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The Dawn of Unmanned and Autonomous Vessels and the Legal Consequences of a M.A.S.S. Collision

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ABSTRACT

Technology is developing at a rapid pace and the world is now faced with the introduction of unmanned and autonomous vessels. This dissertation analyses the attribution of legal liability for collision damage caused by such vessels where there was a defect or malfunction with its onboard software. Since there is no longer a crew and master on board, the question that arises is whether liability can be partly attributed to the manufacturer and partly to the shore-based control operator or, where there is no fault, whether the shipowner of the unmanned vessel can be held solely liable.

This dissertation provides a detailed discussion of the current liability framework applicable to the conventional vessels of today (under both international maritime laws and South African national laws). It then presents a detailed analysis on the issue of collision liability for the unmanned and autonomous vessel. This includes an examination of the various permutations of liability (fault-based liability for personal negligence, vicarious liability and liability for the actions of independent contractors, as well as strict and product liability), as well as an analysis of where the current liability framework would apply to these new forms of vessels and where it will need to be clarified or amended in order to regulate safety at sea sufficiently.

This dissertation finds that the introduction of these vessels will bring a change to the maritime legal framework as we know it today. For the most part, the shipowner's identity and role will remain the same, as a shipowner can be held liable regardless of how his/her vessel is operated. It is in relation to the master's role in the maritime industry that we can expect colossal changes, with new emerging entities such as the shore-based control operator and voyage programmer. Furthermore, the various collision and safety rules and regulations (both internationally and nationally) will need to be clarified and/or amended.

The findings of this analysis are discussed in relation to the work already completed by the prominent international organisations and associations in the maritime industry (such as the IMO, CMI and BIMCO). It is recommended that the South African legislature consider bringing the South African national maritime and admiralty laws in line with international best practices.

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LIST OF ABBREVIATIONS

AA	Aviation Act, 74 of 1962 (South Africa)
AAWA	Advanced Autonomous Waterborne Applications Initiative
ADA	Apportionment of Damages Act, 34 of 1956 (South Africa)
AJRA	Admiralty Jurisdiction Regulation Act, 105 of 1983 (South Africa)
BIMCO	Baltic and International Maritime Council
CDSR	Merchant Shipping (Collision and Distress Signals) Regulations, 2005 (South Africa)
CMI	Comité Maritime International
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea, 1972
CPA	Consumer Protection Act, 68 of 2006 (South Africa)
FAL	Convention on Facilitation of International Maritime Traffic, 1965
Hague Rules	International Convention for the Unification of Certain Rules of Law relating to Bills of Lading, and Protocol of Signature, 1924
Hague-Visby Rules	Hague Rules as amended by the Brussels Protocol, 1968
Hamburg Rules	United Nations Convention on the Carriage of Goods by Sea, 1978
HNS Convention	International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, 1996
IMO	International Maritime Organisation
ISM Code	International Safety Management Code, 1994
ISPS Code	International Ship and Port Facility Security Code
IWG	International Working Group
LLMC	Convention on Limitation of Liability for Maritime Claims, 1976
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973
MASS	Maritime Autonomous Surface Ships

MLA	Maritime Law Association of South Africa
MSA	Merchant Shipping Act, 57 of 1951 (South Africa)
MSC	Maritime Safety Committee
MUNIN	Maritime Unmanned Navigation through Intelligence in Networks
NPA	National Ports Act, 12 of 2005 (South Africa)
RAVEN	Remote-Controlled and Autonomous Vessels for European and National Waters
SAMSA	South African Maritime Safety Authority
SBCO	Shore-based Control Operator
SCC	Shore Control Centre
SMTC Regulations	Merchant Shipping (Safe Manning, Training and Certification) Regulations, 2013 (South Africa)
SOLAS	International Convention for the Safety of Life at Sea, 1974
SRA	Ship Registration Act, 58 of 1998 (South Africa)
STCW	International Convention on Standards of Training Certification and Watchkeeping, 1978
UNCLOS	United Nations Convention on the Law of the Sea, 1982

CHAPTER 1

INTRODUCTION

I BACKGROUND

Technology is changing the world incredibly fast and the digital age is now upon us. Not even fifty years ago would one have imagined that the year 2020 would present us with the coming of robots, pilotless planes and driverless cars. Today, however, all three exist. Japan has already opened the world's first fully robotic staffed hotel in 2015;[1] pilotless planes in the form of drones are being used to make routine military air missions;[2] and driverless cars have been in social debates on the news for almost over a decade.[3] Meanwhile, the maritime and shipping industry has seen the introduction of fully autonomous ports in countries such as the Netherlands and China.[4] Even the cruise industry is showing results of digital change. With the development of artificial intelligence and complex algorithms, a virtual assistant named Zoe has been introduced on the recently launched Mediterranean Shipping Company cruise vessel, the *MSC Bellissima*.[5]

Considering how far technology has come, it brings no surprise that the world is faced with the fact that unmanned and autonomous vessels may be navigating on the high seas in the near future. The reality is that these forms of vessels already exist and, although not yet widely in service, debates surrounding the issues and challenges that they bring with them have been ongoing since as far back as 2012. Norway is at the forefront of these industry developments with various tests currently being conducted in national coastal waters. Wärtsilä (a Finnish technology group) has claimed to have completed the first successful fully autonomous dock-

[1] 'Where hotel is staffed by Robots – BBC Click' available at *https://www.youtube.com/watch?v=FogiE8_3fPE*, accessed on 09 May 2019.
[2] 'Pilotless planes are on the way' *The Economist* 30 May 2019, available at *https://www.economist.com/technology-quarterly/2019/05/30/pilotless-planes-are-on-the-way*, accessed on 01 November 2019.
[3] Mike Brown 'Tesla vs. Waymo: Who will win the self-driving car race?' *Inverse* 03 November 2018, available at *https://www.inverse.com/article/50456-waymo-vs-tesla-who-will-win-the-self-driving-car-race*, accessed on 14 April 2019.
[4] Port of Rotterdam webpage 'The robot is coming' available at *https://www.portofrotterdam.com/en/doing-business/logistics/cargo/containers/50-years-of-containers/the-robot-is-coming*, accessed on 09 May 2019; Marc Prosser 'Chinese Port goes Full Robot With Autonomous Trucks and Cranes' available at *https://singularityhub.com/2018/05/17/chinese-port-goes-full-robot-with-autonomous-trucks-and-cranes/#sm.0011s7dxo11mrcrtqaw2ajdp7qn6l*, accessed on 09 May 2019.
[5] 'ZOE: the new connected experience from MSC Cruises & HARMAN International' available at *https://www.youtube.com/watch?v=Iy0M559YBi8*, accessed on 13 April 2019.

to-dock operation on an 85-metre ferry called the *MF Folgefonn*.[6] The most ground-breaking projects arising from these technological developments are the ones currently in the process of developing unmanned and autonomous cargo-carrying vessels. These projects will be discussed hereunder.

II PROJECTS AIMED AT UNMANNED AND AUTONOMOUS VESSEL TECHNOLOGY DEVELOPMENTS

There are many initiatives that have commenced over the years with a focus on the development of unmanned and autonomous vessel technology.[7] Projects started as early as 2012 and, as will be seen below, these projects were often accompanied by a discussion on the legal feasibility of the introduction of these vessels to the maritime industry. Two of the most prominent of these projects are:

- Maritime Unmanned Navigation through Intelligence in Networks (MUNIN);
- The *MV Yara Birkeland* (by Yara International and Kongsberg).

Each of these will be discussed below.

(a) Maritime Unmanned Navigation through Intelligence in Networks

One of the first major projects to start research on unmanned and autonomous vessel technology developments is the 'Maritime Unmanned Navigation through Intelligence in Networks'[8] (MUNIN). MUNIN is a research project focusing on the economic, technical and legal feasibility of introducing unmanned and autonomous vessels to the maritime industry. The project ran from 2012 to 2015, with its primary aim being to develop a concept for

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[6] Mike Schuler 'Visiting Three Ports, Ferry Successfully Completes Fully Autonomous Test in Norway' available at *https://gcaptain.com/visiting-three-ports-ferry-successfully-completes-fully-autonomous-test-in-norway/*, accessed on 09 May 2019.

[7] There are many other projects with the aim to tackle the issues and challenges facing the introduction of unmanned and autonomous vessels that have not been mentioned in this dissertation. Some examples of other projects are the Advanced Autonomous Waterborne Applications Initiative (AAWA); ENABLE-S3; the Remote-Controlled and Autonomous Vessels for European and National Waters (RAVEN); as well as findings made by the Comité Maritime International (CMI) Working Group (the CMI International Working Group is discussed in great detail under chapter four of this dissertation). A further webpage that may be consulted is that of the One Sea Autonomous Maritime Ecosystem available at *https://www.oneseaecosystem.net/*, accessed on 11 September 2019.

[8] The word MUNIN also means 'memory' or 'mind'. Coming from old Norse mythology, Munin was one of the ravens belonging to the god Odin. The raven would fly around independently during the day only to distribute what he collected to his master in the evening. Today, the name was chosen to represent the unmanned ship that would travel autonomously around the world distributing its cargo, only to return safely to its harbour thereafter. Hans-Christoph Burmeister, Wilko C Bruhn, Ørnulf J Rødseth and Thomas Porathe 'Autonomous Unmanned Merchant Vessel and its Contribution towards the e-Navigation Implementation: The MUNIN Perspective' (2014) *International Journal of e-Navigation and Maritime Economy 1* at 2.

unmanned and autonomous ship operation.[9] The aims of the project were reached, and a newly formed concept of the unmanned vessel was defined. The unmanned vessel would be a ship that would operate

> 'autonomously by newly developed systems on board of the ship and whereby the monitoring and the controlling of the unmanned vessel is carried out in the SCC, which is the operator ashore'.[10]

The full three years of research and results can be found on the MUNIN project web page.[11]

(b) MV Yara Birkeland

The *MV Yara Birkeland* is one of the most recent projects being conducted on unmanned and autonomous vessels. The project is run by Yara International and Kongsberg and it aims to create the first fully electric zero emissions autonomous container ship. The completed vessel was expected to start operations as early as the first quarter of 2020.[12] Kongsberg is a technology corporation based in Norway[13] and a large portion of their business is the supply of vessel technology and systems to over 30 000 ships around the world.[14] This could mean that even in a situation that falls short of involving a fully autonomous ship, the issues highlighted in this study could nevertheless arise when a key function of the vessel has been automated and is being controlled by a computer at the time of the loss or collision. Thus, it has become imperative that the legal issues associated with the operation and regulation of unmanned and autonomous vessels be addressed with some degree of urgency. In order to understand and analyse these legal issues fully, however, it is first important to understand the definitions and distinction between an unmanned and an autonomous vessel.

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[9] Burmeister et al ibid at 2. See also the MUNIN project webpage available at *http://www.unmanned-ship.org/munin/*, accessed on 10 September 2019.
[10] Pol Deketelaere *The legal challenges of unmanned vessels* (unpublished Master dissertation, Universiteit Gent, Belgium, 2016 – 2017) 10.
[11] MUNIN project webpage op cit note 9.
[12] Asle Skredderberget 'The first ever zero emissions, autonomous ship' available at *https://www.yara.com/knowledge-grows/game-changer-for-the-environment/*, accessed on 17 April 2019. [After the submission of this dissertation for examination the launch was delayed on account of the Covid-19 Pandemic. K Nordal & J Kremer 'Yara Birkeland status' available at *https://www.yara.com/news-and-media/press-kits/yara-birkeland-press-kit/*, accessed on 23 May 2020.
[13] Kongsberg webpage 'Technology applied to the challenges of tomorrow' available at *https://www.kongsberg.com/what-we-do/technology-leadership/*, accessed on 04 May 2019.
[14] Kongsberg webpage 'Kongsberg Maritime' available at *https://www.kongsberg.com/who-we-are/kongsberg-maritime/*, accessed on 04 May 2019.

III DEFINITIONS: WHAT ARE UNMANNED AND AUTONOMOUS VESSELS?

Unmanned vessels have been defined as 'vessels without crew on board, but which are controlled remotely from the shore'.[15] They are vessels that are 'able to navigate from point A to point B, without requiring the support from a crew aboard the ship'.[16] This broad definition indicates that these types of vessels still require some degree of human intervention and control in order to function properly. On the other hand, autonomous vessels have been defined as 'pre-programmed vessels that operate using algorithms'.[17] Deketelaere further describes autonomous vessels as follows:

> 'With the autonomous vessels, a human operator is only required to put in the destinations and the vessel itself will navigate to these destinations without requiring further human interactions. These types of vessels rely on preprogramed instructions and artificial intelligence to navigate autonomously.'[18]

This indicates that these vessels have no human intervention whatsoever and contain no degree of control over them. Some tests currently being conducted in Norway involve cargo-carrying vessels that have the ability to alter the degree of autonomy with which they operate.[19] Thus, in order to not exclude any particular vessel of this nature, this study will include both types of vessels and will use these terms interchangeably unless specified otherwise for a particular context or discussion.

The International Maritime Organisation (IMO)[20] has acknowledged that the introduction of these forms of vessels is revolutionary for the maritime industry and has thus commenced investigations into the safety, security and environmental feasibility of these new forms of vessels. The IMO refers to the unmanned and autonomous vessel as MASS (Maritime Autonomous Surface Ships) and has defined them as 'ship[s] which, to a varying degree, can

[15] Shipowner's Club 'Unmanned and autonomous vessels – the legal implications from a P&I perspective' available at *https://www.shipownersclub.com/unmanned-autonomous-vessels-legal-implications-pi-perspective/*, accessed on 18 April 2019.
[16] Deketelaere op cit note 10 at 2.
[17] Shipowner's Club op cit note 15.
[18] Deketelaere op cit note 10 at 2.
[19] Christen Ellingsen & E Tøndel 'Maritime Law in the Wake of Unmanned Vessels' (2017) available at *https://svw.no/contentassets/f424f309bd304e99b39f11355e98571f/svw_maritime-law-in-the-wake-of-the-unmanned-vessel.pdf*, accessed on 18 April 2019.
[20] The IMO has been discussed in greater detail in chapter four of this dissertation.

operate independently of human interaction'.[21] The varying degrees of autonomy have been set out as follows:

- Ships with automated processes and decision support: Seafarers are on board to operate and control the onboard ship systems and functions, but some operations may be automated.
- Remotely controlled ships with seafarers on board: These ships are controlled and operated from another location, but seafarers are on board.
- Remotely controlled ships without seafarers on board: These ships are controlled and operated from another location. There are no seafarers on board.
- Fully autonomous ships: These ships have an operating system on board that is able to make decisions and determine actions by itself.[22]

Under South African law, the Merchant Shipping Act, 57 of 1951 (MSA) defines a 'ship' as:

> '… any kind of vessel used in navigation by water, however propelled or moved, and includes—
>
> (*a*) a barge, lighter or other floating vessel;
>
> (*b*) a structure that is able to float or be floated and is able to move or be moved as an entity from one place to another; and
>
> (*c*) a dynamically supported craft;
>
> and "vessel" has a corresponding meaning'.[23]

The South African Admiralty Jurisdiction Regulation Act, 105 of 1983 (AJRA) defines a 'ship' as:

> '… any vessel used or capable of being used on the sea or internal waters, and includes any hovercraft, power boat, yacht, fishing boat, submarine vessel, barge, crane barge, floating crane, floating dock, oil or other floating rig, floating mooring installation or similar floating installation, whether self-propelled or not'[24]

[21] IMO webpage 'IMO takes first steps to address autonomous ships' available at *http://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx*, accessed on 11 September 2019.
[22] Ibid. See also Luci Carey (2019) *Report on BIMCO Autonomous Ships Seminar* (Report 19/01) *NUS Centre for Maritime Law* 6.
[23] Section 2 of the South African Merchant Shipping Act, 57 of 1951 (MSA).
[24] Section 1 of the Admiralty Jurisdiction Regulation Act, 105 of 1983 (AJRA).

These definitions are significantly broad and allow for a large variety of vessel classifications to fall under their application and operation. Thus, it can be concluded that unmanned and autonomous vessels (including remote-controlled vessels) will be considered ships under South African law.[25]

The important question that arises is whether the current national and international legal maritime frameworks provide for the effective regulation of these new forms of vessels, or whether it will be necessary to make modifications to these existing laws where they are inadequate, or even to enact new laws.

IV RELEVANT ISSUES

The main concern with the unmanned and autonomous vessel is how legal liability will be attributed to it should there be a defect or malfunction with its software which then causes a collision.[26] In other words, since there is no longer a crew and master on board, the question that arises is whether liability could be partly attributed to the manufacturer and partly to the shore-based control operator or, where there is no fault, whether the shipowner of the unmanned vessel will be held solely liable.

