctrine, primarily books and articles produced by legal scholars.[20]

When the characteristics of collision liability have been outlined, the thesis will move forward and analyse it in the context of unmanned shipping. The thesis will make use of *travaux preparatoires* as well as interpretation in accordance with the Vienna Convention on the Law of Treaties, 1969 (VCLT).

It is correct to say that within the context of regulations for commercial shipping the area of unmanned shipping is a reasonably new one. While a considerable amount of research has been conducted concerning the technical aspects the same cannot be said about the legal field, where the academic writing on the topic is in fact comparatively scarce. Due to the lack of international regulation specifically designed to apply on unmanned ship and absence of jurisprudence directly concerning unmanned shipping, there is a substantial need for further research.

Moreover, this thesis will make use of findings produced by selective research projects, such as the MUNIN project, AAWA Initiative and the Yara Birkland. It must be emphasised that these interdisciplinary projects do not constitute any legal authority. The findings of the projects, however, provide guidance in the legal discussion concerning unmanned shipping.

[20] Olena Bokareva, *Multimodal Transportation under the Rotterdam Rules: Legal Implications for European Carriage of Goods and the Quest for Uniformity* (Lund University, Lund, 2015), pp. 25-26.

1.5 Disposition

Firstly, the thesis will take a technical detour explaining the key aspects of unmanned shipping in Chapter 2, with the purpose of highlighting the differences in comparison with traditional manned ships. Secondly, the legal status of the unmanned ship under international law will be specified in Chapter 3, to establish the relevance of chapter 4 where the thesis will describe the regulatory framework concerning collisions at sea. Moreover, Chapter 5 examines the product liability regulation. Chapter 6 will analyse the presented notion of unmanned shipping in regard to collision liability. Chapter 7 summarises the conclusions and address the research questions.

2. Technical Description of Unmanned Ships

In order to examine the regulatory framework, it is crucial to first determine what kind of technology makes unmanned ships distinct from the manned ship we have today. Therefore, this chapter will introduce the reader to the notion of unmanned ships by addressing key elements of the current technological advancements. The components that will be presented have been selected primarily based on their relevance for answering the research questions, as well as on the need to conceptualise the notion of unmanned ships, in order to understand it in the context of this thesis. Moreover, advantages and potential difficulties with unmanned ships will be addressed.

2.1 Current Projects and Development

The advancements related to equipping ships with navigational technology have been major in recent time. Smart systems such as e-navigation are heavily promoted by the IMO with the purpose to implement it broadly.[21] Numerous other sectors of the shipping industry have undergone an automatisation process. One of those areas is navigation where several tasks that traditionally in an exclusive manner have been carried out by the crew on-board the ship are automated nowadays. This has been made possible through enabling technology such as dynamic positioning and automatic berthing or facilitated through equipment such as radar, Global Positioning System (GPS) and Automatic Identification Systems.[22]

Furthermore, several projects have been launched which provide research within the area of autonomous and unmanned shipping. A selection of these projects will be used as a foundation when elaborating further on the concept of unmanned shipping.

[21] IMO: MSC 94th session (2014) Briefing <http://www.imo.org/en/MediaCentre/PressBriefings/Pages/40-MSC94wrap.aspx#.XHatWiAo-Uk> accessed 27 February 2019.

[22] AAWA, "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016), p. 10. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.; IMO: MSC 63th session (1994) "Guidelines for vessels with dynamic positioning systems (MSC/Circ.645)" available at <https://www.imca-int.com/publications/76/guidelines-for-vessels-with-dynamic-positioning-systems-msc-circular-645/> accessed 2 May 2019.

The EU co-funded project "Maritime Unmanned Navigation through Intelligence in Networks" (MUNIN) was launched in 2012 and completed in 2015, under the European 7th Framework Program, with one of the main objectives "to show the feasibility of an autonomous and unmanned vessel."[23] The project focused its research on dry bulk carriers conducting intercontinental trade. Within this project, the autonomous control was only tested during deep sea voyages and not on legs that were heavily trafficked or in congested waters.[24]

Another project that attracted attention was the "Advanced Autonomous Waterborne Applications Initiative" (AAWA), managed by Rolls-Royce with funding provided by the Finnish Funding Agency for Technology and Innovation (Tekes). It was launched in 2015 and completed in 2017. The project sought to bring together a variety of stakeholders and universities in an interdisciplinary collaboration, with the purpose of addressing crucial factors for making the autonomous ship a reality. [25]

Additionally, actual testing of unmanned and autonomous ships are being carried out more and more frequently. One example is the world's first remote-operated commercial vessel that was successfully tested and navigated through a harbour in Copenhagen, Denmark.[26] Simultaneously, the construction of the first fully electronic and autonomous container ship, called Yara Birkland, is being developed in Norway. Whereas testing is conducted during 2019, the ambition of the project is that when the ship is deployed in 2020 it will "gradually move from manned operation to fully autonomous operation by 2022."[27]

[23] MUNIN, "About MUNIN – Maritime Unmanned Navigation through Intelligence in Networks" <http://www.unmanned-ship.org/munin/about > accessed 19 February 2019.

[24] MUNIN, "Results" <http://www.unmanned-ship.org/munin/about/munin-results-2/> accessed 26 February 2019.

[25] AAWA, "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016), p. 5. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.

[26] Rolls-Royce, "Rolls-Royce demonstrates world's first remotely operated commercial vessel"<https://www.rolls-royce.com/media/press-releases/2017/20-06-2017-rr-demonstrates-worlds-first-remotely-operated-commercial-vessel.aspx> accessed 26 February 2019.

[27] Kongsberg, "Autonomous ship project, key facts about YARA Birkeland" <https://www.km.kongsberg.com/ks/web/nokbg0240.nsf/AllWeb/4B8113B707A50A4FC125811D00407045?OpenDocument.> accessed 26 February 2019.

2.2 Characteristics of Unmanned and Autonomous Ships

In order to differentiate between automated processes such as autopilot, already in use today, and the technology enabling the development of unmanned ships, certain characteristics of the unmanned ship need to be addressed.

2.2.1 Remote or Autonomous control?

Firstly, the term *unmanned ships* can be divided into two main classes, “remote-controlled” and “autonomous ships”. The two terms are to a certain extent used in an interchangeable way. It is, however, of utmost importance to keep them separated since the two classes are associated with different legal considerations. A distinction can be made based on the different technology and methods used for controlling the unmanned vessel.[28]

In the context of the MUNIN project, an autonomous ship is described as a ship that has a certain level of automatisation, meaning that the ship´s processes can operate without human intervention. In contrast, a remote-controlled ship refers to a ship which through enabling technology can be controlled remotely, presumably from an on-shore location by a human operator.[29]

Even though such a distinction can be made in theory, practitioners hold that it is extremely difficult to create fully autonomous ships and that such ships will not be a reality within the near future. Furthermore, the concept of a solely remote-controlled ship has disadvantages both due to the large costs and the difficulties involved in communicating all the relevant data between the controlled ship and the onshore control centre as well as extensive risks presented in case of disruption of the communication link.[30]

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[28] Ørnulf Jan Rødseth & Håvard Nordahl, “Definition for autonomous merchant ships” (2017) Norwegian Forum for Autonomous Ships (NFAS), pp. 7-8. <http://nfas.autonomous-ship.org/resources/autonom-defs.pdf.> accessed 26 February 2019.

[29] MUNIN, “The Autonomous Ship” <http://www.unmanned-ship.org/munin/about/the-autonomus-ship/> accessed 26 February 2019.

[30] MUNIN, “Results” <http://www.unmanned-ship.org/munin/about/munin-results-2/> accessed 26 February 2019.

Instead, researchers are inclined to hold that it is more advantageous to take an integrated approach where the two categories, remote and autonomous control, to a certain extent are combined or intertwined. This could be exemplified by placing the control of the ship on the remote operator in situations during the voyage that requires close monitoring. Whereas otherwise, e.g. at legs of the high sea where the traffic density is low, the control is placed at the fully autonomous system. The concept of combining the two systems of controlling the ship – an automated on board decision system while supervised by an on-shore control centre – is referred to as a "holistic" approach in the MUNIN project. The AAWA initiative also provides for the possibility to regulate the level of autonomy during the voyage and describes it as "dynamic autonomy".[31] Additionally, the benefits of combining the two systems have been recognised by the IMO.[32]

2.2.2 Degrees of Autonomy

The definition of "Maritime Autonomous Surface Ship" (MASS) put forward by the IMO, for the purpose of a regulatory scoping exercise[33] concerning autonomous shipping, has a similar wording, describing it as "...a ship which, to a varying degree, can operate independently of human interaction...".[34] It is, however, necessary to divide these "steps" of autonomy in order to address legal concerns regarding the control and operation of the ship. This is regarded as a complicated task and researchers have provided several different solutions and methods for creating identifiable classes of autonomy.[35]

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[31] AAWA, "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016), p. 7. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.

[32] IMO: MSC 99th session (2018) Briefing <http://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx> accessed 26 February 2019. See also AAWA, "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London, (2016), p. 13. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.

[33] The scoping exercise will investigate how questions concerning safety and environmental aspects, in the context of MASS, may be addressed through IMO instruments.

[34] IMO: MSC 99th session (2018) Briefing <http://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx> accessed 26 February 2019.

[35] Ørnulf Jan Rødseth & Håvard Nordahl, "Definition for autonomous merchant ships" (2017) Norwegian Forum for Autonomous Ships (NFAS), p. 7. <http://nfas.autonomous-ship.org/resources/autonom-defs.pdf.> accessed 26 February 2019. See also Lloyd's Register "LR

This thesis will rely upon the degrees of autonomy that were identified by the IMO for the purpose of the regulatory scoping exercise on MASS:

- Degree one: Ship with automated processes and decision support: Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control.

- Degree two: Remotely controlled ship with seafarers on board: The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions.

- Degree three: Remotely controlled ship without seafarers on board: The ship is controlled and operated from another location. There are no seafarers on board.

- Degree four**:** Fully autonomous ship: The operating system of the ship is able to make decisions and determine actions by itself.[36]

When looking at these different degrees it is possible to boil the division of steps down to a question of who has the control, either the operator of the ship or an automated program, and where that control is located, either on board the ship or at another location.[37] While examining the notion of the "unmanned ship", only degree three and four will be of direct relevance for the purposes of this thesis.[38] This is because both degree three and four have in common the lack of human presence on board the ship.

2.2.3 Navigational System

The unmanned ship´s navigational control could either be held by a remote operator in the Shore Control Centre (SCC)[39] or by the autonomous systems on board the

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Code for Unmanned Marine Systems" (2017), pp. 1-2. available at <https://www.lr.org/en/unmanned-code/> accessed 22 April 2019.