Thus, this study examines the issue of liability in the context of a collision scenario involving an unmanned and autonomous vessel. In doing so, the following research questions are addressed:

Chapter two

i. how legal liability is currently attributed to a manned vessel for collision damaged caused by it (under both South African[27] and international maritime law);

Chapter three

ii. whether unmanned and autonomous vessels can comply with existing international rules and regulations;

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[25] See the CMI *Maritime Law for Unmanned Ships: Questionnaire* (2017). Completed by the Maritime Law Association of South Africa available at *https://comitemaritime.org/work/unmanned-ships/*, accessed on 27 November 2019. This questionnaire and the CMI International Working Group are discussed in great detail under chapter four of this dissertation. The question of what constitutes a defect or malfunction in any software used on an autonomous or unmanned vessel falls outside the scope of this study as it is not primarily a legal question, but rather a mechanical, technological and/or engineering one. In a court of law such a question would be dealt with by calling expert witness testimony.

[26] See page 16 of this dissertation for a discussion on what constitutes a collision.

[27] Section 1(1)*(e)* of the South African Admiralty Jurisdiction Regulation Act, 105 of 1983 (AJRA) states that a 'maritime claim' is 'any claim for, arising out of or relating to damage caused by or to a ship, whether by collision or otherwise'.

iii. how legal liability can be attributed in the unmanned and autonomous vessel scenario for collision damage caused by it;

iv. whether the shipowner can be held solely liable for collision damage caused as a result of an onboard system malfunction;

v. whether the correct test to be applied to collision liability situations is that of the current negligence / fault-based liability test;

Chapter four

vi. whether there are any approaches already being considered by the various international organisations; and

vii. whether there are any approaches being adopted by Norway towards regulating unmanned and autonomous vessels.

By addressing these particular issues, the dissertation aims to identify whether the current international liability framework provides a sufficient mechanism to ascertain the legal entity that could be held responsible for a collision occurring with an unmanned or autonomous vessel. The possibility of developing a new liability framework is considered or, in the alternative, whether a broader interpretation of existing global instruments can sufficiently be applied to technology. For the purpose of this study, only unmanned and autonomous merchant ships will be examined.

V LITERATURE REVIEW

There is a great deal of uncertainty surrounding the question of who will be held liable for a collision between an unmanned/autonomous vessel and another vessel. One of the first steps in ascertaining liability is to determine whether the relevant rules and regulations have been complied with.[28] This enables one to ascertain whether there was any negligent conduct, either existing prior to the vessel's departing the port of origin, or by the master and crew during the voyage, which then caused a collision during the vessel's voyage.

[28] The relevant rules and regulations governing the safe navigation of vessels at sea include: the Convention of the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS); the International Convention for the Safety of Life at Sea, 1974 (SOLAS); the International Convention on Standards of Training Certification and Watchkeeping, 1978 (STCW); and the Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, 1910 (the 1910 Brussels Collision Convention).

A key issue identified by academic writers on the topic is whether unmanned and autonomous vessels will be able to comply with these safety rules and regulations[29] regardless of the fact that they lack one of the most essential items on board: Man. It has been suggested by the academic commentaries on the subject reviewed in this study that the safety rules and regulations will need to be either updated or amended in order to bring these forms of vessels sufficiently under their governance. Luci Carey in her article entitled 'All hands off deck? The legal barriers to autonomous ships' states this as follows:

> 'Law must keep pace with technology. As the COLREGs currently stand, the autonomous ship will not comply. However, this is not an insurmountable issue. The COLREGs can be, and have been, readily updated by the IMO.'[30]

A thesis submitted to the University of Bergen (Norway) states that it may not be necessary to go as far as updating the current safety rules; however, a broader interpretation of them is necessary. It states as follows:

> 'I had a hypothesis that the rules might become less fitting as the ships became increasingly automated and based on technology. This theory was for the most part proven wrong as liability to a certain extent is as suitable for the remote and automated ship as it is for the manned ship. This will, however, require a broader law interpretation than might be comfortable for some, so a revision of the laws is necessary.'[31]

Because of the global nature of shipping, however, it has become imperative that a uniform approach be adopted towards unmanned and autonomous vessels and that the issues presented by them be addressed with some degree of urgency. Paolo Zampella emphasises this by stating:

[29] Fiona Cain and Matthew Turner 'New Ships, Old Rules: Updating IMO Rules to Cover Autonomous Ships' (2018) *Robotics Law Journal*, available at *http://www.roboticslawjournal.com/analysis/new-ships-old-rules-updating-imo-rules-to-cover-autonomous-ships-56804504*, accessed on 25 February 2019; Luci Carey *All Hands Off Deck? The Legal Barriers to Autonomous Ships* NUS Centre for Maritime Law (Working Paper 17/06 NUS, Working Paper 2017/011 NUS) (2017); Deketelaere op cit note 10; Paolo Zampella *Maritime and Air Law Facing Unmanned Vehicle Technology* (unpublished PhD thesis, Università degli Studi di Cagliari, Italy, 2019); Ellingsen & Tøndel op cit note 19.

[30] Carey (2017) *Legal Barriers to Autonomous Ships* ibid at 15.

[31] Candidate 128 *Shipowner's liability for unmanned ships. Can existing legislation handle the challenges of the future?* (unpublished Master thesis, University of Bergen, Norway, 2017).

> '[U]nmanned aircraft and unmanned ships are both involving actors of their relevant sectors and their relative regulatory bodies *at a global level*, emphasising the need of *common solutions* to be taken *worldwide*, given the *transnational nature* of maritime and aviation law'[32] (emphasis added).

An important aspect in which these academic commentaries are limited relates to the issues surrounding the legal liability enquiry for collision damage caused as a result of a system malfunction on the unmanned/autonomous vessel.[33] Furthermore, there is no academic commentary found on these same issues in a South African context. The purpose of this study, therefore, is to address this lacuna in analysing which parties could be held liable for a collision between an unmanned/autonomous cargo-carrying vessel and another vessel, and the extent to which those parties may be held liable. This issue will be considered under both South African and international maritime laws. This scenario has been chosen for detailed analysis because there are clear international and national laws that apply, which are listed below.

VI METHODOLOGY

This dissertation will be adopting a legal positivist approach providing a black letter law analysis of both international and national maritime law and will involve elements of comparative analysis. It will conduct desk-based research, using sources from the public domain; and will be analysing academic commentary found in journals and books. It will rely on both South African as well as foreign international writings. It will further consider case law on the topic and will refer extensively to both South African legislation as well as International Conventions. In doing this, the following South African and international laws have been identified as pieces of legislation that currently apply to collision matters and will be affected by the introduction of unmanned and autonomous vessels to the maritime industry:

- The South African Admiralty Jurisdiction Regulation Act, 105 of 1983 (AJRA);
- The South African Merchant Shipping Act, 57 of 1951 (MSA);

[32] Zampella op cit note 29 at 2. Zampella considers the legal position of Italy towards unmanned and autonomous navigation in both maritime and aviation laws. He has chosen to address both sectors as, under Italian law, both maritime and aviation laws are embraced under the same code of law ('*La codice della Navigazione*' enacted on 30 March 1942 in the Royal Decree n. 327). He states that the reason behind this unitary approach is based on the principle of '*trasporto autarchico*' which stipulates that these sectors require the human to operate in an environment outside of their natural habitat and thus require a different approach to that of ordinary land transportation. Zampella op cit note 29 at 1.

[33] Two papers that have extensively focused on these issues are: DNV GL (2018) *Remote-Controlled and Autonomous Ships in the Maritime Industry*. (Position Paper) *Group Technology & Research*, available at *https://www.dnvgl.com/maritime/publications/remote-controlled-autonomous-ships-paper-download.html*, accessed on 07 October 2019; and Zampella op cit note 29.

- The Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS);
- The International Convention for the Safety of Life at Sea, 1974 (SOLAS);
- The International Convention on Standards of Training Certification and Watchkeeping, 1978 (STCW);
- The Hague Rules as amended by the Brussels Protocol, 1968 (the Hague-Visby Rules); and
- The Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, 1910 (the 1910 Brussels Collision Convention).

These pieces of legislation are relevant to this topic as they apply in South Africa and have been widely adopted by most maritime nations. This study will also consider an analysis of the national laws of Norway. Norway was chosen for comparison as it is at the forefront of industry developments in implementing autonomous cargo-carrying vessels (with the *MV Yara Birkeland* due for launch in 2020). The detailed analysis of proposals by Norwegian scholars will provide insight into the possibilities for the development or interpretation of South African law in addressing the same issues as they are both new and challenging.

VII LIMITATIONS

The whole world has to prepare itself in time for the introduction of these vessels to the maritime industry. Countries that have compulsory pilotage laws, such as South Africa,[34] have to consider whether they will still require a pilot to navigate the unmanned or autonomous vessel into the port and the ways in which that will be made possible. Countries also have to consider whether their ports are sufficiently equipped to handle the arrival of these forms of vessels.

Issues surrounding their environmental impact, how salvage operations would work, how claims for loss of life or personal injury can be made against them and the protection of these vessels against cyber-attacks and piracy are all questions that need to be asked before these vessels take to our high seas. Some of these issues have already been analysed (such as that of the technological aspects of unmanned navigation[35]), but there is still a great deal of uncertainty as to how the world can sufficiently prepare itself in time for these new forms of vessels.

[34] Section 75 of the South African National Ports Act, 12 of 2005 (NPA).

[35] Thomas Porathe (2014) *Remote Monitoring and Control of Unmanned Vessels - The MUNIN Shore Control Centre* (Proceedings of the 13th International Conference on Computer Applications and Information Technology in the Maritime Industries (COMPIT '14), Chalmers University of Technology, Sweden); James Colito

This study is limited to the issues surrounding unmanned/autonomous collision liability and claims for collision damage, with a specific focus on the master, the crew, the shipowner and the demise charterer. It will not specifically examine other claims that may arise in a collision scenario such as claims for personal injury, loss of life, salvage, environmental pollution (such as through an oil spill) or the registration of such ships;[36] nor will it examine issues related to compulsory pilotage, cyber security or piracy. In addition, this study will not consider how the defences under Article IV of the Hague-Visby Rules (such as the defence of perils of the sea or heavy weather) could be applied to unmanned or autonomous vessels.

VIII STRUCTURE OF DISSERTATION

Chapter two of this dissertation examines how legal liability is currently attributed to a manned vessel for damage caused in a collision. In doing so, it examines the relevant provisions of the 1910 Brussels Collision Convention and the South African MSA. Chapter three examines how legal liability can be attributed to an unmanned and autonomous vessel for collision damage caused by it. In doing so, the chapter will discuss fault-based liability for personal negligence, vicarious liability and liability for the actions of independent contractors, as well as strict and product liability. Chapter four examines the recent work of the international organisations as well as the national maritime laws of Norway to determine whether there are any helpful approaches already being considered for the unmanned/autonomous vessel scenario. Lastly,

Autonomous Mission Planning and Execution for Unmanned Surface Vehicles in Compliance with the Marine Rules of the Road (unpublished Master thesis, University of Washington, 2007); Ørnulf J Rødseth and Hans-Christoph Burmeister (2012) *Developments toward the unmanned ship* (MUNIN project research paper) available at *https://pdfs.semanticscholar.org/6a8a/771d52e210f36d48cd345a13aab294d83780.pdf*, accessed on 13 November 2019; LP Perera, JP Carvalho and C Guedes Soares *Autonomous guidance and navigation based on the COLREGs rules and regulations of collision avoidance* (2009); Tor Arne Johansen, Tristan Perez and Andrea Cristofaro 'Ship Collision Avoidance and COLREGS Compliance using Simulation-Based Control Behaviour Selection with Predictive Hazard Assessment' (2016) *IEEE Transactions on Intelligent Transportation Systems* Volume: 17 Issue: 12; Wasif Naeem and George W Irwin (2011) *Evasive Decision Making in Uninhabited Maritime Vehicles* (Paper presented at 18th International Federation of Automatic Control (IFAC) World Congress, Milan, Italy) 12833 – 12838; Wasif Naeem and George Irwin 'An automatic collision avoidance strategy for unmanned surface vehicles'. (2010) In K Li, X Li, S Ma & GW Irwin (eds) *Life System Modeling and Intelligent Computing.* ICSEE 2010, LSMS 2010; (2010) 98 *Communications in Computer and Information Science* 184–191; Sebastian Ohland and Axel Stenman *Interaction between unmanned vessels and COLREGS* (unpublished Bachelor's thesis, Novia University of Applied Sciences, 2017); Thomas Stenersen *Guidance System for Autonomous Surface Vehicles* (unpublished Master thesis, Norwegian University of Science and Technology, 2015); Jian Hong Mei and MR Arshad 'A smart navigation and collision avoidance approach for Autonomous Surface Vehicles' (2017) *Indian Journal of Geo Marine Sciences*; Kyle Woerner *COLREGS Compliant Autonomous Collision Avoidance using Multi-Objective Optimization with Interval Programming* (unpublished Master thesis, Massachusetts Institute of Technology, 2014).

[36] The registration of ships in South Africa is governed by the Ship Registration Act, 58 of 1998 (SRA). In particular, see section 16 of the SRA which sets out the various classes of vessels that are entitled to registration in South Africa.

chapter five concludes the issues discussed, and any recommendations made are found thereunder.

CHAPTER 2

COLLISION LIABILITY OF THE MANNED MERCHANT VESSEL

I INTRODUCTION

In order to consider the legal liability of the unmanned/autonomous merchant vessel for collision damage caused by it, it is firstly necessary to consider how legal liability is currently attributed to manned vessels. Thus, this chapter sets out the current position on the attribution of legal liability where a collision has occurred between manned vessels. It sets out the importance of complying with the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) and the consequences of any non-compliance with them. It further includes an in-depth discussion on:

- the relevant provisions of the Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels 1910 (1910 Brussels Collision Convention);
- the relevant provisions of the South African Merchant Shipping Act, 57 of 1951 (MSA); and
- the current method used to determine collision liability (internationally and in South Africa) through the fault-based liability test.

Lastly, it sets out how the measurement of compensation for damages is determined, as well as the relevant international and South African provisions determining the apportionment of those damages.

II LIABILITY FOR COLLISION DAMAGE DONE TO ANOTHER VESSEL: THE CURRENT POSITION OF MANNED VESSELS

The international laws governing collisions at sea revolve around three essential aspects. First, there is a set of international regulations that prescribe the rules to be followed to ensure that vessels are navigated safely at sea. These regulations are derived from a multilateral treaty called the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) which are commonly referred to as the maritime ‘rules of the road’. They primarily aim to prevent the occurrence of collisions at sea through the safe navigation of most forms of vessels. Second, where a collision has nevertheless occurred due to non-compliance with these rules and regulations, the legal fault of the parties involved in the collision and the degree to which each party is at fault must be determined. Lastly, there is a separate international convention that sets out the ground rules for determining the legal liability of the

parties at fault in the collision, and the apportionment of damages to be compensated by those parties are found therein. This Convention is called the Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, 1910 (commonly referred to as the 1910 Brussels Collision Convention).

In South Africa, where a matter involving a collision is brought before a South African court of law, the relevant court (exercising its admiralty jurisdiction) will have regard to the following pieces of legislation:[1]

- The Admiralty Jurisdiction Regulation Act, 105 of 1983 (AJRA);
- The Merchant Shipping Act, 57 of 1951 (MSA);[2]
- The Apportionment of Damages Act, 34 of 1956 (ADA);
- The COLREGS (as mentioned above).

Section 3(4) of AJRA sets out that a claimant may pursue damages (through an action *in rem* against a vessel) where the claimant has a maritime claim. In order for a maritime claim to be enforceable through an action *in rem*, a claimant must either have a maritime lien over the property to be arrested, or be able to prove that the owner of the property to be arrested would be liable to the claimant in an action *in personam* in respect of the cause of action concerned.[3] Collision, specifically damage done by a ship,[4] is a form of maritime lien which is enforceable against the vessel through an arrest *in rem*.

The three essential aspects described above that govern collisions at sea will be discussed hereunder from both an international and South African perspective.

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[1] It must be noted that the relevant South African court of law (exercising its admiralty jurisdiction) will also have regard to the applicable law provided under sections 6(1) and (2) of the Admiralty Jurisdiction Regulation Act 105 of 1983, which states:
"(1) Notwithstanding anything to the contrary in any law or the common law contained a court in the exercise of its admiralty jurisdiction shall- (a) with regard to any matter in respect of which a court of admiralty of the Republic referred to in the Colonial Courts of Admiralty Act, 1890, of the United Kingdom, had jurisdiction immediately before the commencement of this Act, apply the law which the High Court of Justice of the United Kingdom in the exercise of its admiralty jurisdiction would have applied with regard to such a matter at such commencement, in so far as that law can be applied; (b) with regard to any other matter, apply the Roman-Dutch law applicable in the Republic. (2) The provisions of subsection (1) shall not derogate from the provisions of any law of the Republic applicable to any of the matters contemplated in paragraph (a) or (b) of that subsection."

[2] The MSA embraces legal concepts and principles not only from the 1910 Brussels Collision Convention but also from the International Convention for the Safety of Life at Sea, 1974 (SOLAS), the ISPS (International Ship and Port Facility Security) Code and the International Convention on Standards of Training Certification and Watchkeeping, 1978 (STCW).

[3] Sections 3(4)*(a)* and 3(4)*(b)* of AJRA, read with section 1(3) of AJRA, which deems the demise charterer as the owner of the ship for the period of the charter by demise.

[4] *Transol Bunker BV v mv Andrico Unity; Grecian-Mar SRL v mv Andrico Unity* 1989 (4) SA 325 (A).

(a) The maritime 'rules of the road'

The COLREGS govern the safety of navigation at sea and the duties and responsibilities contained therein fall upon the master and the crew.[5] The COLREGS are applied in South African law by way of the Merchant Shipping (Collision and Distress Signals) Regulations, 2005 (CDSR). Further to this, section 347 of the MSA indicates that the COLREGS are to be applied in South Africa. It does so by stating that where a party is non-compliant with the relevant COLREGS, that party will be deemed negligent and will bear the onus of proving a reasonable defence.[6] This section not only indicates that it is a requirement that the crew, master and owner ensure that the COLREGS are complied with, but also indicates that the party which has been non-compliant with the COLREGS will then have the responsibility of proving a reasonable defence for that non-compliance.[7] This leads us to the discussion on determining legal fault and the proving of negligence in the collision that has occurred.

(b) Determining legal liability: Proving fault by negligence

South Africa follows the basic guiding principles found in English law for determining the liability of a vessel in collision cases. These basic principles indicate that in order for a party to be held liable in a collision matter, three elements must be present: (1) Fault, (2) Causation, and (3) Damages. The first element, fault, refers to the blameworthiness of a person and includes both a wrongful act and/or an omission. McKoy states that as a result of the nature of the fault element, 'one should at all times be exercising a degree of skill and care which are ordinarily to be found in a competent seaman'.[8] The second element is the principle of causative fault. A plaintiff vessel must aver that the defendant vessel caused the collision that resulted in the plaintiff's loss. There can be no liability on the defendant vessel where a plaintiff vessel does not aver as such.[9] Causative fault can be proved even where the defendant vessel was not solely negligent in causing the collision. Contributory negligence on the part of both the vessels

[5] See rule 2 of the COLREGS which states: '(a) Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case. (b) In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger'.

[6] 'If any damage to person or property arises from the non-observance by any ship of any of the collision regulations, the damage shall be deemed to have been caused by the wilful default of the person in charge of the deck of the ship at the time, unless it is proved that the circumstances of the case made a departure from the regulations necessary'.

[7] John Hare *Shipping Law & Admiralty Jurisdiction in South Africa* 2 ed (2009) 371.

[8] Kerry-Ann N. McKoy *Collisions: A legal analysis* (published Master thesis, World Maritime University, 1999) 17–18.

[9] Hare op cit note 7 at 364.

involved in the collision is a form of fault recognised to determine liability.[10] Secondly, the plaintiff is the one who is alleging that the defendant is to blame for the collision; thus it is the plaintiff who has the onus of proving the defendant's negligence in causing the collision. This comes from the basic principle of 'he who alleges must prove'.[11] Lastly, there must be the element of damages.[12]

The word 'collision' does not only provide for a situation where a vessel collides with another vessel. It also includes the situation where a vessel collides with a non-vessel, such as a port quay side or an anchor chain. Thus, negligence can be proved in situations where there was no actual contact between two vessels.[13] Where a vessel has collided with a stationary object, the law infers that the moving vessel is negligent in colliding with the stationary object. This inference is not absolute and the party defending the moving vessel has the opportunity to explain colliding with the stationary object.[14]

The negligence also does not need to be related to the navigation of the vessel but can even be related to the general management of the ship.[15] In the first situation, it is the master or crew who could be held liable,[16] and the shipowner could be held vicariously liable for their negligence.[17] In the latter, it is the shipowner who could be held liable, whether it is due to a failure:

> 'to properly man or equip a vessel, to maintain the vessel in a seaworthy condition, to instruct or supervise the crew on the operational procedures on board the ship, to carry out the required inspections and to make every other decision as a prudent shipowner to make the ship's operation safe [*sic*]'.[18]

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[10] *The Statue of Liberty* [1971] 2 Lloyd's Rep 277 (HL).
[11] Hare op cit note 7 at 364.
[12] Discussed in further detail under chapter two section II*(c)* and *(d)* of this dissertation.
[13] *The Eland* [1969] 2 Lloyd's Rep 328.
[14] *The Olympic Action: Shell and BP South African Petroleum Refineries (Pty) Ltd v Osborne Panama SA* 1980 (3) SA 653 (D). This case has since been appealed and the inference of negligence due to a collision with a stationary object was dismissed on the evidence (The Olympic Action: *Osborne Panama SA v Shell and BP South African Petroleum Refineries (Pty) Ltd* 1982 (4) SA 890 (SCA)).
[15] *The Merchant Prince* [1892] P 179.
[16] The master can be excused for the decisions he/she makes when placed in a difficult situation and where an alternative peril caused the damage. The master can do this by raising the defence of 'alternative danger' (also referred to as the 'agony of the moment' defence). See chapter three of this dissertation for a further discussion on this defence.
[17] Although the term shipowner is used throughout this dissertation, a demise charterer would be in the same position as the shipowner, as he/she is the employer of the master and crew under a demise charter. See sections 3(4)*(a)* and *(b)* of AJRA, read with section 1(3) of AJRA.
[18] Paolo Zampella *Maritime and Air Law Facing Unmanned Vehicle Technology* (unpublished PhD thesis, Università degli Studi di Cagliari, Italy, 2019) 213.

Fault can also be determined not only by the commission of a wrong act (such as issuing an incorrect order) but also by a failure to act according to the duties and responsibilities required to ensure the safe and seaworthy navigation of the vessel. A perfect example of such a failure is the failure to maintain a proper look-out as required by rule 5 of the COLREGS. Rule 5 is considered to be one of the most important safety navigation rules and will be discussed in greater depth later in this chapter.

Once the vessel's negligence has been determined, the next step in the process is to determine the measurement of compensation for the damages and the apportionment of those damages where there was contributory negligence on the part of one or more vessels involved in the collision.

(c) The measurement of compensation for damages

The measurement of compensation for damages is determined in accordance with the common law. In doing so, the first step is to determine the extent of the damages. This involves an investigation into the remoteness and foreseeability of the damages caused. These two principles (of foreseeability and remoteness) dictate that the damages caused cannot be too remote and they must have been foreseeable, especially when dealing with consequential losses. The leading English cases of *Re Polemis and Furness Wilthy and Co*[19] and *The Wagonmound*[20] established a test of foreseeability which has since been relied upon in many collision cases, both in England and South Africa.[21] The most prominent of these cases in South African law is that of *The Olympic Action*,[22] where the second plaintiff's vessel was delayed in leaving the Durban Port as a result of a collision that had occurred between the first plaintiff and the defendant vessels. The court rejected the second plaintiff's claim for demurrage on the basis that, although the damage was foreseeable, the defendant vessel had no duty of care towards the second plaintiff vessel and 'in the absence of legal duty there can be no unlawfulness'.[23]

The next step, then, is to determine how the damages will be divided where there has been an apportionment of fault.

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[19] *Re Polemis and Furness Wilthy and Co* [1921] 3 KB 560 (CA).
[20] *The Wagonmound* [1961] AC 388 PC.
[21] See the following English cases of *The Giacinta Motta* [1977] 2 Lloyd's Rep 221 and *The Soya* [1956] 1 Lloyd's Rep 557 (CA), as well as the following South African cases of: *The Olympic Action* supra note 13; and *Trimmel v Williams* 1952 (3) SA 786 (C), specifically at 791 where the court states that the damages were remote 'but not so remote that they could be ignored'.
[22] Supra note 14.
[23] Stated by Van den Heever JA in the case of *Herschel v Mrupe* 1954 (3) SA 464 (SCA) at 490A.

(d) Ground rules for determining the apportionment of damages

The 1910 Brussels Collision Convention applies internationally to situations involving a collision between vessels, whether sea-going or navigated inland. Article 1 of the Convention expressly states that it shall apply to the apportionment of damages for collisions between vessels 'in whatever waters the collision takes place'. It sets out the rules to use when deciding which parties bear the liability for the compensation of damages and loss caused by the collision.

The first relevant provision, article 2, sets out which parties bear liability where the collision occurred without proven fault. It states:

> 'If the collision is accidental, if it is caused by *force majeure*, or if the cause of the collision is left in doubt, the damages are borne by those who have suffered them. This provision is applicable notwithstanding the fact that the vessels, or any one of them, may be at anchor (or otherwise made fast) at the time of the casualty.'

Article 3 then goes on to provide: 'If 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.' Thus, article 3 provides that where the collision was caused by the fault of one of the vessels, that vessel will bear the liability to compensate for the damages done to the vessels involved in that collision.

The last provision relating to liability for damage done to the vessel is article 4, which provides that:

> '[i]f two or more vessels are in fault the liability of each vessel is in proportion to the degree of the faults respectively committed. Provided that if, having regard to the circumstances, it is not possible to establish the degree of the respective faults, or if it appears that the faults are equal, the liability is apportioned equally. The damages caused, either to the vessels or to their cargoes or to the effects or other property of the crews, passengers, or other persons on board, are borne by the vessels in fault in the above proportion, and even to third parties a vessel is not liable for more than such proportion of such damages'.

Thus, this article provides for the situation where two or more vessels are at fault for the collision, stating that each vessel shall be liable for the proportion to which it was at fault for the collision or, where such proportion of fault cannot be ascertained, the damages are to be borne equally by both vessels involved in the collision.

It is important to remember that claims of such a nature have a time limit to them. Article 7 of the Convention sets out a two-year time frame within which the recovery of collision damages can be claimed. It stipulates that '[a]ctions for the recovery of damages are barred after an interval of two years from the date of the casualty'. Thus, the parties who bear the loss and damage from the collision must ensure that they claim for the recovery of such damages within two years from the date that the collision occurred.

South Africa has not ratified the 1910 Brussels Collision Convention but the South African MSA has adopted and incorporated certain concepts contained in the Convention. Part IV of the MSA governs matters relating to collisions, accidents at sea and the limitation of liability. Similar to article 4 of the 1910 Brussels Collision Convention is section 255 of the MSA,[24] which states that where damage or loss is caused by the fault of two or more ships involved in the collision, the liability to compensate the damage or loss shall be in proportion to the degree in which each ship was at fault. Where a collision occurs in a manner not provided for by the MSA, such as between a ship and a non-ship, liability for damages will be apportioned according to the provisions contained in the South African ADA. However, section 4(2) of ADA states '[n]othing in this Act contained shall derogate in any manner from the provisions of any law relating to collisions or accidents at sea …'. Thus, only the provisions for the apportionment of damages that do not conflict with the MSA are to be applied to maritime collisions between ships and non-ships.

A further provision that South Africa has incorporated into the MSA from the 1910 Brussels Collision Convention is section 344(1). Similar to article 7 of the 1910 Brussels Collision Convention, section 344(1) of the MSA provides that:

[24] '(1) Whenever by the fault of two or more ships damage or loss is caused to one or more of them or to the cargo or freight of one or more of them or to any property on board one or more of them, the liability to make good the damage or loss shall be in proportion to the degree in which each ship was at fault: Provided that— (*a*) if, having regard to all the circumstances of the case, it is not possible to establish different degrees of fault, the liability shall be apportioned equally; and (*b*) nothing in this section shall operate so as to render any ship liable for any loss or damage to which her fault has not contributed; and (*c*) nothing in this section shall affect the liability of any person under any contract, or shall be construed as imposing any liability upon any person from which he is exempted by any contract or by any provision of law, or as affecting the right of any person to limit his liability in the manner provided by law. (2) For the purposes of this chapter, references to damage or loss caused by the fault of a ship shall be construed as including references to any salvage or other expenses, consequent upon that fault, recoverable at law by way of damages'.

> '[t]he period of extinctive prescription in respect of legal proceedings to enforce any claim or lien against a ship or its owners in respect of any damage to or loss of another ship, its cargo or freight, or any goods on board such other ship, or damage for loss of life or personal injury suffered by any person on board such other ship, caused by the fault of the former ship, whether such ship be wholly or partly in fault, shall be two years and shall begin to run on the date when the damage or loss or injury was caused'.

Thus, the time bar for collision claims in South Africa is also two years from the date that the loss or damage was caused.

III CONCLUSION

The international collision laws are made up of three essential elements: (1) all vessels are required to comply with the 'maritime rules of the road' (the COLREGS); (2) where a collision has nevertheless occurred, the legal fault of the parties involved in the collision has to be determined; and (3) the parties liable for the compensation of the collision damages must be determined in accordance with the 1910 Brussels Collision Convention.

Under South African law, the COLREGS apply by way of the CDSR as well as through section 347 of the MSA. Legal liability for a collision is determined through the fault-based liability system, which requires one to prove three basic elements: (1) Fault, including causative fault (the defendant must be negligent for a wrongful act/omission which then resulted in the collision); (2) Causation (the defendant must have caused the collision which then resulted in the plaintiff's loss); and (3) Damages (there must be resultant damages in order for the plaintiff to have a claim against the defendant). Determining the compensation for damages is done in accordance with the MSA, which incorporates the major principles contained in the 1910 Brussels Collision Convention. Where the apportionment of damages cannot be ascertained by applying these provisions, the South African ADA will then apply.

Now that the law as it currently stands has been set out, it is possible to consider the perspective of a collision between the unmanned and autonomous merchant vessel and another vessel.

CHAPTER 3

THE DAWN OF THE UNMANNED AND AUTONOMOUS VESSEL

I INTRODUCTION

One of the main advantages of introducing autonomous vessels to the maritime industry is that these forms of vessels will eliminate the number one cause of accidents at sea: human error.[1] Court cases have shown that most of the collisions that have occurred in the past have almost always been as a result of human error and that almost all occurred in either close proximity to one another or where conditions have restricted visibility of the watchmen.[2] Many collisions have also frequently involved the use of excessive speed.[3] The arrival of fully autonomous vessels that operate by the sole use of complex algorithms is expected for the foreseeable future, with the autonomous container vessel (the *MV Yara Birkeland*) to be launched in a fully autonomous state by the first quarter of 2020. Even where the maritime industry sees the introduction of fully autonomous vessels; however, since algorithms depend on human input, the possibility of human error is never entirely eliminated.

On the other hand, unmanned vessels are designed to have no personnel on board but the vessel itself will still be controlled by a shore-based control operator in an Innovation Lab. This means that there is still room for a great deal of human error. It is thus necessary to ascertain how legal liability will be attributed where there is a collision between an unmanned or autonomous merchant vessel and another vessel. Thus, chapter three analyses the following aspects:

- whether unmanned and autonomous vessels are compliant with the regulations contained in the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) and the extent to which they do or do not comply with them;
- which parties can be held liable where there is negligence in the operation of the unmanned or autonomous vessel;

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[1] Pol Deketelaere *The legal challenges of unmanned vessels* (unpublished Master dissertation, Universiteit Gent, Belgium, 2016 – 2017) 11; and Thomas Porathe (2014) *Remote Monitoring and Control of Unmanned Vessels - The MUNIN Shore Control Centre* (Proceedings of the 13th International Conference on Computer Applications and Information Technology in the Maritime Industries (COMPIT '14), Chalmers University of Technology, Sweden) 461 – 462. Also see the following article in which the author states that 'around 80 percent of accidents [at sea] are considered to be the fault of a person. Somewhere, somehow and in some way, someone has either done or not done something'. Crewtoo The Home of Seafarers Online 'A New Look At What Causes Accidents At Sea?' available at *http://www.crewtoo.com/crew-life/rules-regs/what-causes-accidents/*, accessed on 30 July 2019.

[2] John Hare *Shipping Law & Admiralty Jurisdiction in South Africa* 2 ed (2009) 357.

[3] Ibid.

- whether the guiding principles discussed in chapter two in relation to collisions can be applied to the unmanned and autonomous vessel or whether they would need to be developed in order to accommodate them;
- lastly, whether the correct test to be applied to collision liability situations involving unmanned/autonomous vessels is that of the current negligence test. This analysis includes a discussion around the various permutations of liability, including fault-based liability for personal negligence, vicarious liability and liability for the actions of independent contractors, as well as strict and product liability.