[36] IMO: MSC 100th session (2018) Meeting Summary <http://www.imo.org/en/MediaCentre/MeetingSummaries/MSC/Pages/MSC-100th-session.aspx> accessed 27 February 2019.

[37] Danish Maritime Authority, "Analysis of regulatory barriers to the use of autonomous ships" Final Report (2017), p. 6. <https://www.dma.dk/Documents/Publikationer/Analysis%20of%20Regulatory%20Barriers%20to%20the%20Use%20of%20Autonomous%20Ships.pdf> accessed 27 February 2019.

[38] See Chapter 1.2 of the thesis for the established purpose and research questions.

[39] See Chapter 2.2.4 of the thesis.

ship. The autonomous navigation system itself can be divided into two groups, global and local planning. Whereas the former is based on path planning made at the beginning of the voyage based on previously existing information, e.g. electronic nautical charts, the latter is based on reactive navigation founded on current information collected by sensors.[40] In both situations, either where the autonomous navigation system or where the remote operator is in control of the ship, a crucial aspect of being able to navigate the unmanned ship safely will be to implement technology which enables a certain standard of Situational Awareness (SA). Sufficient SA will, therefore, be a fundamental element in the transition from on board ship control to on-shore control of the ship.[41]

The formal notion of SA can be described as the "perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future".[42] In traditional shipping, where personnel is physically present on board the ship SA will be achieved by both the perceptions of the human senses complemented by technical assistance systems such as radar equipment, Automatic Information System or Integrated Navigation System. In the context of unmanned shipping however, the absence of human senses on-board the ship must be counterbalanced with improved technological perception.[43]

In the MUNIN project, this was held to be achievable through the implementation of Advanced Sensor Module (ASM) which makes use of a diversity of navigational sensors and process the information in order to create an accurate picture of the

[40] Shahida Khatoon & Ibraheem Nasiruddin, "Autonomous Mobile Robot Navigation by Combining Local and Global Techniques" (2012) 37(3) International Journal of Computer Applications 1, p. 1. See also AAWA, "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016), p. 21. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.
[41] Thomas Porathe et al., "Situation awareness in remote control centres for unmanned ships" (Human Factors in Ship Design & Operation conference, London, February 2014), p. 4. <http://publications.lib.chalmers.se/records/fulltext/194797/local_194797.pdf> accessed 6 May 2019.
[42] Mica R. Endesly, "Design and Evaluation for Situation Awareness Enhancement" (1988) 32(2) Proceedings of the Human Factors Society Annual Meeting 97, p. 97.
[43] MUNIN, "D8.6: Final Report: Autonomous Bridge" Research paper (2015), p. 6. <http://www.unmanned-ship.org/munin/wp-content/uploads/2015/09/MUNIN-D8-6-Final-Report-Autonomous-Bridge-CML-final.pdf> accessed 22 February 2019.

vessels current and future surroundings. The functional description of the ASM is to maintain a lookout for traffic, objects which might cause hindrance as well as collect and assess meteorological data. An objective when developing the ASM was that it would be able to minimise the risk of collision and assure that the unmanned ship is able to fully comply with the international regulations governing navigation at sea.[44]

It is, however, at present disputable whether it is really possible to replace the human senses with technological infrastructure. Some argue that the technology used to create SA for unmanned ships need to be further developed in order to match the level of SA which can be achieved by the navigators on board manned ships. The technological solutions must be able to sufficiently create an overview of the collected data and process it adequately.[45]

2.2.4 The Shore Operation

In order to tackle the challenges presented in the context of unmanned shipping, the notion of establishing remote control centres is presented in both the MUNIN and the AAWA projects. Through the centres the onshore personnel will have the ability to remotely control the ship, supervise the ship's voyage and possibly assure compliance with existing regulatory requirements for the ship to be properly manned.

The MUNIN project introduced the notion of a SCC. It is described as a workstation devoted to monitoring or controlling one or several unmanned vessels. The idea is that during deep sea legs of the voyage, the autonomous systems on board the ship will be in control and continuously transmit data to the SCC in order to enable proper monitoring. The monitors in the SCC will allow the operator to assess the

[44] Ibid, pp. 6-7, 9, 11.
[45] Yemao Man et al., "From Desk to Field - Human Factor Issues in Remote Monitoring and Controlling of Autonomous Unmanned Vessels" (2015) 3(2674) Procedia Manufacturing, pp. 2674, 2781. <http://www.sciencedirect.com/science/article/pii/S2351978915006368> accessed 22 April 2019.

ship´s various control processes and also indicate dangerous situations where the operator needs to intervene and take control over the vessel remotely.[46]

Moreover, due to the legal requirements derived from the flag states, as well as international instruments, concerning the duty to properly man the ship, the composition of the SCC personnel will also become an important factor when introducing unmanned ships.[47] For this purpose the Norwegian Forum for Autonomous Ships (NFAS) has made a preliminary identification of certain personnel that must be present at the SCC:

- ***Master***: Person on overall charge of the ship. One may also include ship security officer duties in this role.
- ***Chief engineer officer***: Person in overall charge of the mechanical propulsion and the operation and maintenance of the mechanical and electrical installations of the ship.
- ***Officer of the watch (OOW)***: Person that at any time is responsible for monitoring the ship and intervening if needed.[48]

2.3 Conclusion

The notion of creating unmanned ships has sparked a boom of interest within a large field of stakeholders. It is likely that more initiatives similar to the Yara Birkland or the AAWA will be conducted, and thus drive the progress towards unmanned ships even further.

The research projects presented above address merchant vessels operating within the field of commercial shipping. A common feature of these projects is that the autonomous control has been mainly tested on deep-sea legs of the voyage, and not

[46] MUNIN, "D8.8: Final Report: Shore Control Centre" Research paper (2015), pp. 8-9. <http://www.unmanned-ship.org/munin/wp-content/uploads/2015/09/MUNIN-D8-8-Final-Report-Shore-Control-Centre-CTH-final.pdf> accessed 26 February 2019.
[47] MUNIN, "Results" <http://www.unmanned-ship.org/munin/about/munin-results-2/> accessed 26 February 2019.
[48] Ørnulf Jan Rødseth & Håvard Nordahl, "Definition for autonomous merchant ships" (2017) Norwegian Forum for Autonomous Ships (NFAS), pp. 10-11. <http://nfas.autonomous-ship.org/resources/autonom-defs.pdf.> accessed 26 February 2019.

within heavily trafficked legs. Furthermore, they prescribe that during these trafficked areas the remote-control operator will take over the control from the autonomous system.

As mentioned above, a distinction can be made between remote-controlled and autonomous ships, where the control of the vessel is either placed on the automated system or on the remote-control operator in the SCC. Furthermore, in practice, it is likely that the two modes of controlling the ships are combined to a certain extent.

It is possible to identify the following situations where navigational incidents can be linked to the technology used. Firstly, we have the situation where the automated navigational system malfunction or make the wrong decisions when processing the collected data. Secondly, we have the situation where the automated sensor module is not working properly, either in the context of providing the automated control system with information or during the remote control operation.

3. Legal Status of the Unmanned Ship

Before investigating how liability will be attributed in the context of unmanned shipping accidents, it is of great importance to clarify whether the notion of an unmanned ship falls under the same regulatory framework as their counterparts, i.e. "manned ships". If that is the case, the unmanned ship will be imposed duties as well as being able to enjoy rights and privileges derived from the international conventions.

Considering that there is no internationally uniform definition of the term "ship", this chapter will examine a selection of international conventions and their definitions of a ship and determine whether human presence on board constitutes a prerequisite for their applicability.

In order to determine the scope of application most international conventions contain a definition of what constitutes a ship. Notably, the definitions provided in these conventions are affected by several factors such as the material content of the convention, whether it is public or private maritime law as well as the purpose of the convention. It is therefore not possible to establish a presumption of what constitutes a "ship" merely by looking at a single convention since the scope of these definitions generally are limited to the individual convention.[49] An exhaustive analysis of every available definition falls outside the scope of this thesis. However, as stated above, it is of paramount importance to ascertain whether international conventions are also applicable on unmanned ships.

3.1 Public International Law

In a broad perspective, the duties of flag states, as well as navigational rules, are outlined in the United Nations Law of the Sea Convention, 1982 (UNCLOS). The Convention is considered to be one of the most important instruments in the field of maritime regulations.

[49] Juan Pablo Rodriguez Delgado "The Legal Challenges of Unmanned Ships in the Private Maritime Law: What Laws would You Change?" in Musi, Massimiliano (ed.), *Port, Maritime and Transport Law Between Legacies of the Past and Modernization* (Bonomo Editorr, Bologna, 2018) p. 498.

Despite the frequent use of and reference to the word “ship”, UNCLOS does not provide any definition of the term. The provisions of UNCLOS refers to “ships” and “vessels” in an interchangeable way, contrary to English law where the word vessel is considered to have a more extensive scope. Thus, in the context of public international law, these two terms can be considered as equal.[50] Apart from stating requirements as to having a master together with an adequately skilled crew, UNCLOS does not state conditions as to having the crew physically present on-board the ship.[51]

Some legal scholars argue that the absence of an overarching definition allows for healthy flexibility in regard to the specific purpose of individual instruments. However, this lack of definition could also be viewed as problematic since the definition of a ship provided by the IMO instruments will have a restricted applicability, confined by the scope of that individual instrument.[52]

Moreover, a majority of commentators consider that the unmanned ship must be regarded as a "ship" for the purposes of UNCLOS, due to the absence of a definition expressly excluding unmanned ships.[53]

In the COLREGs the term “vessel” is frequently used. It is defined in Article 3(a) as “every description of water craft, including non-displacement craft, WIG79 craft and seaplanes, used or capable of being used as a means of transportation on water”.

For the purpose of the United Nations Convention on Conditions for Registration of Ships, 1986[54] the term is defined in Article 2 as “any self-propelled sea-going

[50] Robert Veal and Michael Tsimplis, “The integration of unmanned ships into the lex maritima” (2017) Lloyd's Maritime & Commercial Law Quarterly, 303, p. 307.
[51] UNCLOS, Article 94(4)(b).
[52] Robert Veal and Michael Tsimplis, “The integration of unmanned ships into the lex maritima” (2017) Lloyd's Maritime & Commercial Law Quarterly, 303, pp. 308-309.
[53] Eric Van Hooydonk, “The Law of Unmanned Merchant Shipping: An Exploration.” (2014) 20 The Journal of International Maritime Law 403, p. 406. See also Comité Maritime International “CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework” (2018), p. 3. <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf> accessed 5 April 2019.
[54] United Nations Convention on Conditions for Registration of Ships, 1986 (Not yet in force).

vessel used in international seaborne trade for the transport of goods, passengers, or both, with the exception of vessels of less than 500 gross registered tons”.

The International Convention for the Prevention of Pollution from Ships (MARPOL) offers the following definition of a “ship” “a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms”.[55]

3.2 Private International Law and National Maritime Law

Several conventions regarding private maritime law which apply to seagoing vessels do not provide any definition of what constitutes a “ship”. Examples include instruments such as the 1910 Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, the 1952 International Convention Relating to the Arrest of Sea-Going Ships (Arrest Convention) and the 1976 Convention on Limitation of Liability for Maritime Claims (LLMC).[56] Notably, neither the national maritime legislation gives any indication as to requiring the crew to be physically present on board the ship. For example the definition of a “ship” provided in the United Kingdom´s Merchant Shipping Act 1995, in Section 313(1), which states that the term encompasses “every description of vessel used in navigation”.[57]

3.3 Conclusion

After reviewing the selected definitions provided by international and national law, having a crew physically on board is not a prerequisite for applying international rules in regards to unmanned ships. As long as the unmanned ships fulfil the technical requirements found in some of these definitions, the conventions will impose duties and grant privileges to the same extent as in traditional manned shipping.

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[55] International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL), Article 2(4).
[56] Eric Van Hooydonk, “The Law of Unmanned Merchant Shipping: An Exploration.” (2014) 20 The Journal of International Maritime Law 403, p. 407.
[57] Ibid, p. 408.

4. Collision Liability

This chapter serves the purpose of familiarising the reader with key aspects of the regulatory framework concerning collision liability. In addition to a historical review the emphasis will be on components which can be used when determining liability for a collision accident at sea.

4.1 Historical Background

The rules concerning collisions at sea can be traced back to ancient times. The first mentioning of fault (*culpa*) by mariners in collision accidents dates back to the *Digest of Justinian* in the 6th century. Moreover, principles imposing the ship master with the obligation to provide a sufficient crew were articulated in different maritime codes as early as the medieval times.[58] Notably, these codes did not provide any rules devoted to the prevention of collisions at sea but were mostly focused on collisions occurring in harbours or with anchored vessels. Arguably, the reason for the earlier maritime codes limited scope was the lack of navigational skills as well as the basic construction of vessels, which confined most ships to coastal waters.[59]

The Roman civil law principles of fault and negligence became the prevailing test, and remained to be at present, for determining liability for collisions. While the concept was unfamiliar to the medieval common law system, the usage was widely recognised through customs practised by mariners at the time. Thus, the principles were incorporated and given influence in the British maritime law, which is evidenced through jurisprudence from the early 16th century which encompasses notions such as "negligence, oversyghte, carelessness and fault".[60]

When applying the fault-based test it is necessary to first determine certain standards of care owed by those navigating the ship. The test is built on the notion that deviation from these specified standards is evidence of negligence and could

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[58] Boris Soyer, *Warranties in Marine Insurance* (2nd edn, Cavendish, London 2006), p. 48.
[59] David R. Owen, "Origins and Development of Marine Collision Law" (1976-1977) 51(4) Tulane Law Review 759, pp. 760-764.
[60] Ibid, p. 781.

thus render the person in fault liable for damage. Before the development of modern maritime law, the standard of care was based on custom. Codifications of the customary standards were later introduced through legislation in the mid-19th century, in situations where the regulations were not applicable, the concept of good seamanship was used for filling the gaps.[61]

It was not until around the 1840´s that the developments on collision law accelerated. This is also the point in time where "modern collision law" emerged. The sudden evolution was in part initiated by the industrial revolution as well as increased global trade. During the time that industrialisation progressed wooden vessels under sails were replaced with metal-hulled ships with mechanical propulsion. As a result of this transition, and also because of growth in trade between nations, the number of serious accidents increased significantly.[62]

In England, the increased risks of collision were recognised and led to the first formal adoption of steering rules for steam vessels in 1840. Setting forward one of the very first navigational rules that sailing vessels would have priority over vessels powered by steam. At this time there was an understanding that the lack of uniform rules for preventing accidents at sea posed a serious problem, and that this problem could only be solved by a "universal understanding of the rules of the road".[63] However, the effect of these rules was limited only to the British vessels. Due to the international character of shipping, it was common that the parties involved in a collision originated from different nations with diverse legal systems. This was later recognised and led to the conclusion that "the effectiveness of the safety measures depends on the co-operation between states".[64] The formation of the Sea Regulations of 1863, constituted the most extensive set of rules of the time. A significant characteristic for the regulations were that they could be adopted by the

[61] Ibid, pp. 781-782.
[62] Ibid, pp. 767-769; Samir Mankabady, *Collision at Sea: A Guide to the Legal Consequences* (North-Holland, Amsterdam, 1978) p. 6.
[63] David R. Owen, "Origins and Development of Marine Collision Law" (1976-1977) 51(4) Tulane Law Review 759, p. 783.
[64] Samir Mankabady, *Collision at Sea: A Guide to the Legal Consequences* (North-Holland, Amsterdam, 1978) p. 5.

international maritime community, which led more than 30 countries to notify Britain of their desire to be bound by the rules.[65]

In 1889 the first worldwide maritime conference was initiated by the United States, with the purpose of developing rules for preventing collisions at sea. The outcome of this conference was a new set of rules which became effective worldwide in 1897. Consecutive international conferences were held where minor changes were agreed upon.[66] The result of these conferences, as well as a pressing need to adapt the rules to modern practices and evolving technology, was the development of COLREGs. The regulations, as amended, are commonly referred to as the "rules of the road" (ROR) and "constitute the authoritative measurement of conduct of ships on navigation".[67]

Notably, as the modern maritime law evolved, international organizations came to play a leading role in the development of new regulations. IMO was formally established in 1948 under the United Nations and assigned with the task to adopt and modify conventions in the area of maritime concerns.[68] The organization has since produced numerous works concerned with improving the standards of safety. Two examples that are of significant importance and which will be examined further are the STCW- and SOLAS Conventions. The STCW Convention encompasses the minimum qualification standards for the personnel on board the ship, thus including the masters, officers and watchkeeping personnel. The SOLAS Convention imposes upon the contracting states minimum standards in regard to construction, equipment and operation of the ship.[69]

It should be noted that the IMO conventions do not enter into force or become immediately binding upon state ratification. Formal acceptance from the individual

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[65] David R. Owen, "Origins and Development of Marine Collision Law" (1976-1977) 51(4) Tulane Law Review 759, p. 784.
[66] The 1910 Brussels Maritime Conference, The 1929 International Conference on Safety of Life at Sea and the subsequent 1948 and 1960 SOLAS Convention.
[67] Aleka Mandaraka-Sheppard, *Modern Maritime Law. Vol. 2, Managing Risks and Liabilities* (3th edn, Informa Law, Abingdon, Oxon, 2013) p. 391.
[68] There are three main groups 1) maritime safety 2) prevention of marine pollution 3) liability and compensation.
[69] IMO, "Brief History of IMO" <http://www.imo.org/en/About/HistoryOfIMO/Pages/Default.aspx>, accessed 7 Mars 2019.

governments is also needed, which means that the individual nations who choose to ratify the international convention must also incorporate the terms into the domestic legal system.[70]

Despite the evolution of safety measures and the international rules devoted to preventing accidents at sea, collisions would inevitably still occur. One of the organizations that recognised the need for uniform laws regulating division of liability in collision cases was Comité Maritime International (CMI).[71] CMI managed to bring together a number of conferences dedicated to the development of a uniform set of laws in respect of collision. This resulted in the formation of a multilateral treaty, the 1910 Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels (1910 Collision Convention).[72] The Convention forms part of the private international law and has been ratified by a majority of maritime nations, and apply to collisions between sea-going ships flying under the flag of two different High Contracting Parties.[73]

4.2 Underlying Principles of the Fault-Based Liability

Establishing a definition for "collision" in the concept of modern maritime law is of fundamental importance in order to determine liability. One of the most elementary explanations is "the impact of ship against ship".[74] The scope has however been expanded through customs. This is evidenced by jurisprudence where the concept of collision also encompasses accidents involving two or more ships without any physical contact taking place. An example of this can be found in the case, *The Royal Eagle*, where it was held to constitute a collision when a ship

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[70] Christopher Hill, *Maritime Law* (6th edn, Informa Law, London, 2003) p. 288; IMO "About IMO", <http://www.imo.org/en/About/Conventions/Pages/Home.aspx>, accessed 7 Mars 2019.
[71] CMI is a non-governmental organization devoted to creating legal harmonisation within the maritime field, established in 1897.
[72] CMI, *The Travaux préparatoires of the International Convention for the Unification of Certain Rules of Law with Respect to Collision Between Vessels 23 September 1910 and of the International Convention for the Unification of Certain Rules Relating to the Arrest of Sea-going Ships, 10 May 1952* (CMI Headquarters, Antwerpen, 1997), p. 6.
[73] CMI Yearbook (2016), "Part III - Status of ratifications to Brussels Conventions" 367, pp. 367-370 < https://comitemaritime.org/publications-documents/cmi-yearbook/> accessed 29 Mars 2019. The scope of application is stated in Article 1 of the 1910 Collision Convention.
[74] George L. Canfield and George W. Dalzell, *Law of the Sea: A Manual of the Principles of Admiralty Law for Students, Mariners, and Ship Operators* (New York, D. Appleton, 1926) p. 148.

by proceeding in excessive speed caused swells which damaged a docked ship.[75] This notion is correspondingly recognised when applying both the 1910 Collision Convention and COLREGs.[76]

When establishing liability for collisions two different systems exists, namely strict liability and fault-based liability. The first category can be defined as an "[L]iability for a wrong that is imposed without the claimant having to prove that the defendant was at fault".[77] The strict liability is generally imposed for situations where an extra layer of protection has been deemed necessary. Two examples are pollution damage[78] and shipping incident that causes death or injuries.[79] The second category, fault-based liability, is the opposite of strict liability and in order to distribute liability, it must be proven that the defendant's conduct was either negligent or intentional.[80] In English law negligence is formulated as "the breach of a recognised duty of care owed to a person who may reasonably be foreseen to suffer loss as a direct result of that breach".[81]

The principle of proven fault means that the burden of proof, i.e. the establishment of the fact that the damage suffered was caused by the defendant's failure to comply with the required standard, will be placed on the party claiming compensation for damages. Notably, in order to establish liability, it is not sufficient to prove a breach of duty, the claimant must also prove that there is a causal link between the breach and the damages suffered. In collision cases this often proves to be a complex task,

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75 *The Royal Eagle* (1950) 84 Lloyd's Rep. 543.

76 Simon Gault et al. (ed.) *Marsden and Gault On Collisions at Sea* (14th edn, Sweet & Maxwell, London, 2016) pp. 7-8. See also Plinio Manca, *International Maritime Law,* Vol. 3 *(*Antwerpen, 1971) p. 71.