II COMPLIANCE WITH THE COLREGS

As demonstrated above, the legal liability in the case of a collision is based on whether there is any negligence of the master or crew involved, as well as on any possible non-compliance with the COLREGS. The issue that arises here is whether an unmanned or autonomous vessel can comply with the COLREGS where there no longer exists any crew or master on board the vessel. Rule 1*(a)* of the COLREGS states that '[t]hese Rules shall apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels'. The wording of this rule indicates that all vessels that operate on a seagoing voyage will be required to comply with the COLREGS, whether or not they are manned, unmanned or autonomous. The question that arises then is whether the unmanned and autonomous vessel will be considered a vessel under the various definitions provided under international maritime laws. Currently, there is no uniform definition for the term 'vessel'; however, as can be seen by the definition of a vessel provided under the COLREGS,[4] it can be concluded that the unmanned and autonomous vessel will be considered a vessel. Thus, for the purpose of this study, the unmanned and autonomous cargo-carrying vessel will be assumed to be bound to comply with the rules in the COLREGS.[5]

The essential rule that will affect the unmanned and autonomous vessels' compliance is rule 5, the 'look-out provision', which states:

> '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*' (emphasis added).

[4] The definition of vessel contained in rule 3(a) of the COLREGS states: '[t]he word "vessel" includes every description of water craft … used or capable of being used as a means of transportation on water'.
[5] Luci Carey *All Hands Off Deck? The Legal Barriers to Autonomous Ships* NUS Centre for Maritime Law (Working Paper 17/06 NUS, Working Paper 2017/011 NUS) (2017) 10.

This rule is considered to be the most important rule in the COLREGS as all the other rules contained therein are based on the assumption that the master and crew are maintaining a full awareness of their surroundings.[6] The three most important aspects that can be taken from this rule are that a proper look-out must be maintained:

- by sight and hearing;
- by all available means; and
- in order to make a full appraisal of the situation and of the risk of collision.

There are two views that have developed on this subject. The first is that, should it be decided that unmanned and autonomous vessels cannot sufficiently satisfy the requirements in the look-out provision, these types of vessels will then be non-compliant with the COLREGS and the only way to avoid this will be to update the COLREGS to provide for this new form of vessel.[7] On the other hand, there is still the possibility that unmanned and autonomous vessels will comply with the COLREGS where the installation of the latest and most appropriate radar technology and camera equipment can be proved to be a sufficient substitution for the 'sight and hearing' requirement.[8] This is an achievable outcome as all the rules in the COLREGS refer to the vessel itself rather than man.[9] Whether it is decided that the COLREGS should be updated or the courts decide to interpret the rules in a manner that allows for the latest technological developments to substitute human sight and hearing appropriately, it is likely that an improved adaptation of the rules will result[10] as

> 'it is in the full interest of the drafters of the COLREGs to achieve the highest possible applicability in order to guarantee an appropriate level of safety in preventing collisions at sea'.[11]

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[6] Captain Rajeev Jassal '8 COLREG rules every navigating officer must understand' *My Sea Time* 28 June 2016, available at *https://www.myseatime.com/blog/detail/8-colreg-rules-every-navigating-officer-must-understand*, accessed on 18 April 2019.

[7] Carey (2017) *Legal Barriers to Autonomous Ships* op cit note 5 at 15.

[8] Tor Arne Johansen, Tristan Perez and Andrea Cristofaro 'Ship Collision Avoidance and COLREGS Compliance using Simulation-Based Control Behaviour Selection with Predictive Hazard Assessment' (2016) *IEEE Transactions on Intelligent Transportation Systems* Volume: 17 Issue: 12. At page 2, the authors briefly mention the appropriate types of technology and equipment to use, these being: radar, lidar, automatic identification systems (AIS), camera and infrared thermal imager, or similar sensors and tracking systems.

[9] Rule 2, however, is the only exception to this as it directly places the responsibility to comply with the COLREGS upon the master, shipowner, vessel or crew members.

[10] See MUNIN *Research in maritime autonomous systems: Project results and technology potentials* (2016) 2, in which MUNIN carried out a legal assessment on the feasibility of unmanned vessels. 'MUNIN concluded that the legal framework can be adapted to allow autonomous vessels in maritime transport, if unmanned vessels can at least sail as safe as a manned ship'. Deketelaere op cit note 1 at 11.

[11] Paolo Zampella *Maritime and Air Law Facing Unmanned Vehicle Technology* (unpublished PhD thesis, Università degli Studi di Cagliari, Italy, 2019) 52.

This is evidenced by the extremely broad definition given to the term ‘vessel’.

III LIABILITY FOR THE NEGLIGENT OPERATION OF UNMANNED AND AUTONOMOUS VESSELS

The law demands that legal liability be placed on a specific actor who bears the responsibility for when things go wrong.[12] Since an unmanned and autonomous vessel has no master or crew on board, this raises the issue of whether the negligence of any other party involved in their operation may then be attributed to the vessel for the purposes of the *in rem* action. There are currently two main actors who are responsible for and will be held liable for the damages caused by the collision of a manned vessel. These two traditional actors are the master and the shipowner. With the introduction of unmanned vessels to the maritime industry, however, we find ourselves faced with new legal actors who may be found liable for the same damages. These new actors are the shore-based control operators, the voyage programmers, the manufacturers and the software providers. What follows is an analysis of the general guiding principles on the parties liable for collision damage and a discussion into whether these general principles can be applied to the unmanned and autonomous vessel scenario, or whether they will need to be modified to accommodate their introduction into the maritime industry. The possibility of whether new approaches will need to be adopted will also be considered. Conclusions will be submitted and proposed on a hypothetical basis as the true legal effect of the implementation of the unmanned and autonomous vessel is yet to be discovered.

IV THE MASTER VERSUS THE SHORE-BASED CONTROL OPERATOR/ VOYAGE PROGRAMMER

(a) The international perspective

The master’s role in the maritime industry is one of the most essential and remains the most traditional. Also referred to as the shipmaster, the captain and the commanding officer, the master has been defined generally as:

[12] Zampella ibid at 219, who states: ‘There will undoubtedly always be a need for placing liability on a specific actor of the shipping industry’.

> ‘a natural person hired by contract who lives on a vessel and manages it and its related matters while the vessel is navigating and carrying goods or performing services for freights or hire. Thus, he is the appointed and retained commander of a vessel in commercial service and is the person who is responsible for a vessel in navigation and licensed by competent national authority’.[13]

It has been suggested that the more technology develops, however, the more the role of the master will diminish.[14] Since the beginning of international trade, the master has had the unlimited power to represent the shipowner and to perform an array of functions on his/her behalf.[15] A perfect example of this unlimited power includes that of contracting on the shipowner’s behalf, whether it be for the purchase or sale of goods, the employment of new crew members or contracting for the repairs of the vessel. In each of these examples, the master’s role has been diminished now that the business industry in general has been introduced to telephonic technologies, the Internet and other communicative methods that now afford one the possibility of connecting directly with the shipowner or the head office of the company which owns the ship.[16]

The master’s two most essential roles that bear the focus of this discussion, however, are that of responsibility for the conduct of the ship and that of representing the shipowner.[17] Now, with the removal of the master from being present onboard the vessel, the question that arises is whether the legal entity that is placed on land in the shore-based control lab will bear the same legal duties and responsibilities as those of the traditional master that currently exist today. A further question that arises is whether this substituted shore-based legal entity and its human operators will be subjected to the same rules and regulations as the current master and whether they will be able to raise the same defences that a current master is afforded by law.

Where a situation arises in which both manned and unmanned/autonomous vessels are navigated simultaneously at sea, one of two legal consequences may result in answering the legal questions above. The first is that the traditional role of the master can be extended to include the role of the shore-based control operator (SBCO) as a form of master on land. This

[13] John AC Cartner, Richard P Fiske, and Tara L Leiter *The International Law of the Shipmaster* (2009) 3.
[14] Zampella op cit note 11 at 217; Professor Dr Eric Van Hooydonk ‘The Law of Unmanned Merchant Shipping – An Exploration’ (2014) 20 *Journal of International Maritime Law* 412.
[15] Van Hooydonk ibid at 412.
[16] Ibid.
[17] Regardless of the extent that technology has developed, the master still retains the role of representing the shipowner although in modern times he/she no longer possesses the unlimited power that the master had when international trade was first introduced to the world.

could certainly be achievable in the case of the unmanned vessel scenario. When looking at the definition of a master (as provided above), four aspects can be taken from it to describe him/her. The master is:

- a natural person;
- who is responsible for the vessel;
- and all those present on it (both human and property); and
- is responsible for ensuring that the laws of the flag state are enforced on board the vessel.[18]

Deketelaere describes the SBCO as a human operator who is located on land in the Shore Control Centre (SCC) and who will have control over the unmanned vessel. The unmanned vessel will be wirelessly connected to the SCC and will transmit all the information and data that is received from the onboard technological systems (such as the radars, sensors, and satellites) to the SBCO through the SCC. The SBCO will then have the duty to interpret all information and data received from the unmanned vessel in order to send a command in reply. The unmanned vessel's electronic systems will execute the commands received back from the SBCO through the SCC.[19] In comparing the definition of a master with the explanation of what the SBCO would be expected to do, one can see that the two are not so different from each other as to render them incompatible. A SBCO will also be a natural person who would be responsible for the (unmanned) vessel, and all property on it (as the human element would no longer be applicable) and would be responsible for ensuring that the laws of the flag state are enforced on board the (unmanned) vessel.

This approach entails that the SBCO controlling the unmanned vessel will be bound by the same rules and regulations as the traditional master on board the manned vessel, as far as they relate to the safe navigation of the unmanned vessel and their representation of the shipowner in performing their navigational duties. This also means, however, that the master's traditional responsibility for its crew onboard the vessel will disappear from the SBCO's role[20] since there will no longer be any personnel whatsoever onboard the unmanned vessel to be responsible for

[18] Zampella op cit note 11 at 218.
[19] Deketelaere op cit note 1 at 2.
[20] An interesting question that arises here is whether an SBCO will still be bound by the master's duty to render assistance at sea and the extent to which an SBCO will be able to carry out that duty considering the unmanned and autonomous vessel approach. The answer to this question will depend on the extent to which technology evolves with the unmanned and autonomous vessel, and on the extent to which the law may require an unmanned or autonomous vessel to respond to signals of distress out at sea. This question is not dealt with in this dissertation and requires further research in both the technological and legal industries.

it, and such a responsibility will be limited to the traditional master on board the manned vessel. Furthermore, it is unlikely that the SBCO will be able to rely on the same defences that a master is currently afforded by law. The reason for this is due to both the nature of the master's current defences as well as the difference between the working environments of the SBCO and the master respectively.

Firstly, there are different pressures involved in working as a SBCO (who controls the unmanned vessel from land, most likely in a 'luxury condition'[21]) from those related to working as a master on board the vessel (who navigates the manned vessel directly from its bridge). Deketelaere describes the average pressures placed on a seafarer due to the nature of their working conditions as follows:

> 'One of the main aspects to the seafarer's profession is the fact that all their duties and "free time" must be executed on board the ship. A seafarer is working, sleeping, living and socializing on the ship, in a multinational crew with unknown people from different cultures and nationalities. In addition, seafarers need to travel through multiple seas, different time zones, changing climates and contrasting weather conditions. The everyday life of a seafarer takes place in a lonely and dangerous environment, with several disturbing factors such as vibrations, sea motion and noises [among many other factors] …'

Secondly, the master has the opportunity to be absolved from the decisions he/she makes where he/she can prove that they were made in 'the agony of the moment' or that there was an 'alternative danger' which then caused the collision damage.[22] This defence is called the 'alternative danger' defence or the 'agony of the moment' defence. The rationale behind the defence is that a master cannot be held liable where there was an intervening danger which subsequently caused the collision damage. It also provides that a master cannot be held liable for negligence where his/her failure to react properly was due to the crisis thrust upon him/her.[23]

The possibility of a SBCO successfully relying on such a defence is open to objection but not entirely unlikely. On paper, should the role of the master be extended to the SBCO, nothing in the wording of this defence could prevent a SBCO from relying on it. However, this may not be the case where one takes into consideration the vast differences between the working environments of the SBCO and the master. Although the work required of the SBCO still has

[21] Deketelaere op cit note 1 at 39.
[22] Hare op cit note 2 at 365.
[23] *The Miraflores v The Abadesa* [1967] 1 Lloyd's Rep 191 (HL). This defence has also been discussed at great length in the English cases of *The Eland* [1969] 2 Lloyd's Rep 328; *The Bywell Castle and The Princess Alice* [1879] PD 219; and *Admiralty Commissioners v SS Volute* [1922] 1 AC 129.

the potential to cause serious consequences where the wrong decisions are made, such pressure placed on the SBCO could never amount to the same pressure that is placed on the master working aboard the manned vessel.

As illustrated by the quote above, the master is subjected to a working environment that is not only strenuous but that puts his/her life at danger almost on a daily basis. In any case, the decision as to whether a master or (potentially) a SBCO can rely on this defence must be assessed on the facts of each case and according to a question of degree. This is illustrated by the following *dictum* of Lord Price in the case of the *Miraflores v The Abadesa*:[24]

> 'Between the extremes in which a man is either wholly excused for a foolish act done in the agony of the moment as the result of another's negligence, or is wholly to blame because he had ample opportunity to avoid it, lies a wide area where his proportion of fault in failing to react properly to a crisis thrust upon him by another, must be assessed as a question of degree'.

The application of this first approach in extending the master's role to that of the SBCO has been criticised by some authors specialising on the topic. It has been suggested by Zampella that it is an incorrect approach to adopt for the long term (although possibly the easier approach to be adopted for the near future). There are many complications that can arise from extensively interpreting the current liability framework, despite its being useful in resolving many immediate issues.[25]

An example of a long-term complication is that of the voyage programmer. With the autonomous vessel scenario, the voyage programmer is a human operator who is simply required to input the correct data relating to the voyage destinations, after which the autonomous vessel will be able to navigate by itself to those destinations without any further human input. As explained by Deketelaere, '[t]hese types of vessels rely on preprogramed instructions and artificial intelligence to navigate autonomously'.[26] As one can see, the voyage programmer will no longer be in control of the (autonomous) vessel. This greatly limits a legislator's possibility of extending the current legal framework to include the voyage programmer as a form of master on land. Liability regimes may prove sufficient where adapted slightly to include the SBCO's new role in the maritime industry. As stated above, this proves to be a feasible approach for the near future. However, once autonomous vessels take to the

[24] Ibid.
[25] Zampella op cit note 11 at 219.
[26] Deketelaere op cit note 1 at 2.

high seas and the maritime industry is confronted with this new legal entity of the voyage programmer, the liability regimes will need more than minor adjustments and adaptations.

This leads one to the second approach that may result from answering the legal questions above. Instead of extending the current traditional framework (relating to the master's duties and responsibilities) to include those of the SBCO, a completely new legal entity could be created to encompass the new roles emerging in the maritime industry from the introduction of unmanned and autonomous technology. In the case of the unmanned vessel, this new legal entity will be the SBCO, who will be charged with the duty of controlling the unmanned vessel from a SCC. In the case of the autonomous vessel, this new legal entity will be the voyage programmer, who will be charged with the duty of inputting voyage data into the vessel algorithms. These new legal entities will be independent from the traditional master's role. This would mean that this new form of master on land will be subject to a new set of rules and regulations that govern its duties and responsibilities and that directly relate to the operation of the unmanned and autonomous vessel technology.

(b) The South African perspective

Under South African law, the master is defined in the Merchant Shipping Act (MSA)[27] as '…in relation to a ship, any person (other than a pilot) having charge or command of such ship'. A master has also been defined in the South African Ship Registration Act (SRA)[28] as

> '…the person having lawful command or charge, or for the time being in charge, of a ship, but does not include a pilot aboard a ship solely for the purpose of providing navigational assistance'.

These definitions do not expressly state that the master of a vessel must be physically present on board the vessel. However, both definitions refer to the master as a person in 'command' or 'charge' of the vessel. As a general rule, South African courts must consider the ordinary meaning of the words within their context. This was stated by the court in the case of *Natal Joint Municipal Pension Fund v Endumeni Municipality*:[29] '… the proper approach … is from the outset to read the words used in the context of the document as a whole and in the light of all relevant circumstances'.[30]

[27] Section 2 of Act 57 of 1951.
[28] Section 1(xiii) of Act 58 of 1998.
[29] 2012 (4) SA 593 (SCA).
[30] Ibid para 24.

The Merriam-Webster Dictionary defines the word 'command' as 'the ability to use or control something' and the Lexico Online Dictionary defines the words 'in charge' as 'in control or with overall responsibility'.[31] In theory, this does not limit the master to being physically present on board the vessel as an unmanned vessel can be 'controlled' from the SCC. Conversely, the South African Merchant Shipping (Safe Manning, Training and Certification) Regulations, 2013 (SMTC Regulations), specifically regulations 2 and 91, state that the master's duties include the monitoring of on-board safety.