77 Jonathan Law and Elizabeth A. Martin (eds.), *A dictionary of law* (7th edn, Oxford University Press, Oxford, 2009), on "strict liability".

78 International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001 (BUNKER); International Convention on Civil Liability for Oil Pollution Damage, 1969 (CLC).

79 Athens Convention relating to the Carriage of Passengers and their Luggage by Sea 1974 (PAL), as amended by the 2002 Protocol, Article 3(1).

80 Peter Cane et al., (ed.) *The New Oxford Companion to Law* (Oxford University Press, Oxford, 2008) p. 449.

81 Micheal Tsimplis, "The Liability of the Vessels" in Baatz, Yvonne (ed.) *Maritime Law* (4th edn, Informa Law from Routledge, Abingdon, 2018), p. 234. With reference to *Donoghue v Stevenson* [1932] A.C. 562. In regards to the maritime regulatory framework for liability, this thesis will only address the system of fault-based liability.

both due to the lack of a uniform definition concerning acts that constitute fault, and also because causation might be hard to evidence.[82]

As stated above, the rules concerning civil liability for collisions form part of the domestic legislation and as a result creates variations between different jurisdictions. However, due to the broad international adoption by maritime nations of the 1910 Collision Convention, it is possible to ascertain that the Convention creates a foundation for the international law applicable in the context of collision liability.

In Article 3 the Convention ascertains the fault-based principle by stating that "[I]f the collision is caused by the fault of one of the vessels, liability to make good the damages attaches to the one which has committed the fault". Notably, the article creates a personification of the vessel which can mislead the reader to believe that the vessel itself can be at fault. That is however incorrect, and the personification should be regarded as "merely a figurative expression"[83], derived from the concept that ships may be arrested *in rem*[84] under specific circumstances. The article should be understood such as only individuals can be at fault.[85] Furthermore, the notion of proved fault also abolishes any pre-existing "legal presumptions of fault in regard to liability for collision".[86]

Should the collision be accidental, caused by force majeure or if the cause of the collision is left in doubt, each ship will manage their potential losses.[87] Moreover, Article 4 introduced the notion of distributing liability proportionally based on the degree to which each vessel is at fault. The article additionally states that in situations where it is deemed impossible to determine the proportion of fault committed by each vessel, the liability will be divided equally.

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[82] Micheal Tsimplis, "The Liability of the Vessels" in Yvonne Baatz (ed.) *Maritime Law* (4th edn, Informa Law from Routledge, Abingdon, 2018), p. 237.
[83] Simon Gault et al. (ed.) *Marsden and Gault On Collisions at Sea* (14th edn, Sweet & Maxwell, London, 2016) p. 12.
[84] A legal action where the primary object is a status or property.
[85] Simon Gault et al. (ed.) *Marsden and Gault On Collisions at Sea* (14th edn, Sweet & Maxwell, London, 2016) p. 12.
[86] The 1910 Collision Convention, Article 6.
[87] The 1910 Collision Convention, Article 2.

There is no uniform definition or list over acts that are considered to constitute fault. Instead, there are certain guidelines that need to be applied when establishing negligence. The existence of fault in collision cases may be derived from various causes. A notable legal scholar, *Force,*[88] has listed the following four causes: negligence or lack of proper care or skill on the part of the navigators, failure to comply with local navigational customs or usage, unseaworthy condition or malfunction defect, violation of the rules of the road. Furthermore, *Force* asserts that the fault-based test ultimately will seek to determine if a "collision could have been avoided by the exercise of ordinary care, caution, and maritime skill".[89]

Correspondingly, *Tsimplis*[90] argues that it is important to make a distinction between two categories of negligence. Firstly, the type of negligence which is linked to the navigation of the ship and encompasses faults committed by the master, pilot or crew. Secondly, the type that is linked to the management of the ship, e.g. proper maintenance or service on the ship. Negligence in management encompasses faults by the master, crew or shipowning company "in ensuring that the ship is safe to sail and is operated in a safe way".[91] Hence the causation behind an accident might be connected both to the moment just prior to the collision as well as a decision made by the management at the shipowning company's headquarter several months ago. Negligence derived from both these categories will attach to the employer´s overarching responsibility. The employer in this context would normally be the shipowner or a bareboat charterer[92], which will accrue vicarious liability for damage caused by their employees.[93]

Subsequent to the creation of the 1910 Collision Convention several conventions have been developed and implemented concerning guidance and standards for

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[88] Force, Robert: Professor of Maritime Law, Tulane Law School, USA.
[89] Robert Force, "Admiralty and Maritime Law" (2004) Tulane Maritime Law Center, Federal Judicial Center, p. 125.
[90] Tsimplis, Michael: Professor in Law and Ocean Sciences, University of Southampton, England.
[91] Micheal Tsimplis "The Liability of the Vessels" in Baatz, Yvonne (ed.) *Maritime Law* (4th edn, Informa Law from Routledge, Abingdon, 2018), p. 235.
[92] Arrangement of hiring a ship without crew. The people who hire the ship are responsible for manning the ship and appointing the crew.
[93] Micheal Tsimplis "The Liability of the Vessels" in Baatz, Yvonne (ed.) *Maritime Law* (4th edn, Informa Law from Routledge, Abingdon, 2018), pp. 234-235.

correct actions at sea. A selection of rules contained in these conventions will be examined further below since infringements or deviations from these regulations might indicate the presence of fault. With reference to fault in navigation COLREGs provisions will be examined and in connection to fault in management of the ship provisions contained in SOLAS and STCW will be depicted.

4.2.1 Standards in Navigation

The COLREGs determine "the rules of the road" and establishes rules of action in navigation.[94] When examining the regulations, it is important to consider their international character and that their primary purpose is to prevent collision, not to distribute liability after an accident has occurred.[95]

The scope of applicability is stipulated in COLREGs Rule 1(a) and states that the Convention shall apply "...to all vessels[96] upon the high seas and in all waters connected therewith navigable by seagoing vessels". The high seas refer to waters that are not controlled by any state, in contrast to territorial waters.[97] However, as stated in Rule 1, COLREGs is applicable in all waters, both territorial and internal waters, which are connected with the high seas provided they are navigable by seagoing vessels.[98]

Rule 2(a) imposes the duty on the master, owner and crew to act in compliance with the rules encompassed in COLREGs and ascertains the principle of good seamanship. Moreover, in some instances deviation from the rules are excused according to Rule 2(b), therefore, good seamanship also encompasses the notion that deviation from the rules may be excused in order to avoid immediate danger.[99] In *The Saragossa*[100] it was held that such deviation from the rules must be necessary

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[94] Robert Force, "Admiralty and Maritime Law" (2004) Tulane Maritime Law Center, Federal Judicial Center, p. 125.
[95] Simon Gault et al. (ed.) *Marsden and Gault On Collisions at Sea* (14th edn, Sweet & Maxwell, London, 2016), pp. 150-151.
[96] The definition of "vessels" found in Rule 3(a) and it has been considered under Chapter 3 of the thesis.
[97] UNCLOS, Article 3.
[98] Samir Mankabady, *Collision at Sea: A Guide to the Legal Consequences* (North-Holland, Amsterdam, 1978), pp. 81-82.
[99] *The Allan and Flora* (1866) 14 L.T 860; *The Moderation* (1863) 1 Moo. P.C. (N.S) 528.
[100] *The Saragossa* (1892) 7 Asp. M.C 289.

due to the circumstances and that the degree of deviation must not exceed what is necessary.

The responsible actors are expected to comply both with the provisions of COLREGs as well as the overarching duties derived from the concept of good seamanship. Failure to comply may constitute fault, and thus create a foundation on which liability is attributable.[101]

The concept of good seamanship is of fundamental importance and a source from where other standards found in the COLREGs provisions derive from. Despite its importance, there is no coherent definition of the concept. Instead, its content is composed of several considerations and qualities that ultimately serve to establish a certain standard of conduct. In addition, the content of good seamanship will be decided individually in each case, based on the particular circumstances.[102]

National courts have in several judgments sought to elaborate on the concept of good seamanship when it comes to navigators' duty to avoid collisions. In *The Queen Mary* it was stated that:

> The ship must conform to the practice of good seamanship, it lays upon those in charge of her the duty of taking account of all the concrete circumstances of the emergency, and of acting with reference to them in their totality as a skilled seaman of ordinary prudence would act.[103]

Furthermore, it was held by Dr. Lushington in *The Thomas Powell* and *The Cuba* that duties imposed on the seamen should not be understood as a requirement to show extraordinary skills or extraordinary due diligence, but as an expectation that the seamen will act in accordance with the general requirements as to skill and intelligence of an ordinary competent seamen.[104]

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[101] Simon Gault et al. (ed.) *Marsden and Gault On Collisions at Sea* (14th edn, Sweet & Maxwell, London, 2016), p. 167.
[102] Ibid, p. 95.
[103] *The Queen Mary* (1949) 82 Lloyd's Rep. 303.
[104] *The "Thomas Powell"* and *"The Cuba"* [1866] 14 LT 603.

Another important example of good seamanship is the sufficiency of the crew. The benchmark for what constitutes a sufficient crew on board the ship is what is deemed customary for the type of voyage on which the ship is engaged. In *The Murdoch*[105] the vessel was operated single-handedly and since the operator alone could not perform all the tasks required in order to avoid collision the crew was held to be insufficient. Furthermore, in *The Arthur Gordon, The independence*[106] the shipmaster went below deck to eat breakfast and left an inexperienced sailor in charge of the deck. It was held that the collision that followed could have been avoided if the shipmaster were present, thus establishing the principle that "the officer in charge should always be on deck".[107]

The duty to maintain a proper look-out, found in COLREGs Rule 5, is considered to be a crucial obligation since an inadequate look-out has a distinct and contributory connection to many collision incidents. However, it should be noted that if the duty is breached but had no causative effect to the collision, it will not be regarded as a fault contributing to the collision.[108]

According to COLREGs Rule 5: "Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision". The Master has an untransferable duty to make sure that a proper look-out is kept at all times. The person in charge of the look-out is responsible for keeping the officer in charge fully informed of potential dangers. Moreover, the look-out should not leave his station, even for shorter periods.[109] The requirements as to equipment and personnel will ultimately be decided individually in the case at hand, determined by factors such as the weather conditions and the general situation.[110]

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[105] *The Murdoch* [1953] 2 Lloyd's Rep 433 at 440.
[106] *The Arthur Gordon, The Independence* (1861) lush 270.
[107] Simon Gault et al. (ed.) *Marsden and Gault On Collisions at Sea* (14th edn, Sweet & Maxwell, London, 2016), pp. 96-98.
[108] Ibid, pp. 185, 187.
[109] Samir Mankabady, *Collision at Sea: A Guide to the Legal Consequences* (North-Holland, Amsterdam, 1978), p. 106.
[110] Micheal Tsimplis, "The Liability of the Vessels" in Yvonne Baatz (ed.) *Maritime Law* (4th edn, Informa Law from Routledge, Abingdon, 2018), p. 236.

There is no designated place on the ship where the look-out must be placed in order to fulfil the obligation. The look-out must, however, have an unobstructed view, which makes the bridge a usual choice for the look-out to be stationed.[111] Since the requirements depend on the specific circumstances other places on board the ship might be compatible with the imposed obligation, such as the for-end of the ship[112] or at the upper bridge.[113]

The obligation to have a sufficient look-out encompasses more than just visual and aural observance, it also refers to the intelligent interpretation of data collected by the various technological devices[114] being used. For this reason, the person in charge of the look-out must be a competent and adequately experienced seaman.[115] It might, additionally, be necessary to take shore-based assistance, e.g. radar, in order to fully comply with the obligation.[116] In the classic book on collision liability, *Marsden and Gault On Collisions at Sea*, it is argued that “the use of radar is no substitute for a visual and aural look-out, which must also be kept”.[117]

Since the phrase “all available means” is vaguely formulated, it is of importance to examine the minimum requirements regarding equipment, construction and operation of ships, which are found in the SOLAS Convention. Moreover, there are several requirements to ensure safe procedures in watchkeeping in the STCW Convention. A selection of those regulations will, additionally, be reviewed below in order to discuss the content of the phrase "proper look-out".

4.2.2 Standards in Ship Management

The SOLAS Convention imposes upon the Contracting States to ensure that the ships flying under their flags comply with certain minimum standards, in particular

[111] Samir Mankabady, *Collision at Sea: A Guide to the Legal Consequences* (North-Holland, Amsterdam, 1978) pp. 105-106.
[112] *The British Confidence* (1951) 2 Lloyd’s Rep. 615.
[113] *The Dea Mazzella* (1958) 1 Lloyd's Rep. 10 at 21.
[114] There are numerous technological appliances for nautical navigation. Radar, sonar and electronic navigation are a few of the most commonly used.
[115] Samir Mankabady, *Collision at Sea: A Guide to the Legal Consequences* (North-Holland, Amsterdam, 1978) pp. 105-106.
[116] *The Nordic Ferry* [1991] 2 Lloyd’s Rep 591.
[117] Simon Gault et al. (ed.) *Marsden and Gault On Collisions at Sea* (14th edn, Sweet & Maxwell, London, 2016) pp. 184-185.

regarding construction, equipment and operation of the ship. The Convention has been adopted by a majority of maritime nations, it also applies for non-contracting States in accordance with international customary law. The regulations contained in the convention normally apply to all cargo ships over 500 gross registered tons.[118]

Chapters II-1, II-2 and III establish minimum standards as to structure, stability, machinery and electrical installations (II-1) fire protection (II-2) and life-saving appliances (III). A common feature of all the three chapters is that they encompass various degrees of operational requirements, as to communication between the crew and monitoring when the ship is operated.[119]

Concerning the manning of the ship, Chapter V Regulation 14 SOLAS requires that "ships shall be sufficiently and efficiently manned". While there is nothing that expressly states that there must be personnel present on board the ship some commentators argue that there is an underlying "assumption of some minimum manning by crew on board the ship"[120]. Moreover, IMO has stated in a non-binding resolution that the minimum manning level may increase or decrease depending on the extent technology enabling automatisation is implemented in regards to the operation of the ship.[121]

Another noteworthy rule is Regulation 24(1) which concerns navigation in hazardous situations. The Regulation requires that it "...shall be possible to establish manual control of the ship's steering immediately". It is, therefore, possible to conclude that even when the navigation of the ship is controlled through automated

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[118] SOLAS, Regulation 3(a)(2); William Tetley, *Marine cargo claims* (4th edn, Vol 1, Thomson Carswell, Cowansville, 2008), pp. 938-939.

[119] AAWA, "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016), p. 42. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.

[120] CMI: Bernard Eder "Unmanned Vessels: Challenges Ahead" (2018), p. 54. <https://comitemaritime.org/wp-content/uploads/2018/05/Sir-Bernard-Eder-Berlingieri-Lecture-London-Assembly-2018.pdf> accessed 19 February 2019.

[121] IMO: Assembly 27th session (2011) Resolution A.1047 (27) - Principles of Safe Manning. <http://www.imo.org/en/KnowledgeCentre/indexofimoresolutions/documents/a%20-%20assembly/1047(27).pdf> accessed 4 April 2019; See especially Annex 2, paras. 1.1.3. and 1.1.10. of the same document.

systems there is still a requirement of human presence, a person who instantly can intervene and assume control over the ship.[122]

The STCW Convention encompasses the minimum qualification standards for the personnel on board the ship, thus including the masters, officers and watchkeeping personnel. All ships flying under a contracting flag state are covered by the Convention, and might also be imposed on ships flying under the flag of non-contracting countries due to port state control.[123] The Convention consists of three parts: 1) the convention itself, 2) the Annex to the convention, and 3) the STCW Code.[124]

According to Article 3, the Convention applies “to seafarers serving *on board*[125] seagoing ships”. Moreover, Article 9(1) grants national administrations the possibility to retain or adopt other equivalent educational and training arrangements:

> ...especially adopted to technical developments and to special types of ships and trades, provided that the level of seagoing service, knowledge and efficiency as regards navigational and technical handling of ship and cargo ensures a degree of safety at sea and has a preventive effect as regards pollution at least equivalent to the requirements of the Convention.

Therefore, deviation from the imposed standards might be excused under specific circumstances.[126]

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[122] Comité Maritime International, “CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework” (2018), p. 11. <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf> accessed 5 April 2019.
[123] International Transport Workers´ Federation, “STCW A GUIDE FOR SEAFARERS - Taking into account the 2010 Manila amendments”, p. 63. <https://www.mptusa.com/pdf/STCW_guide_english.pdf> accessed 5 April 2019.
[124] The STCW code consists of two annexes. Whereas Annex A imposes mandatory requirements and Annex B consists of non-mandatory instructions.
[125] Emphasis added.
[126] AAWA, “Remote and Autonomous Ships: The Next Steps, Rolls-Royce” plc, Position Paper, London (2016), p. 47. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.

In order to satisfy the requirements concerning watchkeeping several actors, such as the "company, the master, the chief engineer officers and the whole watchkeeping personnel" will be involved.[127] In fulfilling this duty the "officers in charge of the navigational watch … shall be physically present on the navigating bridge or in a directly associated location such as the chartroom or bridge control room at all times".[128]

Chapter VIII of the STCW Code is concerned with standards for watchkeeping. In regards to the watch arrangements, it is held that the bridge must not be left unattended at any time.[129] Furthermore, paragraph 24 states that "the officer in charge of navigational watch shall" "keep the watch on the bridge"[130] and "in no circumstances leave the bridge until properly relieved"[131].[132]

4.3 Conclusion

When examining the presented material above, it is possible to conclude that in order to attribute liability both fault and causative effect to the damage suffered needs to be established. The wrongful act can be both a particular act as well as an omission. Compliance with the examined regulations, as well as the notion of good seamanship, will be used when determining fault. There are two categories of negligence, namely in navigation and in management of the ship, they can be used to attach liability to the Master, shipowner or crew. The shipowner can, additionally, be held vicariously liable for negligence by his employees.

It is, moreover, possible to conclude that the examined regulations to various degrees refer to, or has an underlying assumption of, a human element being present

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[127] STCW Annex, Regulation VIII/2(1).
[128] Ibid, Regulation VIII/2(2)(1). See also AAWA, "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016), p. 48. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.
[129] STCW Code, Annex-A, Part 4, para. 18(1).
[130] Ibid, Part 4, para. 24(1).
[131] Ibid, Part 4, para. 24(2).
[132] Comité Maritime International, "CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework" (2018), p. 16. <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf> accessed 5 April 2019.

when operating the ship. An essential part of good seamanship is to provide a sufficiently manned crew, and in certain situations, the master is required to be present on the bridge. Additionally, COLREGs Rule 2 states the importance of consciousness when making decisions. Especially in situations covered by Rule 2(b), which calls for discretion in the choice to comply with the regulations or to depart from the rules in order to avoid imminent danger. It is therefore debatable whether an unmanned vessel, where no human is present on board the ship, can comply with these regulations.[133]

The duty to maintain a proper look-out stated in COLREGs Rule 5, also influenced by regulations in SOLAS and SCTW, serve the fundamental purpose of gathering and interpreting the information needed to avoid collisions. The traditional notion encompasses a human element, an experienced seaman which is able to process and assess the information that has been collected by visual and aural means, in combination with technological equipment. It is, therefore, crucial to ask whether technology can replace the human element and thus assure compliance with the regulations in the context of unmanned ships. In regards to the SCTW Convention, it is questionable if the regulations could be applied to operators of an unmanned ship since they essentially would be stationed on land.[134] It is even more questionable whether the unmanned ship could comply with the minimum standards for safe manning especially in the context of maintaining a safe look-out and watchkeeping.

In conclusion, uncertainty regarding applicability and compliance of the revised regulations in the context of unmanned shipping might contribute to difficulties in asserting liability under the fault-liability regime. The following Chapter will provide an overview of the product liability regime in order to discuss its relevance in relation to unmanned shipping.

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[133] Robert Veal and Michael Tsimplis "The integration of unmanned ships into the lex maritima" (2017) Lloyd's Maritime & Commercial Law Quarterly 303, p. 325.

[134] See Chapter 4.2.2. of the thesis regarding the applicability of the STCW Convention and Article 3.

5. Product Liability

Within the EU Member States, the regulations governing maritime concerns have traditionally been the instrument of choice for determining liability. The rules concerning product liability have gained little traction within this field, although, several countries impose safety standards which the ship manufacturers should comply with. This chapter provides a foundation for the discussion regarding how the product liability regime could come to influence the traditional maritime liability rules, when shipping will have to rely more heavily on the proper functioning of technology.

5.1 Historical Background

The term "product liability" can be described as "liability of any or all parties along the chain of manufacture of any product for damage caused by that product".[135] The liability imposed is generally strict but could in some instances also be based on negligence or breach of warranty of fitness.[136]

Professor *Reimann*[137] argues that the origin of the European modern law of product liability can be traced back to the United States jurisprudence. In the case *Greenman v. Yuba Power Products*[138] it was established that "the manufacturer of a defective product would be strictly liable in tort to the ultimate consumer".[139] The limitation in action, derived from the notion of privity of contract, had been set aside by prior judgments. This meant that the injured party, as the ultimate purchaser of a product, could sue the manufacturer for negligence directly.[140] The injured party gradually gained a stronger position both due to relief in the requirements concerning the

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135 Cornell Law School - Legal Information Institute "Products liability" <https://www.law.cornell.edu/wex/products_liability> accessed 8 April 2019.