It is upon this basis that the Maritime Law Association of South Africa (MLA) is of the opinion that the role of the master cannot be extended to that of the SBCO or the voyage programmer.[32] The MLA further substantiates their opinion on the basis that in order to become a master, one must have completed the requisite certification in accordance with regulation 2 of the SMTC Regulations. Such certification can be received only once the required time and experience has been gained on board a vessel at sea.[33] Thus, according to the South African SMTC Regulations, the current role of the master cannot include the new emerging roles of the SBCO and voyage programmer.

An unfortunate consequence of the introduction of unmanned and autonomous technology may be that the traditional role of the master at sea will slowly fade away into history. The fact that this will cause an abandoning of the master's traditional role is shown by the following quote:

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[31] Merriam-Webster Dictionary: definition of 'command', available at *http://www.merriam-webster com*, accessed on 19 January 2020; Lexico Online Dictionary: definition of 'in charge', available at *http://www.lexico.com*, accessed on 19 January 2020.

[32] See the Comité Maritime International (CMI) questionnaire completed by the MLA of South Africa, available at *https://comitemaritime.org/work/unmanned-ships/*, accessed on 27 November 2019. This questionnaire and the CMI International Working Group are discussed in great detail under chapter four of this dissertation.

[33] See generally regulation 27 of the SMTC Regulations which require inter alia 12 months of sea service as an officer in charge of the navigational watch. Note that the amendments published for public comment on 06 August 2019 under regulation 22 requires 24 months of sea service (available online at *http://www.samsa.org.za/Acts%20and%20Regulations/Regulations/Merchant%20Shipping(Safe%20Manning,Training%20and%20Certification)Amendment%20Regulations%202015/MS%20(Safe%20Manning,%20Training%20and%20Certification)%20Regulations,%202013.pdf*, accessed 09 December 2019). See also the minimum mandatory requirements for certification of a master in charge of a vessel of 500 gross tonnage or more under Regulation II/1 of the STCW Convention. The STCW Convention applies in South Africa by way of the SMTC Regulations and the South African Maritime Safety Authority (SAMSA) Marine Notice No. 19 of 2019 Draft Regulations relating to Seafarers Education, Training, Assessment and Certification and the Safe Manning of Ships published on the 06 August 2019.

> 'The legal powers exercised by the master on board ship will cease to have any object. No longer is there anybody on board who is responsible for the nautical command of the ship, or who may in case of emergency perform legal acts on behalf of the owners, exercise the employer's authority over a community of workers temporarily isolated from society, and who in certain circumstances represents authority.'[34]

Van Hooydonk powerfully paints the future position as follows:

> 'Better communications, automation, the services of pilots and the instructions of shore-based traffic managers, computer-controlled planning of container stows, etc mean that the captain has ever less autonomy, even when taking nautical and other operational decisions … Once unmanned ships appear on the world's shipping lanes, this degradation will have reached its nadir, the captain will be banished from his ship. This once so considerable office will be no more than a romantic memory.'[35]

V SHIPOWNER'S LIABILITY

The shipowner is generally the party that is held liable for collision damage and is the one who is indirectly brought before the court to defend an action against his/her vessel(s). It has been suggested that the law as it stands regarding a shipowner's liability should be left as it is, as the shipowner will be considered liable no matter how the vessel is operated.[36] The question that arises here, however, is whether the shipowner could still be held liable for collision damage where the unmanned vessel was operated and navigated independently from a SCC and by an independent SBCO or voyage programmer.

As has been shown above under chapter two, liability for collision damage is currently determined using a fault-based liability system, in which a test of negligence is conducted. In general, maritime laws nationally and internationally have accepted this to be the correct method for determining liability. To determine collision liability on the current fault-based liability system means that there must be an enquiry into the conduct of the shipowner relating to the management of the vessel as well as an enquiry into the conduct of the shipowner's 'servants' (being the master and crew) in the navigation and operation of the vessel. However, where the shipowner chooses to conduct his/her business using an unmanned or an autonomous vessel, the enquiry will no longer involve an investigation into the conduct of the master and

[34] Van Hooydonk op cit note 14 at 412.
[35] Ibid.
[36] Zampella op cit note 11 at 215.

crew as they will no longer be present on board the vessel. Thus, the following is analysed hereunder:

- a general discussion on the South African principles of liability (negligence, strict liability, vicarious liability and liability for independent contractors);
- an analysis into whether the SBCO or voyage programmer will be considered as 'servants' of the shipowner for the purposes of a collision liability enquiry (employees versus independent contractors);
- an analysis of whether the shipowner can be held liable for the conduct of these two parties;
- whether negligence will continue to be the appropriate test when enquiring into collision liability or whether another liability test (such as using a strict liability test) will be more appropriate for the unmanned and autonomous vessel scenario; and
- lastly, the shipowner's right of recourse against the manufacturer or the software provider for malfunctioning autonomous systems.

(a) Negligence, strict liability and vicarious liability

Under South African law, liability for negligence is based on the principle that the law disapproves of the defendant's conduct in his/her actions towards causing the harm.[37] The enquiry, therefore, involves an evaluation of the defendant's conduct compared against a standard of conduct that is socially acceptable by the public. Where the defendant's conduct falls outside this socially acceptable standard, the defendant will be considered negligent and will be held liable for causing the resultant harm.[38] Thus, the defendant's conduct is tested against an objective standard of the reasonable person (*bonus paterfamilias*) which is based upon the principle that:

> 'a person is blamed for an attitude or conduct of carelessness, thoughtlessness or imprudence because, by giving insufficient attention to his actions, he failed to adhere to the standard of care legally required of him'.[39]

Strict liability, on the other hand, is a form of liability with no fault. It expresses the viewpoint that a society must hold a person liable for their conduct where they have chosen to act in a certain way, or where there is a risk associated to their action that then causes harm to another.

[37] J Neethling & JM Potgieter et al *Law of Delict* 7th ed (2015) 137.
[38] Max Loubser & Rob Midgley et al *The Law of Delict in South Africa* 3rd ed (2018) 154.
[39] Neethling et al op cit note 37 at 137.

Loubser and Midgely et al describe the nature of strict liability (liability without fault) as follows:

> '…society determines that the nature of the conduct, or the risk associated with the conduct is such that the responsible person or entity should compensate anyone who suffers harm as a result of the conduct.'[40]

There are various general characteristics that make up the essence of liability without fault. Neethling and Potgieter et al set them out as follows:

> '*(a)* Fault is not required for liability in claims for compensation;
> *(b)* *Vis major* (act of God) and fault on the part of the prejudiced person are generally recognised as defences;
> *(c)* Strict liability is usually imposed – either by legislation or judicial pronouncement – in cases involving activities which as a rule create extraordinary increases in the risk of harm to the community;
> *(d)* In instances where strict liability has been imposed by legislation, the extent of the liability is usually curtailed by fixing maximum amounts of compensation; and
> *(e)* Liability without fault is restricted in most cases to damage to life, limb and property (and therefore does not include pure economic loss).
>
> In Continental systems, liability without fault originated primarily from legislation, while in Anglo-American law, case law played the dominant role. In South Africa, both the legislature and the courts have contributed to the development of liability without fault'.[41]

There are two theories behind liability without fault. The first is the interest/profit theory. This theory states that 'where a person acts in his *own interest*, and causes harm to another, he bears the burdens and disadvantages which his activities bring about'.[42] Thus, someone who is acting in his/her own interests, and benefits as a result of that activity, should then bear the responsibility for any harm that results from that activity.[43] The second theory is the risk/danger theory. This theory states that

[40] Loubser et al op cit note 38 at 458.
[41] Neethling et al op cit note 37 at 381.
[42] Neethling et al op cit note 37 at 380.
[43] This theory has been criticised by Neethling et al op cit note 37 at 380, who references JC Van der Walt 'Strict Liability in the South African law of delict' (1968) *Comparative and International Law Journal of Southern Africa* 49 – 83 (Van der Walt *Risiko-aanspreeklikheid* 203 ff).

> 'where a person's activities create a considerable increase in the risk or danger of causing harm, ie, an increased potential for harm, there is sufficient justification for holding him liable for damage even in the absence of fault'.[44]

Since the core principle behind delict law in South Africa is that there can be no liability where there is no fault,[45] the question that arises, then, is whether there are any restrictions on imposing strict liability in South Africa. The answer is that there are many areas of South African law that already impose strict liability on individuals who undertake an action with an associated risk that could potentially have a harmful outcome on others. The most obvious example is found under labour law in the relationship between employers and employees.[46] An employer can be held vicariously liable for an employee's actions. Loubser and Midgely et al state that vicarious liability can be seen as a form of strict liability:

> 'This is where the employer is held liable without fault for the wrongdoing of an employee, and the liability of the employee, determined according to the normal principles of delict (including fault), is transferred to the employer'.[47]

This form of liability is already used under international maritime laws where the shipowner can be held liable for the wrongful conduct of his/her 'servants', being the master and crew on board the shipowner's vessel. The issue that arises here is whether the SBCO of the unmanned vessel (or the voyage programmer of the autonomous vessel) will be considered as 'servants' of the shipowner for the purposes of determining collision liability. This further leads to the question of whether the current fault-based liability regime will continue to be the sufficient test to use when determining collision liability, or whether a new system should be adopted (such as the strict liability test). These two aspects will be discussed hereunder.

(b) Employees versus independent contractors

Employees and independent contractors have been distinguished by South African courts by the type of contract of service that they hold. The main distinguishing feature is that:

[44] Neethling et al op cit note 37 at 380.
[45] Ibid. Loubser et al op cit note 38 at 458.
[46] Other examples of strict liability in South Africa can be found under the Aviation Act, 74 of 1962 (discussed in further detail under part VI of this chapter); the Post and Telecommunication-related Matters Act, 44 of 1958; and the Genetically Modified Organisms Act, 15 of 1997. Neethling et al op cit note 37 at 401 – 402. Loubser et al op cit note 38 at 458.
[47] Loubser et al op cit note 38 at 458.

> 'an employee is under the control of the employer in respect of the nature of the work and the manner in which it is to be done, whereas an independent contractor is not subject to the control of the person paying for the services'.[48]

An employee's contract of employment usually terminates upon death or when the agreed period has expired, while an independent contractor is contracted to perform certain specified work which may not have a specified deadline or time limit. The courts will, however, take into consideration all the relevant factors under the circumstances in order to determine whether the person is an employee or an independent contractor. Some of the factors taken into consideration are:

- the nature of the work;
- the manner of performing that work;
- the manner of payment;
- the state of the social and economic interdependence of the person;
- the authority to give instructions;
- whether any membership of medical or pension fund is involved;
- whether there is any provision for paid vacation;
- the number of working hours required;
- the use of the employer's premises and equipment; and
- to what extent the person performing the work forms an essential part of the business organisation.[49]

(c) The shipowner's liability for the SBCO and voyage programmer

In applying these general principles of fault liability to a Maritime Autonomous Surface Ship (MASS) collision, it is clear that each case will need to be decided on the basis of its own facts. This would entail at least two potentially complex factual enquiries.

Firstly, should it be decided that the SBCO, or voyage programmer, is in fact an employee of the shipowner, the shipowner could then be held vicariously liable for the damage caused by a collision in which the SBCO negligently operated the unmanned vessel, or the voyage programmer negligently input erroneous information into the autonomous vessel's system.

[48] *Smit v Workmen's Compensation Commissioner* 1979 (1) SA 51 (A). Loubser et al op cit note 38 at 469.
[49] See the test used in the cases of *Midway Two Engineering & Construction Services v Transnet Bpk* 1998 (3) SA 17 (SCA); and *Stein v Rising Tide Productions CC* 2002 (5) SA 199 (C). Loubser et al op cit note 38 at 469.

On the other hand, should it be decided, instead, that either one of or both the SBCO and voyage programmer are not employees of the shipowner, but are rather independent contractors, the question arises as to whether a similar conclusion can be reached (but which requires an additional step in the analysis) under South African law as:

> '…a person is liable for the acts of an independent contractor only in respect of operations where there is a 'non-delegable' duty, in other words, where engaging a contractor does not absolve the employer from a duty not to harm third parties, such as when the operations involve an abnormal level of danger'.[50]

South African courts have expressed that this enquiry is not a question of vicarious liability but rather a question of whether the employer had personal liability[51] on the basis that he/she had the duty to take reasonable precautions to ensure that no danger ensued from undertaking the dangerous activity. In the case of *Langley Fox Building Partnership (Pty) Ltd v De Valence*[52] the court states as follows:

> '… if work entrusted to an independent contractor is of such a character that, if the contractor does the work and no more, danger will ensue, then liability for damages remains with the employer on the failure of his contractor to take precautions in addition to doing the work. It is the duty of the employer to take such precautions as a reasonable person would take in the circumstances'.[53]

On the other hand, where an employer undertakes the services of a skilled independent contractor, 'where the extent of the danger and the reasonably practicable measures to minimise it can only be determined by such skilled person',[54] the employer can be discharged from liability as he/she will be considered to have taken all reasonable measures to eliminate or minimise the potential dangers associated with that activity. This is an example of where the South African courts have recognised that there may be situations where it would be reasonable to rely solely on the expertise of an independent skilled contractor. The court states this as follows:

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[50] Loubser et al op cit note 38 at 469, discussing *Langley Fox Building Partnership (Pty) Ltd v De Valence* 1991 (1) SA 1 (A). See also *Chartaprops 16 (Pty) Ltd v Silberman* 2009 (1) SA 265 (SCA) at 272A; and *Pienaar v Brown* 2010 (6) SA 365 (SCA).
[51] *Chartaprops* ibid at 278E-F, para 29.
[52] *Langley Fox* supra note 50.
[53] *Langley Fox* supra note 50 at 11B.
[54] *Langley Fox* supra note 50 at 11C. See generally the full discussion at 10A-13C.

> 'In my opinion, therefore, the duty to take care where the work undertaken is *per se* dangerous could in some cases be discharged by delegating its performance to an expert. In my judgment, the correct approach to the liability of an employer for the negligence of an independent contractor is to apply the fundamental rule of our law that obliges a person to exercise that degree of care which the circumstances demand'.[55]

There are earlier decisions setting out the position that there is a non-delegable duty on an employer who appoints an independent contractor for an inherently dangerous activity to ensure that the proper precautions are taken. However, the SCA has made it clear that this is not an invariable rule as in certain circumstances it may be reasonable to rely solely on the skill of the independent contractor. In the latter circumstance, the employer would not be liable even if the independent contractor had acted negligently.

In any case, South African courts are required to consider the

> 'extent of the danger, the degree of expertise available to the employer and the independent contractor respectively, and the reasonably practicable means available to the employer to avert the danger'.[56]

VI AN ARGUMENT IN FAVOUR OF THE STRICT LIABILITY APPROACH

Neethling and Potgieter et al state that the traditional basis in the law of delict is that of the fault theory, which stipulates that there can be no liability without fault. However, due to the industrial and technological revolutions from the 18th to the 20th century, a new approach was developed to accommodate appropriately the new challenges that machinery and technology brought with them. This new approach is the liability without fault approach. Thus, it can be seen that liability without fault was a reaction to the technological developments of this new era, which is evidence in itself that liability without fault (also referred to as strict liability) has become the better method in determining liability for technological malfunctions.[57]

In applying the general characteristics of strict liability (discussed under section V(a) above) to the unmanned and autonomous vessel scenarios, the following can be seen: Firstly:

(a) Fault will not be a requirement when determining liability in claims for compensation for unmanned/autonomous collision damages;

[55] *Langley Fox* supra note 50 at 11D-E.
[56] *Langley Fox* supra note 50 at 13B. Loubser et al op cit note 38 at 471.
[57] Neethling et al op cit note 37 at 379.

(b) Acts of God (*vis major*) and fault on the part of the prejudiced person will be recognised as defences;

(c) Strict liability can be imposed through international conventions (governing collisions with unmanned and autonomous vessels) in cases involving activities which as a rule create extraordinary increases in the risk of harm to the community (such as the use and operation of an unmanned or autonomous vessel);

(d) In instances where strict liability has been imposed by legislation, the extent of the liability can be curtailed by fixing maximum amounts of compensation;[58] and

(e) The liability without fault approach will be restricted in most cases to damage to life, limb and property (all of which the operation and navigation of an unmanned and autonomous vessel involve).

Secondly, the two theories justifying the use of strict liability will apply to the unmanned and autonomous vessel scenario as a shipowner will be both investing a personal interest and benefiting from the profits thereof in conducting his/her business with autonomous technologies; and by choosing to conduct his/her business with an unmanned or autonomous vessel, the shipowner will be increasing the level of risk and danger associated with navigating a vessel at sea.

In order for this to apply, it needs to be expressly stated in international conventions that the operation of an unmanned and autonomous vessel should be considered as an operation that involves an abnormal/increased level of danger. It has been suggested that such an approach should be taken for these forms of vessels.[59] Zampella indicates that adopting this strict liability approach may be the direction to go towards for collision liability involving unmanned and autonomous technology:

[58] This would entail the various national laws imposing a monetary limit on collision liability. Under an international maritime context, however, this would entail a consideration of the issue on whether there should be an amendment to the current convention on limitation of liability for maritime claims or whether a new separate limitation of liability convention dealing with unmanned and autonomous vessels should be developed.
[59] Zampella op cit note 11 at 216.