136 Robert Force, "Maritime Products Liability in the United States." (1986) 11(1) Maritime Lawyer 1, p. 4.

137 Reimann, Mathias W: Professor at University of Michigan Law School, USA.

138 *Greenman v. Yuba Power Products, Inc*., 59 Cal. 2d 57, No. 26976 (L. A. 1963).

139 Mathias Reimann, "Product Liability in a Global Context: the Hollow Victory of the European Model" (2003) 11(2) European Review of Private Law 128, p. 130.

140 Ibid. With reference to *MacPherson v. Buick Motor Co*., 111 N.E. 1050, 217 N.Y. 382 (N.Y. 1916).

burden of proving fault, but also due to the fact that they later were able to hold the manufacturer strictly liable despite lack of a contractual relationship.[141]

From an international perspective, there is a similarity between the regimes governing collision liability and the regulation of product liability, in so far that both regimes form part of national legislation, and thus varies from jurisdiction to jurisdiction. For Member States of the European Union, however, a level of harmonisation has been achieved through mandatory national implementation and enforcement of the Product Liability Directive[142] and the legal practices derived therefrom.[143] The European model on product liability has, moreover, had great influence on a legislative level internationally.[144] While several other parts of the EU legislation seek to prevent damages from coming into existence, the Directive should be understood as a measure to compensate the injured party after the damage already has been inflicted.[145]

5.2 The EU Product Liability Directive

The Directive imposes strict liability for producers in regards to damages caused by malfunction of their products.[146] The injured person must according to Article 4 prove 1) the damaged suffered, 2) defectiveness of the product 3) and causative effect between them. Notably, the injured party is relieved from having to prove the producers' fault, hence the liability is strict. In this context, the strict liability has the effect that the injured party does not have to prove "a contractual link, a duty of care or failure to take reasonable care to comply with relevant legislation".[147]

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[141] Mathias Reimann, "Product Liability in a Global Context: the Hollow Victory of the European Model" (2003) 11(2) European Review of Private Law 128, pp. 130-131. See also *Henningsen v. Bloomfield Motors, Inc.*, 161 A 2d 69, 32 NJ 358 (N.J. 1960).
[142] The Product Liability Directive 85/374/EEC.
[143] Danish Maritime Authority, "Analysis of regulatory barriers to the use of autonomous ships" Final Report (2017), p. 87. <https://www.dma.dk/Documents/Publikationer/Analysis%20of%20Regulatory%20Barriers%20to%20the%20Use%20of%20Autonomous%20Ships.pdf> accessed 27 February 2019.
[144] Mathias Reimann, "Product Liability in a Global Context: the Hollow Victory of the European Model" (2003) 11(2) European Review of Private Law 128, pp. 129, 132-133.
[145] European Commission, "Evaluation of the Directive 85/374/EEC concerning liability for defective products", p. 2. <http://ec.europa.eu/smart-regulation/roadmaps/docs/2016_grow_027_evaluation_defective_products_en.pdf> accessed 3 May 2019.
[146] The Product Liability Directive 85/374/EEC, Article 1.
[147] European Commission, "Evaluation of the Directive 85/374/EEC concerning liability for defective products", p. 2. <http://ec.europa.eu/smart-

5.2.1 The Products Covered

Article 2 provides a definition of product as "...all movables, with the exception of primary agricultural products and game…", it also includes electricity. Even if the movables are incorporated into another movable or immovable it will still be considered as a product covered by the Directive. The product must, moreover, have been put into circulation.[148] Services are excluded by this definition and it is not permissible to incorrectly label a product as a service in order to avoid application of the Directive. As was stated by the Court of Justice of the European Union (CJEU) in the case *Veedfald v Århus Amtskommune,* the use of a defective product in the course of providing a service, which is causative of the damage, will fall within the scope of the Directive.[149]

Commentators have discussed whether software, such as non-embedded data, can be classified as a product for the purpose of the Directive. One of the questions that has been asked is if there is an underlying requirement that the movable must also be tangible. References could be made to how the Directive expressly includes electricity, which is not a tangible good. Therefore, some commentators argue that software, which is composed of intangible data, also must fall within the scope of the Directive.[150] Others draw the opposite conclusion and argue that the inclusion of electricity evidences the sole exception as to the supposed requirement of tangibility, thus excluding e.g. software that is downloaded from the internet.[151]

If, however, the software is incorporated or embedded into a physical product such as a data carrier there is broader agreement that it is covered by the Directive.[152]

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regulation/roadmaps/docs/2016_grow_027_evaluation_defective_products_en.pdf> accessed 3 May 2019.

[148] The Product Liability Directive 85/374/EEC, Article 7.

[149] Case C-203/99 *Veedfald v Århus Amtskommune* [2001] ECLI:EU:C:2001:258, paras. 11, 12.

[150] The European Consumer Organisation, "Review of Product Liability Rules - BEUC Position Paper" (2017), p. 3. <https://www.beuc.eu/publications/beuc-x-2017-039_csc_review_of_product_liability_rules.pdf> accessed 4 April 2019.

[151] K. Alheit, "The Applicability of the EU Product Liability Directive to Software" (2001) 34(2) The Comparative and International Law Journal of Southern Africa 188, pp. 199-200.

[152] Ibid, pp. 202-203; European Commission: Commission Staff Working Document, "Liability for emerging digital technologies", SWD (2018) 137 final, pp. 9-10. <https://ec.europa.eu/digital-single-market/en/news/european-commission-staff-working-document-liability-emerging-digital-technologies> accessed 10 April 2019.

Furthermore, *Deaconu-Dascalu*[153] holds that since defective software, e.g. "surgical assistance software, navigational software", may cause injuries and damage it should for the purpose of the Directive be regarded as a product.[154] Furthermore, *Fairgrieve*[155] elaborates on this notion by stating that in relation to the operation of an airplane the software "must be treated as a product within the meaning of the Directive, given its inextricable link with the product itself".[156]

Notably, there is also uncertainty whether the embedded software itself should be regarded as a product when incorporated into a tangible device. That discussion will be of particular importance when the software developer and the producer of the tangible device are two different actors. However, that question falls outside the scope of this thesis and will not be elaborated upon.

5.2.2 Liable Party and Bases for Liability

Liability is imposed on the producer, which is defined in Article 3 and refers to the "the manufacturer, the person putting his name or trademark on the product, the importer and, when the producer cannot be identified, each supplier of the product under some conditions"[157]. This means that strict liability can be imposed on all distributors and retailers of a malfunctioning product which causes damage, regardless of their country of origin. If multiple parties are liable, they will be held joint and severally liable for the damage.[158]

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[153] Diana-Nicoleta Deaconu-Dascalu: Director of Maioresciana Scientia Research Center at the Faculty of Law and Economic Sciences, Titu Maiorescu University, Romania.

[154] Diana Nicoleta Deaconu-Dascalu "Civil Liability for Damages Caused by a Defective Product." (2017) The International Conference Education and Creativity for a Knowledge–based Society 68, p. 69.

[155] Duncan Fairgrieve: Professor at Université de Paris Dauphine, France and Senior Research Fellow at British Institute Of International & Comparative Law.

[156] Duncan Fairgrieve et al., "Product Liability Directive" in Piotr Machnikowski (ed.), *European Product Liability: An Analysis of the State of the Art in the Era of New Technologies* (Intersentia, Cambridge, 2016) p. 47.

[157] European Commission, "Evaluation of the Directive 85/374/EEC concerning liability for defective products", p. 3. <http://ec.europa.eu/smart-regulation/roadmaps/docs/2016_grow_027_evaluation_defective_products_en.pdf> accessed 3 May 2019.

[158] The Product Liability Directive 85/374/EEC, Article 5.

The product is defective when "it does not provide the safety which a person is entitled to expect, taking all circumstances into account".[159] This evaluation which is commonly referred to as the "consumer expectation test" seeks to objectively determine a normal person´s legitimate expectations on product safety.[160] The test is "objective" in the sense that it refers to the general public's expectations, not the subjective expectations of the person who has suffered the damage. The general public should normally be entitled to expect that the product complies with existing product safety legislation, whereas, deviation from such rules would strongly imply that the product is defective. It is, however, important to recognise that such regulations on safety often merely impose minimum standards which the producers without difficulty can exceed. Compliance with the minimum standards should therefore not be conceived as "to exclude the exposure of manufacturers to civil liability"[161].

While the liability according to the Directive is strict, it is not absolute. Several defences to which the producer can resort in order to avoid liability are presented in Article 7. In the context of evolving technology, the "state-of-the-art-defence" also called "development-risk-defence", found in Article 7(e) plays a significant role. It states that the producer will not be held liable if "the state of scientific and technical knowledge at the time when he put the product into circulation was not such as to enable the existence of the defect to be discovered". The EU Member States have been allowed to exempt this defence when implementing the Directive in the national legislation.[162] If the Member State exempts the defence it would allow recovery from the producer if the injured party "can demonstrate that subsequent developments in scientific knowledge prove that the product had a defect when it was originally placed on the market".[163] Such an exemption has, however, been heavily debated since some commentators argue that it would contravene the notion of legitimate expectation on product safety at the time it was marketed, the test used for determining if the product is defective according to

[159] Ibid, Article 6.
[160] Daily Wuyts, "The Product Liability Directive More Than Two Decades of Defective Products in Europe" (2014) 5 Journal of European Tort Law 1, p. 8.
[161] Ibid, p. 19.
[162] The Product Liability Directive 85/374/EEC, Article 15(1)(b).
[163] K. Alheit, "The Applicability of the EU Product Liability Directive to Software" (2001) 34(2) The Comparative and International Law Journal of Southern Africa 188, pp. 198-199.

Article 6.[164] While a few Member States have chosen to exclude the defence partially or in whole, professor *Wuyts*[165] states that it "remains prima facie an important defence for the manufacturers of innovating products".[166]

5.3 Conclusion

It is clear that a ship constitutes a "movable" and thus falls within the Directive definition of a product in Article 2. When the ship is put into circulation by the producer, which could be the shipyard, it will be covered by the Directive. Notably, a ship is composed of numerous individual components, those products will remain within the scope of the Directive after they are incorporated in the ship.

The software used in unmanned shipping will play a crucial role. It is the instrument which provides the remote-controller with information and situational awareness through sensors and technological aural equivalents. This is especially true in case of autonomous control where the software "itself" will be navigating the ship, using certain algorithms. If the software is defective it could render the whole ship defective. Should the software be delivered embedded into a physical product, e.g. collision avoidance module or an auto-pilot system, it will be considered as a product under the Directive. It is, however, unclear whether the software, in the form of intangible data, should be classified as a product under the Directive. In addition, the Directive provides a clear list over the liable persons in Article 3, but it should be emphasised that developers of digital content and software who has exercised influence over the safety of the product are also covered by the Directive.