> 'It might be considered as a solution to avoid the issues deriving from the investigation of fault and negligence regarding new kinds of activities closely dependent on technology. After all, if we consider the employment of an unmanned vessel as a type of activity inherently dangerous, this would justify the adoption of a strict liability regime, for a protection of the other users of the sea from the natural risks deriving from unmanned shipping …'.[60]

This would not be the first time that South African law has recognised the implementation of strict liability for an activity that is considered as inherently dangerous. The South African Aviation Act (AA)[61] imposes strict liability on the owner of an aircraft where material damage has been caused by his/her aircraft. Section 11(2) states:

> 'Where material damage or loss is caused by an aircraft in flight, taking off or landing, or by any person in any such aircraft, or by an article falling from any such aircraft, to any person or property on land or water, damages may be recovered from the owner of the aircraft in respect of such damage or loss, *without proof of negligence or intention or other cause of action* as though such damage or loss had been caused by his wilful act, neglect or default' (emphasis added).

Further to this, just as in the case of maritime law where the charterer is deemed the owner of the ship for the period of the charter by demise for the purpose of an action in rem,[62] South African aviation law recognises that:

> '[w]here any craft has been *bona fide* leased or hired out for a period exceeding fourteen days to any other person by the owner thereof, and no pilot, commander, navigator, or operative member of the crew of the aircraft is in the employment of the owner, this section shall have the effect as though for references to the owner, there were substituted references to the person to whom the aircraft has been so leased or hired out'.[63]

It has already been suggested that aviation laws are more suitable to a high technology environment and serve as a useful precedent for the development of maritime law.[64]

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[60] Ibid 216–217.
[61] Act 74 of 1962.
[62] Section 1(3) read with section 3(4) of AJRA. Thus, in admiralty a collision can not only give rise to a claim in personam against the demise charterer, but an action in rem against the ship itself could also be pursued (which is not a remedy available in aviation law).
[63] Section 11(6) of the Aviation Act, 74 of 1962.
[64] Zampella op cit note 11 at 3, where he states that aviation laws have proven to be more advanced than maritime laws worldwide. Thus, he suggests that aviation laws be used as a guide/model in advancing maritime laws, especially in respect of developing technologies in the industry.

To devise a new strict liability system under either domestic or international maritime law would mean that liability will be linked directly to the actions of the SBCO or voyage programmer where their actions were the factual and legal cause of the collision. It would, however, not require a determination of their fault (negligence) or the shipowner's fault in relation to such actions. Using this system would also mean that the negligence of parties such as the manufacturer and software provider would be excluded from the enquiry into the liability of the shipowner.[65]

Since the shipowner has chosen to undertake the risk of conducting his/her business using an unmanned or autonomous vessel, where such an activity is considered as inherently dangerous, it can be justified that the law adopt a strict liability approach in holding the shipowner liable for any damage resulting from the use and operation of these new forms of vessels, such as where there is a system malfunction with the autonomous software/autonomous onboard systems, or even where there is negligence on the part of the shipowner's 'servant', 'agent', 'employee' or 'independent contractor'. Such a collision liability regime can appropriately accommodate the use of this new autonomous technology in the maritime industry and can ensure that the general use of such vessels on the high seas is regulated and provides equivalent safety to the operation of conventional vessels.

Furthermore, the approach of the courts to the use of independent contractors in relation to a shipowner's duty to make a vessel seaworthy under article III rule 1 of the Hague Rules[66] and the Hague-Visby Rules[67] may also be helpful to consider, although it arises in a different context. In the case of the '*Muncaster Castle*',[68] the court gave a wide interpretation of the words in the Hague-Visby Rules.[69] In doing so, the court interpreted the shipowner's duty as a non-delegable duty in that he/she remains liable where he/she has employed the services of an independent contractor. This is evident from the following passage taken from the case:

[65] A strict liability system should not, however, exclude the possibility of the shipowner seeking indemnification from manufacturers and software providers where technology failure or errors in the programming are showing to have contributed to the collision.
[66] The International Convention for the Unification of Certain Rules of Law relating to Bills of Lading, and Protocol of Signature, 1924.
[67] The Hague Rules as amended by the Brussels Protocol, 1968.
[68] *Riverstone Meat Company (Pty) Ltd v Lancashire Shipping Company Ltd* [1961] 1 All ER 495 ("*The Muncaster Castle*" case).
[69] *The Muncaster Castle* ibid at 502–505.

> 'An attempt was made to draw a distinction between negligence shown by the shipowner's servants, his agents and independent contractors. But this could but fail. For no sensible reason could be found for such a distinction. To take a relevant example: repair work might equally be entrusted by a shipowner to his own servants or to an independent contractor. To fasten him with liability for negligence in the one case but not in the other would wholly defeat the purpose of the Act.'[70]

The court further stated (by referring to the case of *Northumbrian Shipping Co Ltd v E Timm & Son Ltd*[71]) that the Canadian Water Carriage of Goods Act[72] has taken a similar approach in interpreting the shipowner's liability to make the vessel seaworthy:

> 'The obligation to make a ship seaworthy is personal to the owners, whether or not they entrust the performance of that obligation to experts, servants or agents'.[73]

The strict liability system has not been welcomed by many maritime nations in the past.[74] It would not, however, be the first time that international maritime laws recognise the use of such a system when determining compensation for damages.[75] In any case, should this new method be accepted by the various maritime nations, there is still the issue of uniformity. The determination of collision liability for the unmanned and autonomous vessel may begin to differ from one country to the next, which will promote a divergence from one of the core principles of international maritime law, that of uniformity,[76] and this should be avoided across the international plane. Lastly, it must be borne in mind that introducing a strict liability approach will have additional implications on the shipowner's cost of insurance cover for civil liability. While there is a great need to implement an efficient system to determine collision

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[70] *The Muncaster Castle* supra note 68 at 503.
[71] [1939] 2 All ER 648; [1939] AC 397.
[72] See sections 6 and 7 of the Water Carriage of Goods Act, 1910 (Canada).
[73] *The Muncaster Castle* supra note 68 at 504, quoting the case of *Northumbrian Shipping* supra note 71 at 651 (All ER) and 403 (AC).
[74] This is evidenced by the reaction of the many maritime nations (under which the large carriers operated) to the United Nations Convention on the Carriage of Goods by Sea, 1978 ('the Hamburg Rules'). These particular maritime nations refused to ratify the convention for fear of the strict liability it imposed on the Carriers in the exercise of their duties and responsibilities relating to the carriage of goods by sea (Francis Reynolds *The Hague Rules, the Hague-Visby Rules, and the Hamburg Rules* (Maritime Law Association of Australia and New Zealand Journal) (1990) 30 – 33).
[75] One example is the International Convention on Civil Liability for Oil Pollution Damage, 1969 (CLC), which places a strict liability on the shipowner to compensate for oil pollution damage caused by his/her vessel (Zampella op cit note 11 at 17).
[76] Stated by Justice McReynolds in 1916 in the US case of *Southern Pacific Co. v Jensen* 244 U.S. 205, 215, 216 (1916) as follows: 'The general maritime law as accepted by the federal courts constitutes part of our national law applicable to matters within the admiralty and maritime jurisdiction … no such [state] legislation is valid if it … works material prejudice to the characteristic features of the general maritime law or interferes with the proper harmony and uniformity of that law in its international and interstate relations'. (Harvard Law Review Notes 'Uniformity in Maritime Law' (1924) 37 (8) *Harvard Law Review* 1114 – 1118).

liability, the stricter the legal regime is, the more it becomes possible to discourage the adoption of these vessels, making them commercially unviable.

VII SHIPOWNER'S RIGHT OF RECOURSE AGAINST THE MANUFACTURER AND SOFTWARE PROVIDER

Under South African law, a shipowner will still have the opportunity to seek right of recourse against the manufacturer and software provider for malfunctioning autonomous systems. This falls under the category of product liability, which can be regulated by the shipowner by way of a contract. Shipowners would be well advised not to accept standard end-user licence agreements and developer terms and conditions of service that do not include an adequate right of recourse in the event of a technological failure. Alternatively, product liability can be dealt with under delict law.[77] However, a shipowner will not be able to rely on product liability imposed by way of statute.[78]

VIII CONCLUSION

It is apparent that the introduction of unmanned and autonomous vessels will no doubt bring some form of change to the maritime legal framework as we know it today. For the most part, the shipowner's identity and role will remain the same, as a shipowner can be held liable regardless of how his/her vessel is operated. As illustrated above, it is in relation to the master's role in the maritime industry that we can expect colossal changes. The more technology develops, the more the master's role will degrade until he/she eventually becomes a distant figure blown into the winds of history.

The digital age is already upon us and its effect, not only on the maritime industry, but on the world as a whole, is inevitable. International legislation will need to be modified or adapted to

[77] See generally Loubser et al op cit note 38 from pages 305 – 309 and the cases cited therein. As to the particular principles that guide the imposition of delictual liability where there is already a contract between the parties, the locus classicus is *Lillicrap, Wassenaar and Partners v Pilkington Brothers (SA) (Pty) Ltd* 1985 (1) SA 475 (A), most recently referred to with approval in the Constitutional Court in *Arun Property Development (Pty) Ltd v City of Cape Town* 2015 (3) BCLR 243 (CC) at para [68] and *Country Cloud Trading CC v Member of the Executive Council, Department of Infrastructure Development, Gauteng* 2014 (12) BCLR 1397 (CC) at para [63]. This issue of product liability on the software provider for software malfunctions has not been considered recently under South African legal literature. This is a relatively new area and the legal literature on the chain of product liability for software malfunctions is relatively limited.

[78] In South Africa, the Consumer Protection Act, 68 of 2006 (CPA) governs product liability for the supply of defective or unsafe goods (see in particular section 61(1) of the CPA). However, section 5(2) of the CPA specifically provides for the instances under which the CPA does not apply, of which section 5(2)(b) states '[t]his Act does not apply to any transaction— (b) in terms of which the consumer is a juristic person whose asset value or annual turnover, at the time of the transaction, equals or exceeds the threshold value determined by the Minister in terms of section 6'. Thus, a shipowner will not be able to rely on product liability imposed by way of statute under South African law.

account for the new legal entities that are emerging with unmanned and autonomous technology.[79] Suggestions for the near future to accommodate these new forms of vessels include extending the role of the master to the shore-based control operator and considering ways in which the current fault-based liability system can consistently apply to them.

What will need to be borne in mind is that technology develops at an alarmingly rapid pace and the arrival of both unmanned and autonomous vessels is upon us. Since both forms of vessels will bring about some change to the legal framework of maritime law, the extreme cases presented by fully autonomous vessels operating independently of human control by the use of complex algorithms needs to be considered as well. Thus, for the long-term future, it is suggested that the new legal entities of the voyage programmer and the SBCO be uniformly defined[80] and that their duties and responsibilities be accounted for when legislators consider modifying and adapting the current international collision legislation. It is extremely important that this is done in order to ensure that there is a continuation of safe navigation at sea and a continuation in the uniformity of maritime law as a whole. This is particularly relevant when considering the adoption of a strict collision liability regime in order to accommodate and protect the use of these new autonomous technologies in the maritime industry.

The above analysis has explored the effects of adopting a strict liability approach to the unmanned and autonomous vessel scenario. It has been discovered that where the shipowner chooses to conduct his/her business using an unmanned/autonomous vessel, applying the fault-based liability system for any collision damage resulting from his/her business would entail an enquiry into the conduct of the SBCO or voyage programmer, in terms of which the shipowner may be held vicariously liable where the SBCO or voyage programmer is considered under the same umbrella as the master, being a 'servant'/employee of the shipowner.

Where the SBCO and/or voyage programmer are not considered employees of the shipowner, an additional enquiry will need to be made into the shipowner's personal liability in exercising the duty of care required to minimise the risk of danger associated with unmanned and autonomous navigation. Where a shipowner has discharged his/her duty to exercise the

[79] Some examples of international legislation that will need to be amended include: the COLREGS (as above); the United Nations Convention on the Law of the Sea, 1982 (UNCLOS); the International Convention for the Safety of Life at Sea, 1974 (SOLAS); the International Safety Management Code, 1994 (ISM Code); the Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, 1910 (the 1910 Brussels Collision Convention); the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), among many others. These are discussed in further detail under Chapter four of this dissertation.

[80] MUNIN has already defined certain autonomous concepts which can be taken into consideration when deciding on uniform definitions under international law (MUNIN Research Project Results op cit note 10 at 2).

required duty of care in eliminating or minimising the risk of danger associated with autonomous navigation by undertaking the services of a skilled independent contractor (being a skilled SBCO or skilled voyage programmer), the shipowner will not be held liable for collision damage resulting from any negligence on the part of the skilled independent contractor. Where the shipowner has not discharged such a duty, however, he/she will still be held liable for the actions of the independent contractor where the activity involves an increased level of danger to the community.

Where a collision occurs as a result of an onboard autonomous system malfunction, it is suggested that a strict liability approach be adopted in holding the shipowner liable for such collision damage on the basis that the shipowner is benefiting from the profit of conducting his/her business through unmanned/autonomous navigation, and that he/she is undertaking an inherently dangerous activity that endangers the community. Should such an approach be adopted, a limitation of liability should be developed (as provided by most forms of liability without fault).[81] The shipowner will further not be excluded from claiming damages from the software provider or manufacturer under product liability for the supply of defective or unsafe goods.

[81] Neethling et al op cit note 37 at 381. See further chapter three section V*(a)* of this dissertation for the general characteristics of liability without fault.

CHAPTER 4

APPROACHES CONSIDERED BY INTERNATIONAL ORGANISATIONS AND NORWAY

I INTRODUCTION

This chapter considers the work of international organisations that are investigating approaches towards the introduction of unmanned and autonomous vessels to the maritime industry. Norway, in particular, is at the forefront of these latest industry developments, with many unmanned and autonomous vessels currently undergoing tests in their national coastal waters.[1]

Various legal commentaries have identified the major issues associated with these new forms of vessels, the majority of which involve aspects of the regulation of safety and security in the operation of unmanned and autonomous vessels at sea. Naturally, this includes the aspect of liability for collisions at sea, which is the core topic of this dissertation.

In analysing the various legal challenges identified by legal commentary, the following will be discussed:

- a brief introduction to the International Maritime Organisation (IMO);
- issues identified by the IMO in relation to the unmanned and autonomous vessel;
- the Comité Maritime International (CMI) and the findings of their working group;
- the Baltic and International Maritime Council (BIMCO) and their position on unmanned and autonomous vessels;
- a background to the Norwegian Collision Laws; and
- lastly, issues identified by scholars from Norway, as well as any suggestions and/or recommendations made by them to provide a solution to these identified issues.

II THE INTERNATIONAL MARITIME ORGANISATION

The International Maritime Organisation (IMO) is a United Nations organisation and is the 'global standard-setting authority for the safety, security and environmental performance of international shipping'.[2] The IMO allows international collaboration, and places all members on the same level, ensuring that no corners are cut in relation to safety regulations,

[1] World Maritime News 'Norway Opens New Test Area for Autonomous Ships' available at *https://worldmaritimenews.com/archives/237297/norway-opens-new-test-area-for-autonomous-ships/*, accessed on 20 September 2019.
[2] IMO webpage available at *http://www.imo.org/en/About/Pages/Default.aspx*, accessed on 30 August 2019.

environmental protections and security performances simply to cut financial costs.[3] It is imperative that such a vast and powerful sector of the world be effectively regulated. As accurately stated on the IMO website:

> 'International shipping transports more than 80 per cent of global trade to peoples and communities all over the world. Shipping is the most efficient and cost-effective method of international transportation for most goods; it provides a dependable, low-cost means of transporting goods globally, facilitating commerce and helping to create prosperity among nations and peoples. The world relies on a safe, secure and efficient international shipping industry – and this is provided by the regulatory framework developed and maintained by IMO. IMO measures cover all aspects of international shipping – including ship design, construction, equipment, manning, operation and disposal – to ensure that this vital sector for [*sic*] remains safe, environmentally sound, energy efficient and secure'.[4]

Thus, it is the IMO's responsibility to regulate safety, security and environmental protection at an international level. The IMO has already developed a wide range of maritime conventions and regulations to govern safety and security at sea. Some of these key conventions and regulations are:

- The International Convention for the Safety of Life at Sea, 1974 (SOLAS);
- The International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL);
- The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), including the 1995 and 2010 Manila Amendments;
- The Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS); and
- Convention on Limitation of Liability for Maritime Claims, 1976 (LLMC), among many others.[5]

[3] South Africa became a full member of the IMO in 1995. See the IMO Member States available at *http://www.imo.org/en/About/Membership/Pages/MemberStates.aspx*, accessed on 25 November 2019.
[4] Op cit note 2.
[5] See the list of conventions on the IMO webpage available at *http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/Default.aspx*, accessed on 20 September 2019.