It could, moreover, become difficult to determine the defectiveness of a product in the context of unmanned shipping. Since the producers' compliance with product safety legislation plays a central role when applying the "consumer expectation test", it will be of utmost importance that "adequate safety levels for all types of

[164] Ibid, p. 199.
[165] Daily Wuyts: Professor in Law, University of Antwerp, Belgium.
[166] Daily Wuyts, "The Product Liability Directive More Than Two Decades of Defective Products in Europe" (2014) 5 Journal of European Tort Law 1, p. 30.

products”[167] are implemented. Notably, as was concluded in Chapter 4.3 of the thesis, it is uncertain whether the unmanned ship could comply with the examined minimum standards imposed by SOLAS and STCW due to the lack of human presence on board the ship. Similarly, from a product liability perspective, this also raises the issue of whether the embedded software used for the unmanned ship could meet the safety requirements. Even if it would be possible to ascertain the software’s compliance with the safety standards they are, however, often merely “minimum standards” and cannot exonerate the producer from civil liability.

Additionally, the state-of-the-art-defence could have a hindering effect on the process of establishing the producers´ liability, due to the advanced technology used in unmanned shipping. It is clear that the technology which enables unmanned ships is still under development and will continue to evolve as knowledge and scientific research progresses. The defectiveness of a product will ultimately be decided by the courts case-by-case, based on all the relevant circumstances at hand. Nevertheless, when it comes to determining liability for damage caused by autonomous systems and non-embedded software there is uncertainty regarding how the Directive should be utilised.

[167] European Commission: Commission Staff Working Document, “Liability for emerging digital technologies”, SWD (2018) 137 final, p. 18. <https://ec.europa.eu/digital-single-market/en/news/european-commission-staff-working-document-liability-emerging-digital-technologies> accessed 10 April 2019.

6. Liability and Unmanned Ships

As has been described above in the thesis in Chapter 2.2.1, the term "unmanned ship" can be divided into two categories, either remote-control or autonomous.[168] While both categories have in common that there are no personnel physically present on board the ship, there are significant differences when it comes to how they are operated. What characterises the separation of categories is whether the control of the ship is placed on a remote-control operator, or at the autonomous systems. For the remote-controlled ship, there will be a crew present in the SCC, which will control every aspect of the operation and make navigational decisions similar to traditional shipping, whereas the autonomous ship instead will be operated by intelligent systems on board the ship. The autonomous operation of the ship will most likely be supervised by humans, while the overall decision-making will be placed at the intelligent systems. Both categories will rely heavily on the technology enabling the notion of unmanned shipping, especially when the power to make decisions is placed on the autonomous system, which will be discussed further below.

The fault-based liability regime will generally be used for distributing liability on the relevant actors. It has been concluded in Chapter 4.3 of the thesis that regulations traditionally used for determining negligence, and thereby fault, might not be compatible with the notion of the unmanned ship. The application of the conventions, stating the rules of the road, imposing minimum standards in navigation and management of the ship, in the context of unmanned shipping will, therefore, be examined further.

6.1 The Human Element and Compliance with Regulations

The unmanned ship faces great challenges when it comes to comply with the maritime regulations. In regards to COLREGs, Rule 2 has been examined, where the importance of consciousness when making decision and acting in accordance with the principle of good seamanship was emphasised. In the context of a remote-

[168] See the degrees of autonomy provided by the IMO in Chapter 2.2.2 of the thesis, degree 3 and 4.

controlled ship this could arguably be achieved by transferring the traditional duties of the ship master to the shore-based remote-control operator, who would then in a sufficient manner be able to take charge over the operational decision when navigating and manoeuvring the ship. However, the complete lack of human presence in control of the ship when operating in autonomous mode may pose significant challenges, since the decision-making would be fully automated. It has, however, been argued that advanced collision avoidance algorithms could meet these requirements imposed by COLREGs within a near future.[169]

In the recent industry-academia[170] research project Machine Executable Collision regulations for Marine Autonomous Systems (MAXCMAS)[171], the projects partners were bought together with the ambition to create a navigational system which can assure the autonomous operations compliance with COLREGS. The navigational rules that originally were developed for human consumption were depicted and encoded into intelligent MAXCMAS algorithms. These algorithms were thereafter tested comprehensively by means of a simulator as well as practical tests with an unmanned vessel. It was argued that these simulations by means of testing how the developed system responded to "multiple potential collision scenarios"[172] could validate the algorithms safety and compliance with the navigational rules. It was the aspiration of the project that these simulations could ascertain COLREGs relevance and applicability on autonomous ships.

The result has been described as a success by the parties involved in the project. The Rolls-Royce representative and project leader, Eshan Rajabally, stated that

[169] AAWA, "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016), p. 46. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.; Comité Maritime International "CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework" (2018), p. 14. <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf> accessed 5 April 2019.

[170] Industrial partners: Rolls Royce, Atlas Elektronik UK and Lloyd's Register. Academic partners: Queen's University Belfast and Warsash Maritime Academy.

[171] For general information about the project see: Warsash Maritime Academy, "Project MAXCMAS" <https://www.warsashacademy.co.uk/about/our-expertise/maritime-research-centre/project-maxcmas/home.aspx> accessed 16 April 2019.

[172] Jesus M. Varas et al., "MAXCMAS Project-Autonomous COLREGs Compliant Ship Navigation" in Volker Bertram (ed.), *16th International Conference on Computer and IT Applications in the Maritime Industries* (Technische Universität Hamburg, Harburg, 2017) p. 454.

“[T]hrough MAXCMAS, we have demonstrated autonomous collision avoidance that is indistinguishable from good seafarer behaviour…”. Additionally, Ralph Dodds from Atlas Elektronik UK affirmed that “[T]he trials showed that an unmanned vessel is capable of making a collision avoidance judgement call even when the give-way vessel isn’t taking appropriate action,” and “[W]hat MAXCMAS does is make the collision avoidance regulations applicable to the unmanned ship”.[173]

While these conclusions were drawn by some of the industrial partners involved in the project, which should be considered when evaluating their claims, projects like these will help to clarify the legal uncertainty regarding autonomous shipping. It was, moreover, argued and emphasised in the AAWA Initiative that while it might be possible to assure the algorithms compliance with COLREGs steering and sailing rules it might be immensely difficult to codify the overarching principle of good seamanship.[174] In addition, it was also taken into account that “the content of good seamanship will be decided individually in each case, based on the particular circumstances”.[175]

Furthermore, Rule 5 of COLREGs imposes the duty to maintain a proper look-out, and it has been heavily debated whether the unmanned ship by technological means could comply with the objective of the rule. It is possible to derive to basic question from this discussion. Firstly, whether the unmanned ship could achieve sufficient situational awareness. Secondly, whether there is a requirement that the obligation requires the person in charge of the look-out to be stationed on board the ship.

When examining the first question it has been argued that the rules objective together with the vagueness in some of the terms used, such as all *available means* and *proper* could allow for the interpretation that technology could replace the

[173] Rolls-Royce, “MAXCMAS success suggests COLREGs remain relevant for autonomous ships” <https://www.rolls-royce.com/media/press-releases/2018/21-03-2018-maxcmas-success-suggests-colregs-remain-relevant-for-autonomous-ships.aspx> accessed 16 April 2019.
[174] AAWA, “Remote and Autonomous Ships: The Next Steps, Rolls-Royce” plc, Position Paper, London (2016), pp. 46-47. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.
[175] See Chapter 4.2.1 of this thesis, with reference to Simon Gault et al. (ed.) *Marsden and Gault On Collisions at Sea* (14th edn, Sweet & Maxwell, London, 2016), p. 95.

human senses, given that the required situational awareness can be achieved.[176] The legal scholar, *Veal*,[177] argues that the words *sight and hearing* contained in the rule clearly makes a reference to the human element, which the autonomous ship cannot comply with.[178] This position is reaffirmed in the CMI position paper, where it is stated that "algorithmic collision avoidance technology would not satisfy the requirement of appraisal by sight and hearing".[179] However, in the context of a remote-controlled ship the legal scholars are more inclined to hold it possible that a remote-operator by means of advanced aural and camera sensors fulfil the requirement as to human decision-making and interpretation of the collected data.[180]

In regards to the second question, it has been stated above that the rule itself does not contain any requirements as to where the person in charge of look-out must be stationed. Furthermore, resorting to legal authorities concerning the rule case law has been examined.[181] It is, however, difficult to draw any substantial conclusions from these cases. Understandably, the technology enabling unmanned shipping was not contemplated or considered at the time the decisions were established. However, *Veal* presents two arguments in support of the view that the jurisprudence, to a limited extent, evidence that alternative look-out arrangements could comply with the rule. Firstly, he makes a reference to *The Nordic Ferry*[182] where it was held to be in compliance with Rule 5 to complement the lookout, kept on board the ship, with shore-based support. Secondly, he declares that

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[176] AAWA, "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016), p. 46. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.

[177] Robert Veal: Lecturer in Law at the University of Southampton, representative for CMI´s Working Group on Unmanned Ships.

[178] Robert Veal and Michael Tsimplis, "The integration of unmanned ships into the lex maritima" (2017) Lloyd's Maritime & Commercial Law Quarterly 303, pp. 326-327.

[179] Comité Maritime International, "CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework" (2018), p. 14. <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf> accessed 5 April 2019.

[180] Ibid, p. 14; Robert Veal and Michael Tsimplis, "The integration of unmanned ships into the lex maritima" (2017) Lloyd's Maritime & Commercial Law Quarterly 303, pp. 326, 327.

[181] See Chapter 4.2.1. of the thesis.

[182] *The Nordic Ferry* [1991] 2 Lloyd's Rep 591.

technological advances for long have had a close connection to the development of the standards for proper look-out.[183]

Furthermore, minimum standards in regards to watchkeeping arrangements, contained in Chapter VIII of the STCW Code have also been examined.[184] It is clear from the explicit wording in the Convention that it is only applicable to seafarers serving on board seagoing ships, thus excluding unmanned operations from its scope.[185] Although, commentators have argued that it might still be of relevance to examine the provisions. Given the objective of the Convention "to promote safety of life and property at sea and the protection of the marine environment" they express the view that the Convention might be amended to encompass unmanned ship, or act as an blueprint or model when developing similar regulations specifically designed for unmanned ship.[186]

From the examined paragraphs it is clear that the unmanned ship will have significant difficulties complying with the existing watchkeeping standards, since they expressly state that "the officer in charge of navigational watch shall" "keep the watch on the bridge" and "in no circumstances leave the bridge until properly relieved".[187] This conclusion is reaffirmed in the CMI position paper which state that "[T]o the extent that the STCW Convention finds application, these provisions presents difficulty for unmanned ships".[188]

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183 Robert Veal and Michael Tsimplis "The integration of unmanned ships into the lex maritima" (2017) Lloyd's Maritime & Commercial Law Quarterly 303, pp. 327-328.

184 See Chapter 4.2.2. of the thesis.

185 The STCW Convention, Article 3.

186 Aristotelis Komianos, "The Autonomous Shipping Era. Operational, Regulatory, and Quality Challenges" (2018) 12(2) TRANSNAV - International Journal On Marine Navigation And Safety of Sea Transportation 335, p. 341; Comité Maritime International, "CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework" (2018), p. 16. <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf> accessed 5 April 2019.

187 See Chapter 4.2.2. of the thesis.

188 For quote see, Comité Maritime International "CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework" (2018), p. 14. <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf> accessed 5 April 2019. See also, Robert Veal and Michael Tsimplis "The integration of unmanned ships into the lex maritima" (2017) Lloyd's Maritime & Commercial Law Quarterly 303, p. 328.

Lastly, the unmanned ship is not excluded from the scope of the SOLAS Convention. Even though it has been deemed feasible that the unmanned ship could comply with the requirements regarding construction of the ship, concerns has been raised in regards to Chapter V of the Convention and the requirements in navigation.[189] Regulation 14 requires that "ships shall be sufficiently and efficiently manned". While there are no requirements in SOLAS explicitly stating that there must be any crew on board the ship, Regulation 14 could be interpreted in a way to implicitly prohibit the ship to be completely unmanned. However, the requirements as to "safe manning" of the ship will be determined individually and the IMO Guidelines for determination of minimum safe manning provides guidance in the context of unmanned shipping.[190] The Guidelines states that the required manning levels may decrees based on the "level of ship automation"[191] as well "degree of shoreside support"[192]. This support the view that the unmanned ship could comply with Regulation 14. Given that the "efficiency" requirement is fulfilled by the advanced technology used and the ship is sufficiently manned because there will be personnel on-shore operating the ship either remote-controlled, or personnel monitoring the vessel from an on-shore location.[193]

6.2 Maritime Product Liability

It has been concluded that product liability rules may be applicable in shipping accidents.[194] However, due to the lack of jurisprudence referring to the product liability regime, it is also possible to ascertain that the rules for product liability seldom are utilised in this context.

According to modern maritime law, liability is usually attributed to the shipowner or the operator of the ship. This is either because of the overarching vicarious

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189 Ibid, p. 315.
190 Ibid, pp. 319-320.
191 IMO: Assembly 27th session (2011) Resolution A.1047 (27) - Principles of Safe Manning, Annex II, para. 1.1.3.
<http://www.imo.org/en/KnowledgeCentre/indexofimoresolutions/documents/a%20-%20assembly/1047(27).pdf> accessed 4 April 2019.
192 Ibid, Annex II, para. 1.1.10
193 The requirement in SOLAS Chapter V Regulation 24(1) would thus also be fulfilled since the shore-based personnel would be able to establish manual control immediately in hazardous situations.
194 See Chapter 5.3. of the thesis.

liability for damage caused in service of the ship by his employees, or because of the content of a specific regulation[195]. In situations where a defect in the ship is causative to the incident it might prove difficult to attribute the liability between the shipowner, shipbuilder and manufacturer of individual components.[196] Commentators have argued that, considering that the unmanned ship will have no crew on board the ship, the importance and reliance on the technology used might promote the role of product liability.[197]

In the AWWA-initiative, errors committed by a remote-controlled operator could be evaluated in a similar way as faults committed by operators on board the ship. However, the traditional fault-based liability might be difficult to apply in situations where the autonomous system in charge of decision-making malfunctions. Reference is made to situations where human intervention is limited due to faulty programming or defective software, whereby it is deemed questionable that the owner or operator of the ship should accrue liability under the fault-based liability regime.[198] It is, furthermore, stated that "[T]his would mean a shift towards product liability in the maritime context to fill a perceived 'liability gap' in maritime law".[199] This notion is reaffirmed in the CMI position paper, where it is recognised that the great reliance on technology when operating the unmanned ship could indicate a shift of responsibility from human to machine. Thus, to a greater extent exposing the shipowner, shipbuilder and software manufacturer for liability.[200]

It is, moreover, possible to look at how product liability is implemented in regards to autonomous technology in other sectors than shipping. In the European

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[195] E.g. The 1910 Collision Convention, Article 3.
[196] Comité Maritime International, "CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework" (2018), p. 18. <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf> accessed 5 April 2019.
[197] AAWA, "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London (2016), pp. 50-51. <https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf> accessed 22 April 2019.
[198] Ibid, p. 52.
[199] Ibid.
[200] Comité Maritime International, "CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework" (2018), p. 19. <https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf> accessed 5 April 2019.

Commission Staff Working Document on liability for emerging digital technologies, case-studies show that both in relation to autonomous drones and autonomous cars, an injured party may base his claim on the Product Liability Directive and direct his claim towards the manufacturer. For the claim to be successful the claimant must prove that the product was defective and a causal linkage to the damage suffered. In regards to autonomous drones it is recognised that it might be difficult for the injured party to establish the defect of the product, since there are numerous circumstances which might have contributed to the accident, e.g. defective device or weather conditions.[201]

The Product Liability Directive has, furthermore, been evaluated in order to determine whether it is capable of handling emerging technologies, such as autonomous systems. While the result of this evaluation indicates that the Directive serves its purpose in ensuring its initial objectives[202], it is held that "[T]he relevance of the Product Liability Directive in light of new technological developments is more uncertain".[203] The report shows that emerging technologies might provide challenges when applying the Directive, especially in regards to the definitions of "product, damage, defect"[204] contained in the Directive. It is argued that the uncertainty of what constitutes a defective product, when examining advanced technology such as autonomous system, may become "overly burdensome"[205] for the claimant, imposed with the burden of proving the causal link between the damage and defective product. It is additionally recognised that problems could arise when trying to distinguish a "product" from a "service", due to the complexity of the products which is significant for emerging technologies.[206]

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[201] European Commission: Commission Staff Working Document, "Liability for emerging digital technologies", SWD (2018) 137 final, pp. 12, 14. <https://ec.europa.eu/digital-single-market/en/news/european-commission-staff-working-document-liability-emerging-digital-technologies> accessed 10 April 2019.
[202] Essentially to protect consumer safety.
[203] European Commission: "Evaluation of Council Directive 85/374/EEC on the approximation of laws, regulations and administrative provisions of the Member States concerning liability for defective products - Final report" (2018), p. 96. <https://publications.europa.eu/en/publication-detail/-/publication/d4e3e1f5-526c-11e8-be1d-01aa75ed71a1> accessed 3 May 2019.
[204] Ibid.
[205] Ibid, p. 29.
[206] Ibid, pp. 28-29.

The evaluation also examines the “state-of-the-art-defense” contained in Article 7(e). While it is recognised that several stakeholders view this defense for the manufacturer as problematic in regards to establishing the manufacturers liability for defective products, the evaluation quotes *Machnikowski*[207] who argues that a “broad application of this exception may significantly restrict the practical significance of the rules in question, in particular with regard to AI and robots which are out of the control of the producer and are self-learning systems”. The Commission, however, draws the conclusion that “there is no clear evidence that exceptions represent an obstacle to consumer protection”.[208] In conclusion, the evaluation states that the uncertainty regarding how the Directive should be applied on emerging technologies must be resolved, either by revision of the identified provisions which might cause difficulties, or by means of interpretation only.[209]

[207] Piotr Machnikowski: Professor and Head of the Department of Civil and Private International Law, University of Wroclaw, Poland.

[208] European Commission: “Evaluation of Council Directive 85/374/EEC on the approximation of laws, regulations and administrative provisions of the Member States concerning liability for defective products - Final report” (2018), p. 30. <https://publications.europa.eu/en/publication-detail/-/publication/d4e3e1f5-526c-11e8-be1d-01aa75ed71a1> accessed 3 May 2019.
See also K. Alheit, "The Applicability of the EU Product Liability Directive to Software" (2001) 34(2) The Comparative and International Law Journal of Southern Africa 188, p. 204.

[209] European Commission: “Evaluation of Council Directive 85/374/EEC on the approximation of laws, regulations and administrative provisions of the Member States concerning liability for defective products - Final report” (2018), p. 97 <https://publications.europa.eu/en/publication-detail/-/publication/d4e3e1f5-526c-11e8-be1d-01aa75ed71a1> accessed 3 May 2019.

7. Conclusions

The implementation of unmanned ships in the civil commercial sector should be considered as a potential game changer. It has been established that numerous advantages could emanate from removing the human element on board the ships, where one of the major incentives are the possibility to reduce the accidents derived from erroneous human behaviour.

The method for controlling the ship will be of utmost importance in regards to whether the unmanned ship can comply with the existing maritime regulatory framework. While it can be argued that certain parts of the examined regulations are flexible enough to allow the remote-controlled ship to satisfy the requirements regarding human sentience and supervision, placing the control on a fully autonomous system will most certainly result in noncompliance.

With reference to the second research question[210], it is possible to conclude that there are uncertainties as to what extent the regulatory framework concerning collisions at sea is compatible with the notion of unmanned ships. The lack of human presence on board the ship constitutes one of the main hurdles to overcome. While research is progressing, both in regards to creating algorithms that may assure the equivalent standard of safety as manned ships and in the legal field, further research is needed in order to bridge the legal gaps that exist today.

It is the author's opinion that the most favourable approach to manage these legal gaps is by conducting further review of the legal framework, followed by amendments of the existing regulations or development of new rules by a supranational body. Through entrusting an international organization, preferably the IMO, with the assignment to develop standards and regulations for unmanned shipping, it is feasible that international harmonisation can be achieved. The findings from the ongoing regulatory scoping exercise, conducted by the IMO, will hopefully offer well-needed guidance on the next steps towards a uniform set of rules governing unmanned shipping.

[210] Presented in Chapter 1.2. of the thesis.

With reference to the third research question, it is possible to conclude that the new way of utilising technologies in the context of unmanned shipping most likely will expose the shipbuilder, software-developer and the manufacturer of individual components to a wider range of liability. This is particularly true in situations where the autonomous system is in control of the ship. While several commentators argue that this liability should be distributed by means of the Product Liability Directive, several hurdles stand in the way for applying the rules examined onto unmanned ships. There is, as were concluded in the Evaluation, a need for clarification regarding the application if the rules on new technologies. Without this clarification, it is not possible to conclude whether the product liability rules could fill the legal gaps identified in the context of unmanned shipping.

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