(a) The IMO on the topic of unmanned and autonomous vessels

The IMO has already commenced assessments on the existing international conventions and regulations that govern safety at sea in order to analyse how they can be applied to vessels that have varying degrees of automation.[6] In doing so, the IMO has set up a Maritime Autonomous Surface Ships (MASS) working group, which is due to meet on an intersessional basis (as of September 2019) and their findings will be reported at the next Maritime Safety Committee (MSC) meeting in May 2020.[7]

Furthermore, the MSC approved a set of interim guidelines for unmanned and autonomous vessel trials at its 101st session in June 2019. These guidelines set out the manner in which trials should be conducted on unmanned and autonomous vessels to ensure that at least the current degree of safety at sea is maintained.[8] These guidelines have the support of BIMCO.[9] Further to this, the MSC has developed a framework approved by the IMO to assess if the relevant conventions:

- apply to MASS but prevent MASS from operating; or
- apply to MASS and do not prevent MASS from operating, thus requiring no further actions; or
- apply to MASS and do not prevent MASS operations but still require further action, such as an amendment or clarification as they may contain gaps; or
- have no application to MASS operations at all.[10]

[6] IMO webpage 'Autonomous Shipping' available at *http://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx,* accessed on 21 September 2019.

[7] Martyn Wingrove 'IMO outlines autonomous ship trial guidelines' available at *https://www.rivieramm.com/news-content-hub/news-content-hub/imo-outlines-autonomous-ship-trial-guidelines-55664,* accessed on 26 November 2019.

[8] MSC Interim Guidelines available at *https://www.register-iri.com/wp-content/uploads/MSC.1-Circ.1604.pdf,* accessed on 26 November 2019. See also the IMO webpage 'Maritime Safety Committee (MSC), 101 Session, 5-14 June 2019' available at *http://www.imo.org/en/MediaCentre/MeetingSummaries/MSC/Pages/MSC-101st-session.aspx,* accessed on 21 September 2019; and Wingrove ibid. These guidelines have the support of BIMCO. See BIMCO's position on autonomous vessels available at *https://www.bimco.org/about-us-and-our-members/bimco-statements/12-autonomous-ships,* accessed on 29 November 2019.

[9] BIMCO is discussed in further detail under chapter four section IV of this dissertation.

[10] International Harbour Masters Association 'The IMO Maritime Safety Committee (MSC) 100th session 3-7 December 2018 (Based on a Media Briefing kindly provided by IMO staff)' available at *https://www.harbourmaster.org/News/imo-maritime-safety-committee-msc-100th-session-3-7-december-2018-based-media-briefing-kindly,* accessed on 26 November 2019.

These relevant conventions have been tabled into a spreadsheet by the Comité Maritime International Working Group.[11]

III COMITÉ MARITIME INTERNATIONAL

The Comité Maritime International (CMI) is a non-profit and non-governmental organisation the aim of which is 'to contribute by all appropriate means and activities to the unification of maritime law in all its aspects'.[12]

In 2015, the CMI set up a working group called the International Working Group (IWG) to analyse the legal implications of unmanned vessels. The IWG posted a Position Paper on Unmanned Ships entitled the 'CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework'.[13] Section five of the paper considers the general rules of liability for collision matters. It confirms the position that civil liability for collision matters varies greatly from jurisdiction to jurisdiction but that most decisions are based on a fault-based liability regime (prescribed internationally by the Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, 1910 (the 1910 Brussels Collision Convention)) and that there are certain instances under international maritime laws that already require a strict liability approach.[14]

The CMI has also created a questionnaire on unmanned ships which was circulated in March 2017 to the various Maritime Law Associations worldwide.[15] The Maritime Law Association of South Africa (MLA) responded to the questionnaire,[16] and the following was put forward:

a. The definition of a master under the South African Merchant Shipping Act (MSA)[17] and the Ship Registration Act (SRA)[18] does not expressly state that a master must be on board a vessel; however, it does state expressly that the master must be in 'command'

[11] CMI *Maritime Law for Unmanned Ships: Spreadsheet Regarding Conventions* available at *https://comitemaritime.org/work/unmanned-ships/*, accessed on 26 November 2019. The CMI questionnaire on unmanned ships is also available at this internet URL.
[12] CMI webpage available at *https://comitemaritime.org/about-us/*, accessed on 26 November 2019.
[13] 'CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework' available at *https://comitemaritime.org/wp-content/uploads/2018/05/CMI-Position-Paper-on-Unmanned-Ships.pdf*, accessed on 26 November 2019.
[14] Ibid at 17–18.
[15] Op cit note 11. The questionnaire has been completed by the following nations: Argentina, Australia, Belgium, Brazil, Canada, Croatia, Finland, France, Germany, Greece, India, Ireland, Italy, Japan, Malta, Netherlands, Panama, Singapore, South Africa, Spain, UK, US, Venezuela.
[16] Ibid.
[17] Act 57 of 1951.
[18] Act 58 of 1998.

or in 'charge' of a vessel. The MLA is of the opinion that this definition does not include the shore-based control operator.[19]

b. Section 16 of the SRA does not limit the registration of ships based on the method by which they are controlled, thus South African nationals and residents will not be precluded from registering their unmanned and autonomous ships in South Africa. The MLA is of the opinion, however, that the drafters of this legislation did not contemplate the existence of these forms of vessels. Thus, one must be 'cautious in extending the application of its provisions'.[20]
c. The MLA has established that remote controllers of unmanned vessels cannot be included under the term 'crew' as the definition stipulates that crew means 'all seafarers on board a ship'.[21]

In addition to this, the CMI has identified over 50 relevant conventions that will be impacted by unmanned and autonomous vessels. These relevant conventions have been tabled into a spreadsheet and marked according to the required actions for each provision of each convention,[22] of which the following conclusions were reached:

a. The CMI confirms the position that the scope of the various actors (including the new emerging actors) must be clarified.[23] This was stated as follows:

> 'It is necessary to agree on the scope of the term "master" (and, in some cases, "crew", "officer" or "person having charge of the ship") in an unmanned shipping context. More specifically a clarification is necessary as to whether an unmanned ship's remote controller or, for autonomous ships, another responsible person onshore, can assume the obligations of the master (or other responsible person) for these purposes'.[24]

b. As discussed in chapter three, the CMI confirms that rule 1 of the COLREGS will apply to unmanned and autonomous vessels on the basis that it applies 'to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels'. The

[19] See the discussion under chapter three section IV*(b)* of this dissertation.
[20] CMI questionnaire completed by the Maritime Law Association of South Africa op cit note 11.
[21] See section 2 of the MSA.
[22] The three actions identified are 'no more action needed', 'clarification [of provision needed]' and 'amendment [of provision needed]'.
[23] See chapter three for an in-depth discussion on this issue.
[24] CMI *Spreadsheet Regarding Conventions* op cit note 11.

CMI further confirms that the definition of the term 'vessel' under rule 3(a) of the COLREGS is broad enough to include unmanned and autonomous vessels.[25]

c. The CMI further identify that rules 2, 7 and 8 are based on human judgement and the requirement of good seamanship. They are of the opinion that these rules can 'arguably be exercised from shore'; however, their application to unsupervised autonomous vessels is unlikely to be satisfied as it is unknown whether the autonomous technology of today is 'sufficiently sophisticated' to replace the human element contained within them.[26]

d. The CMI confirms the position that rule 5 of the COLREGS will need an amendment as 'the reference to "sight and hearing" strongly indicates that human perception is required'. Alternatively, the position as to whether modern autonomous technology (such as cameras, radar, sound receptacles, and so on) can sufficiently substitute the 'sight and hearing' requirement will need to be clarified.[27]

e. In addition to the COLREG rules discussed in this dissertation, the CMI have further identified rules 3(k), 3(i) and 11 as potentially problematic areas for the unmanned and autonomous vessel. These rules require some clarifications and/or amendments as to the meaning of the terms 'in sight of one another' and 'restricted visibility'.[28]

f. All the rules contained under section II – Conduct of vessels in sight of one another – of the COLREGS can be programmed into an algorithm but are still considered problematic in their application as the 'within sight' requirement still needs clarification.[29]

g. There may be a need to include additional rules under the COLREGS to provide for special situations that require a unified reaction between vessels at sea.[30] An important issue would be to provide for a situation where the unmanned or autonomous vessel loses connection with the SCC, thus rendering a loss of control over the vessel. The possibility of a 'failsafe mode' needs to be considered[31] and a rule could be created stating that the 'uncontrollable vessel' be required to display a warning light automatically in order to notify surrounding vessels immediately of its inability to function without the control of the SBCO. The CMI has specifically stated that the rules

[25] Ibid.
[26] Ibid.
[27] Ibid.
[28] Ibid.
[29] Ibid.
[30] Ibid.
[31] CMI Position Paper op cit note 13 at 15.

in parts C and D of the COLREGS on lights and shapes and sound and light signals need to be considered and they suggest that it may be possible for governments to consider the 'closest possible compliance' with the requirements.[32]

It must be borne in mind that technology continues to develop at an unstoppable pace. There are technologies currently being developed to aid the human limitations (such as sleep, fatigue, limited sight and hearing) out at sea; however, the position of these modern technologies still requires confirmation on whether they are reliable substitutions for the human elements contained within the COLREGS.

IV THE BALTIC AND INTERNATIONAL MARITIME COUNCIL

The Baltic and International Maritime Council (BIMCO) is considered the world's largest international shipping association, with members from all sectors of the maritime industry (including shipowners, operators, managers, brokers and agents).[33] BIMCO supports the trading of autonomous vessels and has taken the following position on their implementation:

a. that a unified set of definitions be created to cover the different levels of automation and their methods of control in order for there to be 'a clearer framework for future regulation';[34]
b. that there be an understanding of the risks and opportunities afforded by autonomous shipping;[35]
c. that the initiatives of the IMO and CMI be supported in order for the changes to international conventions and national laws for autonomous vessels to be applied uniformly on a worldwide scale;[36] and
d. that there still be a recognition of the importance of the human element and that there be a focus on the new skills and competencies required of seamen, as well as on the potential problems arising from a reduction of manning on board these new vessels.[37]

[32] Ibid, which deals with a vessel of 'special construction or purpose'.
[33] BIMCO webpage available at *https://www.bimco.org/about-us-and-our-members*, accessed on 29 November 2019.
[34] BIMCO webpage 'Autonomous Ships' available at *https://www.bimco.org/about-us-and-our-members/bimco-statements/12-autonomous-ships*, accessed on 29 November 2019.
[35] Ibid.
[36] Ibid.
[37] Ibid.

BIMCO has expressly stated that they support the initiatives of the IMO and CMI (including the IMO interim guidelines for MASS trials).[38] In March 2019, BIMCO held an Autonomous Ships seminar in the suburb of Bagsværd (Copenhagen) in Denmark.[39] The aim of the seminar was 'to identify the shipowners' views on this topic, which is currently being driven by manufacturers'.[40]

Luci Carey has published a report that highlights the issues raised at the seminar, many of which have great relevance to this dissertation.[41] The report supports the position that liability is currently based on fault and that it ultimately rests with the shipowner. The possibility of adopting a strict liability approach to MASS in general is also briefly taken into consideration in the report.[42] There is a further suggestion in the report that consideration be given to a liability limitation scheme,[43] where the potential liability of the supplier of the autonomous software becomes relevant in the enquiry.

V NORWAY

(a) A background to the Norwegian legal system and the laws applicable in Norway to collision matters

Norway follows a codified system of law.[44] Norwegian maritime law is contained in the Norwegian Maritime Code,[45] as well as the Ship Safety and Security Act.[46] Collision liability

[38] Ibid.
[39] Further details are available on the BIMCO webpage 'BIMCO Autonomous Ships Seminar' available at *https://www.bimco.org/events/20190327-bimco-autonomous-ships-seminar*, accessed on 29 November 2019.
[40] Ibid.
[41] Luci Carey (2019) *Report on BIMCO Autonomous Ships Seminar* (Report 19/01) *NUS Centre for Maritime Law*. See further Luci Carey (2018) *Report on the 14th IISTL Colloquium on New Technologies and Shipping/Trade Law* (Report 18/05) *NUS Centre for Maritime Law*. The colloquium focused on the 'Impact of New Technologies on Shipping and Trade Law' and covered many of the same issues as this dissertation, including the role of the master, the various permutations of liability, the possibility of adopting a strict liability approach towards collision liability, as well as the impact of these vessels on existing international maritime conventions.
[42] Carey (2019) *BIMCO Report* ibid at 11. There is no indication of whether there was any support by shipowners of a strict liability regime, however it is recorded that this would raise the cost of insurance cover if a strict liability regime is adopted.
[43] See chapter three section VI of this dissertation for a brief consideration of adopting a limitation of liability scheme for collision liability of unmanned and autonomous vessels where a strict liability approach be adopted.
[44] The Norwegian legal system dates back all the way to the 9th century when the country united into one kingdom after several years of being individual regional kingdoms. The first written laws appeared only around the 12th and 13th centuries when King Magnus Lagabøte documented the first codified regional laws into a comprehensive National Code called the Landslov or the Magnus Lagabøtes Lov. See Pål A. Bertnes 'Guide to Legal Research in Norway' (2007) available at *https://www.nyulawglobal.org/globalex/Norway.html#_1.1_Norwegian_Law*, accessed on 22 August 2019.
[45] Act 39 of 1994 available at *http://folk.uio.no/erikro/WWW/NMC.pdf*, accessed on 21 August 2019.
[46] Act 9 of 2007. All Maritime Acts, Regulations, Notices, Hearings and International Conventions applicable in Norway can be found on the Norwegian Maritime Authority's webpage available at *https://www.sdir.no/en/shipping/legislation/#laws*, accessed on 21 August 2019.

in Norway is specifically governed by chapter 8 (sections 161 to 164) of the Norwegian Maritime Code.[47] Like many other maritime nations, Norway has based collision liability on the 1910 Brussels Collision Convention. This is evident in section 161,[48] which provides that where the fault lies upon only one of the parties, that party is liable for the damage caused by the collision. Where, instead, the fault lies on both of the parties involved in the collision, each party shall cover the damage in proportion to the extent to which he/she is liable or at fault.[49]

A further provision that has been adopted from the 1910 Brussels Collision Convention is section 163[50] of the Norwegian Maritime Code. This section explicitly sets out that the term 'collision' also includes a situation where damage has been done to one vessel by another vessel even where there has been no contact between the two vessels involved in the collision.[51] If a collision is accidental or the cause cannot be ascertained, each party will be made to bear its own losses.[52]

As in many other countries, when considering the question of fault, the Norwegian courts must have regard to the rules contained in the COLREGS.[53]

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[47] ICLG 'Norway: Shipping 2019' available at *https://iclg.com/practice-areas/shipping-laws-and-regulations/norway*, accessed on 21 August 2019.

[48] Section 162 reads as follows:

'When damage is caused to ships, goods, or persons as a result of a collision between ships and the fault is all on one side, that side shall cover the damage. If there is fault on both sides, they shall both cover the damage in proportion to the faults committed on each side. If the circumstances give no grounds for an apportionment in any definite proportion, the damage is apportioned equally. Each of the sides at fault is only liable for such proportion of the damages which falls upon it. In the event of personal injury, however, they are jointly and severally liable. If any party has paid more than is finally due from it, it has a right of recourse against the other party at fault for the excess. Against such a claim for recourse, the latter can invoke the same right to exemption from or limitation of liability as it would have been entitled to in relation to the injured party by virtue of the law applicable to the relation between it and the injured party, or by virtue of any valid contractual exemption clause. Such a reservation can nevertheless not be invoked in so far as it exempts from or limits the liability beyond what would follow from Chapters 13, 14 and 15 or corresponding provisions under a foreign law which in such event applies in relation to the injured party. When determining the question of fault, the Court shall especially consider whether or not there was time for deliberation'.

[49] See article 4 of the 1910 Brussels Collision Convention and section 255 of the South African Merchant Shipping Act (discussed in detail under chapter two section II*(d)* of this dissertation).

[50] Section 163 reads as follows:

'The provisions of the present Code relating to collisions between ships also apply when a ship by its manoeuvres or in similar ways causes damage to another ship or to persons or goods on board although no collision takes place between the ships'.

[51] See article 2 of the 1910 Brussels Collision Convention and the English case of *The Eland* [1969] 2 Lloyd's Rep 328 which is applicable under South African admiralty law (discussed in detail under chapter two section II*(b)* and *(d)* of this dissertation).

[52] See section 162 of the Norwegian Maritime Code op cit note 45.

[53] The COLREGS are applied in Norway by way of the Norwegian Regulations of 1 December 1975 No. 5 for Preventing Collisions at Sea (Rules of the Road at Sea) which were enacted by the Norwegian Maritime Directorate available at *https://app.uio.no/ub/ujur/oversatte-lover/data/for-19751201-0005-eng.pdf*, accessed on 27 November 2019.

(b) Issues identified by scholars from Norway (relevant to MASS)[54]

A research paper entitled 'Can unmanned ships improve navigational safety?' has identified that:

> '[t]he introduction of unmanned and autonomous shipping raises fundamental questions on how operational processes should best be structured to ensure the prospective safety of navigation. It is assumed that gradual automation will step by step lead the way from today's conventional shipping to truly autonomous shipping in the future'.[55]

Although this paper predominantly focuses on the MUNIN project[56] and the operational feasibility of these forms of vessels, the technologies and materials used on board are directly linked to the safety of the vessel at sea. As stated by DNV GL in their position paper on remote-controlled and autonomous ships:[57]

> 'The main challenge for implementing fully automated systems controlled by remote operators or by algorithms is not to make them work, but to make them sufficiently safe. What is sufficiently safe, or has a tolerable risk level, will most likely be defined by a competent authority such as the International Maritime Organisation (IMO) and flag states for any given operation'.[58]

[54] There are various legal papers and reports written from other maritime nations that have considered the challenges related to the introduction of unmanned and autonomous vessels to the maritime sector. A few of these include: the Danish Maritime Authority Report (2017) *Analysis of Regulatory Barriers to the use of Autonomous Ships Final Report* (Report December 2017) available at *https://www.dma.dk/Documents/Publikationer/Analysis%20of%20Regulatory%20Barriers%20to%20the%20Use%20of%20Autonomous%20Ships.pdf*, accessed on 07 October 2019; Juan Pablo Rodriguez Delgado 'The Legal Challenges of Unmanned Ships in the Private Maritime Law: What laws would you change?' (2018) 5 *Il Diritto marittimo – Quaderni, Italy* 493 – 524; Candidate 404 *From Manual to Autonomous: One-Hundred Years of Maritime Ship-to-Ship Collision Liability* (unpublished Master thesis, University of Oslo, 2018); Captain Sabbir Mahmood *Liability in Maritime Collision Case: How is Fault Apportioned?* (unpublished Master thesis, London Metropolitan University, 2014); Pol Deketelaere *The legal challenges of unmanned vessels* (unpublished Master dissertation, Universiteit Gent, Belgium, 2016 – 2017); Professor Dr Eric Van Hooydonk 'The law of Unmanned Merchant Shipping – An Exploration' (2014) 20 *Journal of International Maritime Law* 412; and The Hamburg School of Business Administration and International Chamber of Shipping Study 'Seafarers and Digital Disruption' available at *https://www.ics-shipping.org/docs/default-source/resources/ics-study-on-seafarers-and-digital-disruption.pdf?sfvrsn=3*, accessed on 04 December 2019.

[55] Hans-Christoph Burmeister, Wilko C Bruhn, Ørnulf J Rodseth and Thomas Porathe (2014) *Can unmanned ships improve navigational safety?* (Conference paper presented at the Transport Research Arena, Paris) 6.

[56] This paper does not offer any suggestions or recommendations to solve the legal challenges introduced along with the unmanned and autonomous vessel.

[57] DNV GL (2018) *Remote-Controlled and Autonomous Ships in the Maritime Industry.* (Position Paper) *Group Technology & Research*, available at *https://www.dnvgl.com/maritime/publications/remote-controlled-autonomous-ships-paper-download.html*, accessed on 07 October 2019.

[58] Ibid at 4.

The DNV GL paper confirms that

> 'the safety of a ship and its operation depends on the capability and reliability of the materials and technology comprising the ship, and the skills and performance of operators of these technologies'.[59]

There are, of course, various external factors (such as weather and traffic) that still play an important role in safety considerations. It is the introduction of these new fully autonomous technologies on board, however, that presents the overarching challenge above all other safety considerations. DNV-GL emphasises this by stating:

> 'Introducing novel technologies for the automation and control of these functions will potentially transform the entire system and introduce new technology risks, new societal challenges as well as new types of operations requiring new expertise. The new safety regime must therefore be able to handle these new risks'.[60]

A further challenge identified relates to the regulation of these vessels. DNV GL has suggested that the relevant authority (such as the IMO and the MSC) would have to construct a new safety regime which would regulate the safe operation and navigation of these vessels at sea and that, in keeping with the international nature of maritime law, the new safety regime would need to be drafted in a way that is socially acceptable to the wider public. This should be done to prevent any ratification issues down the line.[61]

(c) Recommendations made by scholars from Norway

Four options have been put forward for the development of a regulatory framework for unmanned and autonomous vessels:

1. To amend existing instruments;
2. To develop a completely new and separate instrument addressing unmanned, autonomous and remote-controlled vessels;
3. A combination of the two above; or
4. To develop interim guidelines to enable the international maritime industry to gain experience before considering potential compulsory requirements.[62]

[59] DNV GL op cit note 57 at 5.
[60] Ibid. It is important to note that new risks allow for a new assurance space to evolve with the latest technological developments.
[61] DNV GL op cit note 57 at 4–5 and 16.
[62] DNV GL op cit note 57 at 16.

The following existing international conventions and regulations have been identified as pieces of legislation that will need to be clarified and/or amended when considering the unmanned and autonomous vessel perspective:

- the United Nations Convention on the Law of the Sea, 1982 (UNCLOS);
- the STCW Code (as above);
- SOLAS (as above);
- the COLREGS (as above);
- MARPOL (as above);
- the International Safety Management Code, 1994 (ISM Code);
- the International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, 1996 (HNS Convention);[63]
- the International Convention on Salvage, 1989 (Salvage Convention);
- the International Convention relating to the Arrest of Seagoing Ships, 1952 (Arrest Convention);
- the Convention on Facilitation of International Maritime Traffic, 1965 (FAL);
- the United Nations Convention on Conditions for Registration of Ships, 1986 (Ship Registration Convention),[64]

among many others.

Should it be decided that a new instrument be created to regulate these new forms of vessels, DNV GL has suggested that this new instrument could be in the form of a convention that applies only to autonomous and unmanned/remote-controlled ships. The convention would need to specify that the ship would not only be autonomous or remotely controlled but that it would rather involve

[63] The HNS Convention of 1996 has not yet come onto force and has been amended by a Protocol in 2010 by the IMO in London. See the following HNS Brochure 'The 2010 HNS Convention' available at *https://iopcfunds.org/wp-content/uploads/2018/04/HNS_Brochure_2014-1.pdf*, accessed on 30 November 2019.
[64] This list is not limited. Between the IMO, the CMI and the MSC over 50 conventions have been identified as needing clarifications and/or amendments with regard to the unmanned and autonomous vessel. These can be found in the following sources: DNV GL op cit note 57 at 14 – 15; Carey (2018) *14th IISTL Colloquium Report* op cit note 41 at 15–16; and the CMI *Spreadsheet Regarding Conventions* op cit note 11.

> ‘a ship type, with a specific operation in addition to being autonomous and/or remotely controlled… The requirements would also in this case need to be formulated in at least two versions: fully autonomous or fully remotely controlled, and in various combinations of autonomous and remote control’.[65]

Alternatively, DNV GL has recommended that. in the first stage of developing new regulations, an interim guideline be developed first which could then be developed into a new Autonomous Ship Code (ASC) which could be anchored and mandated in SOLAS. DNV GL states:

> ‘The adoption of an ASC would need to be followed by a process of consequential amendments of many conventions and codes. This could largely be done by referring to the ASC. It is expected that the enabling technologies applicable to remote-controlled and autonomous ships will be developing fast. New and better technology will enter the market frequently, making it impractical to formulate detailed technical requirements (algorithms, sensors, data fusion, etc.) at the IMO level. It is therefore suggested that the code should be goal-based. The aim of the goal-based code should be: “Autonomous and remote-controlled ships shall be as safe as conventional ships of the same type”, or a similar formulation. It should then be left to the class societies to develop specific rules that define an assurance procedure complying with the code. The classification societies would then have to justify their rules, documenting that the rules meet the goals and functional requirements of the code’.[66]

VI CONCLUSION

The various international organisations and associations have already commenced work on assessing the legal implications of operating unmanned and autonomous vessels. The IMO has begun assessing the existing international conventions and regulations that govern safety at sea in order to analyse how they can be applied to vessels that have varying degrees of automation. In doing so, they have set up a MASS working group which is currently undergoing continuous work on providing solutions to the identified issues. Furthermore, the MSC has approved a set of interim guidelines for unmanned and autonomous vessel trials, which set out the manner in which these forms of trials should be conducted to ensure that at least the current degree of safety at sea is maintained.

[65] DNV GL op cit note 57 at 16.
[66] DNV GL op cit note 57 at 17.

The CMI have set up a working group which is tasked with analysing the legal implications of unmanned vessels. In their analysis, the CMI working group have produced various papers and reports which confirm the conclusions reached in this dissertation. BIMCO has expressly stated their support for the trading of autonomous vessels and their support for the work already provided by the IMO.

Lastly, legal commentary from Norway (which is at the forefront of these industry developments) has identified the major issues associated with these new forms of vessels and has recommended a set of solutions to these first stage issues. The DNV GL paper has recommended that a hybrid of the options suggested be adopted in an attempt to develop a strong and sound set of regulatory frameworks governing the safe operation of unmanned and autonomous vessels at sea. The process should commence with developing interim guidelines which will allow the legislation to keep up with the current technological developments and to provide some experience in the area before mandatory requirements are implemented.

CHAPTER 5

CONCLUSION

I INTRODUCTION

This dissertation has analysed the attribution of legal liability for collision damage caused by unmanned and autonomous vessels, such as where there has been a defect or malfunction with its onboard software. It commenced with a background to the development of these new forms of vessels, the various projects initiated for their development and the definitions of the varying degrees of automation on each type of vessel (unmanned, remote-controlled and autonomous).

Chapter two dealt with the current fault-based (negligence) liability framework applicable to the conventional vessels of today (under both international maritime laws and South African national laws).

In chapter three a detailed analysis of the issue of collision liability for the unmanned and autonomous vessel was presented. This included an analysis of the various permutations of liability (fault-based liability for personal negligence, vicarious liability and liability for the actions of independent contractors, as well as strict and product liability). The chapter provided an analysis of where the current liability framework can apply to these new forms of vessels and where it will need to be clarified or amended in order to regulate safety at sea sufficiently. An argument was made that a strict liability approach should be adopted.

Lastly, chapter four considered the work of international organisations that have investigated approaches in terms of regulating unmanned and autonomous vessels. It examined the International Maritime Organisation (IMO), the Comité Maritime International (CMI) and the Baltic and International Maritime Council (BIMCO) and the work that these three organisations/associations have put into amending/developing a concise regulatory framework to ensure that unmanned and autonomous vessels are navigated safely at sea. It also specifically considered the national laws of Norway and the issues and suggestions raised by scholars in Norway on the topic of unmanned and autonomous vessel collision liability.

II FINDINGS AND RECOMMENDATIONS

It is apparent that the introduction of unmanned and autonomous vessels will no doubt bring some form of change to the maritime legal framework as we know it today. For the most part, the shipowner's identity and role will remain the same, as a shipowner can be held liable regardless of how his/her vessel is operated. As illustrated above, it is in relation to the master's

role in the maritime industry that we can expect colossal changes. The more technology develops, the more the master's role will degrade until he/she eventually becomes a distant figure blown into the winds of history.

International legislation will need to be clarified or amended to account for the new legal entities that are emerging with unmanned and autonomous technology.[1] A suggestion for the near future to accommodate these new forms of vessels is to extend the role of the master to the shore-based control operator and the voyage programmer and to consider the ways in which the current fault-based liability system can consistently apply to them. It has become apparent that this will not be a sufficient approach for the long-term future of these forms of vessels as the duties and responsibilities required of the shore-based control operator and voyage programmer will differ greatly from those of the master today. It is evident, however, that there is a need for a unified approach to be adopted in defining these new emerging entities and that their duties and responsibilities must be identified, clarified and uniformly applied. This has been confirmed in the conclusions reached by the CMI and IMO in their ongoing work on Maritime Autonomous Surface Ships (MASS).

An argument in favour of adopting a strict liability approach has been given in this dissertation. The analysis in chapter three illustrated that where the shipowner chooses to conduct his/her business using an unmanned/autonomous vessel, and where the SBCO and voyage programmer are considered to be employees of the shipowner, an application of the current fault-based liability system for any collision damage resulting from the shipowner's business would entail an enquiry into the conduct of the SBCO or voyage programmer in terms of which the shipowner might be held vicariously liable if their conduct was negligent.

It was further discovered that where the SBCO and voyage programmer are not considered employees of the shipowner, an enquiry will need to be made into the shipowner's personal liability in exercising the required duty of care in minimising the risk of danger associated with unmanned and autonomous navigation. Where a shipowner has discharged his/her duty to exercise the required duty of care in eliminating or minimising the risk of danger associated with autonomous navigation by undertaking the services of a skilled independent contractor

[1] As identified in Chapter four of this dissertation, some examples of the international legislation that will need to be amended include: the COLREGS (as above); the United Nations Convention on the Law of the Sea, 1982 (UNCLOS); the International Convention for the Safety of Life at Sea, 1974 (SOLAS); the International Safety Management Code, 1994 (ISM Code); the Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, 1910 (the 1910 Brussels Collision Convention); the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), among many others.

(being a skilled SBCO or skilled voyage programmer), the shipowner will not be held liable for collision damage resulting from any negligence on the part of the skilled independent contractor. Where the shipowner has not discharged such a duty, however, he/she will still be held liable for the actions of the independent contractor where the activity involves an increased level of danger to the community.

Where a collision occurs as a result of an onboard autonomous system malfunction, it was suggested that a strict liability approach be adopted in holding the shipowner liable (without fault) for such collision damage on the basis that the shipowner is benefiting from the profit of conducting his/her business through unmanned/autonomous navigation, and that he/she is undertaking an inherently dangerous activity that endangers the community (both of which are principles found under liability without fault). Should such an approach be adopted, a limitation of liability scheme should be developed (as provided by most forms of liability without fault). The shipowner will further not be excluded from claiming damages from the software provider or manufacturer under product liability for the supply of defective or unsafe goods.

Lastly, the work already completed by the IMO, MSC and CMI has confirmed the conclusions reached in this dissertation in that the relevant international conventions will need to be clarified and/or amended in order to sufficiently provide for the safe regulation of these vessels at sea. Furthermore, the work of Paolo Zampella[2] has presented a similar analysis to that contained in this dissertation in arguing favourably towards a unified strict liability approach towards collision liability for unmanned and autonomous vessels.

As a result of this analysis, it is recommended that the South African legislature continue to monitor legislative developments, and promptly adopt any amendments and/or clarifications to international laws into South African national laws once those amendments and/or clarifications are finalised at an international level. This course of action is recommended in order to ensure South African laws are constantly in line with international best practices.

III CONTRIBUTIONS OF THIS STUDY

This dissertation contains an analysis of the legal framework governing collisions of both conventional and autonomous vessels at sea. The study considered the various approaches to collision liability, including the various permutations of liability (fault-based liability for personal negligence, vicarious liability and liability for the actions of independent contractors,

[2] Paolo Zampella *Maritime and Air Law Facing Unmanned Vehicle Technology* (unpublished PhD thesis, Università degli Studi di Cagliari, Italy, 2019).

as well as strict and product liability) under South African law, and considered international approaches already adopted to govern the safe navigation of unmanned and autonomous vessels at sea. In this way it aims to contribute to South African legal academic resources and to the slowly growing international content on autonomous collision matters.

IV RECOMMENDATIONS FOR FUTURE RESEARCH

It is recommended that further studies be conducted on the impact of autonomous technology on piracy and vessel security. An issue to consider is whether autonomous technology may create a new form of cybercrime (cyberpiracy) and the effect this will have on the global movement towards a technologically driven maritime industry. A further recommended study is the impact of autonomous technology on developing countries. An issue to consider is the impact that autonomous vessels will have on developing countries and whether such developing countries will be appropriately prepared and sufficiently equipped to receive these new forms of vessels into their ports.

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UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

21 July 2020

Ms Ivana Surian (214510482)
School of Law
Howard College Campus

Dear Ms Surian,

Protocol reference number: HSS/0400/019M
New Project Title: The dawn of Unmanned and Autonomous Vessels and the Legal Consequences of a M.A.S.S. Collision

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 09 July 2020 has now been approved as follows:

- Change in title

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

Best wishes for the successful completion of your research protocol.

Yours faithfully

……
Professor Dipane Hlalele (Chair)

/ms

cc Supervisor: Mrs Dusty-Lee Donnelly
cc. Academic Leader Research: Prof Shannon Bosch
cc. School Administrator: Mr Pradeep Ramsewak