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The production of unmanned vessels and its legal implications in the mari- time industry.

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1 Introduction

1.1 The reasons behind the production of autonomous vessels in the maritime industry.

There are two important entities in the maritime transport industry that consider the fact of having human crew on board traditional vessels produces a series of safety, security, environmental; cargo efficiency and cost efficiency disadvantages. For this reason these parties are currently exploring a new type of vessel scheme that would allow correcting and eliminating the mentioned weaknesses.

In this regard, for the reasons that will further be explained, both parties have found that most of the shortcomings traditional vessels have a common element. That common element is the human factor on board. The research of these entities found that a solution to overcome the common drawbacks traditional vessels have could be achieved by altering two elements. The first step is to remove the human factor from board and shift the operation of the vessel from an on board location to an on shore location. The second step towards this solution is to aid the operation and command of the vessel with modern marine technology.

Modern Marine technology has reached a stage that allows the companies involved in this project to research and develop in this direction.¹ The developers of this project believe that the proposed scheme will have a positive impact for the maritime industry in terms of ship safety, efficiency and fuel performance and environment friendliness.² Hence the alternative scheme these companies propose is to have crew-less vessels remotely controlled by humans from on shore facilities aided by the use of modern remote automated technology.

¹ Rupert Neate, Rolls Royce plans remote-controlled ships with no captain or crew on board. British engineering company claims huge cargo carriers will be cheaper, greener and safer than fully manned vessels <http://www.theguardian.com/business/2014/may/30/rolls-royce-remote-controlled-cargo-ships> 30th May 2014, accessed 18th of June 2014.

² Craig Eason, Being led down the road to ship automation <http://www.loydslist.com/ll/sector/ship-operations/article441872.ece>, 20 May 2014, accessed 20th October 2014.

1.2 Scope of the research

This thesis will outline the unmanned vessel project, referring to various reports and online articles. It will make a comparative analysis with the conventional crewed vessels assessing its pros and cons in terms of safety, security, environmental friendliness, cargo efficiency and cost efficiency.

1.2.1 The legal problem has an organizational origin

Unmanned vessels are the result of modern scientific developments applied to the maritime industry. This type of constructions are so recent that the project faces two major problems. The first problem is not technical but organizational since these vessels haven't been specifically addressed by any international rule or regulation so far.³ *“The International Maritime Organization (IMO), the global regulator for shipping hasn't released any approval for this type of vessels and is likely to take some time.”*⁴ The research of this thesis also discovered that the IMO hasn't received any proposal from contracting governments to regulate unmanned vessels. In this respect there is a lack of legal framework for this type of ships that gives origin to a series of legal hindrances that will be further exposed. Consequently the obstacles this project faces are organizational rather than technical⁵.

Given the lack of proper regulatory framework for unmanned vessels the aim of this research is to study how unmanned vessels comply with the framework set by present international maritime Conventions such as SOLAS and ISM Code⁶ It is the objective of this

³ Douwe Cunningham, Waterborne TP SRA: The Autonomous Ship, SEA Europe / Waterborne Technology Platform MUNIN Workshop at SMM, 10th of September 2014, p.13 <http://www.unmanned-ship.org/munin/wp-content/uploads/2014/09/MUNIN-WS@SMM-140909-2-Waterbourne-TP-OJR.pdf> , accessed 15th October 2014.

⁴ Ibid, p. 1.

⁵ Ørnulf Jan RØDSETH, Developments towards unmanned vessel MARINTEK Dept. Maritime Transport Systems, Hans-Christoph Burmeister, Fraunhofer Center for Maritime Logistics and Services CML, <http://www.unmanned-ship.org/munin/wp-content/uploads/2012/08/R%C3%B8dseth-Burmeister-2012-Developments-toward-the-unmanned-ship.pdf> accessed 20th October 2014.

⁶ Esa Jokioinen, Towards Remote Controlled Ships, 2014 Rolls Royce Plc. MUNIN workshop at SMM, 10th September 2014 <http://www.unmanned-ship.org/munin/wp-content/uploads/2014/10/MUNIN-WS@SMM-140909-4-Rolls-Royce-Approach-EJ.pdf> accessed 15th September 2014.

thesis to assess whether they fulfil or not of obligations as defined in the mentioned regulatory instruments.

In considering the possibility of such vessels operating on the high seas, it is common knowledge that the maritime industry focuses on insuring shipowners vessels for example by one of the many P&I Clubs. It is once this insurance is in place; the ship-owner is (as he covered for risks arising from third party liability) to charter the vessel through a contract of carriage such as a charterparty.

These charterparties and bills of lading are governed by fundamental international conventions, which are codified into the law of individual countries. This thesis will therefore critically analyse the definition of unmanned vessel in terms of these contracts and will explore if these legal conventions will apply to them. It will be argued that, if they do not apply, there are serious implications bearing upon the shipowner who is operating an unmanned vessel. An underlying example that is expressly stated in these contracts of carriage is the obligation of the shipowner to provide a seaworthy vessel. This obligation is of paramount importance in the industry and if the shipowner has failed to provide one not only will he be in breach of the contract but also the insurance cover that he has in place. The central issue concerns whether an unmanned vessel will effect the seaworthiness obligation. This thesis will reflect on the Norwegian maritime legal system and the. Analysis of the Norwegian Maritime Code will focus upon its interpretation of seaworthiness in light of charter party contracts. Further, a brief overview of the *Maritime Insurance Act (1906)* (UK) will also be contrasted to the *Carriage of Goods by Sea Act (1992)* (UK). Case precedent from both jurisdictions will further inform interpretation of such legislation. A practical view of the Commercial Maritime Contracts will be included in the discussion.

The conclusion of the thesis will suggest possible solutions on how to effectively deal with an area of maritime law that is therefore not up to date with dynamic change to this area of technological development. The proliferation of unmanned vessels may have dramatic implications for the maritime and shipping industry, which will be the subject of further legislative and judicial reform.

2 The concept of autonomous vessels

2.1 Introduction

This chapter will seek to define the literal meaning of an autonomous vessel. Relying on various reports and articles, it will analyse related research and development of one company and one entity, which are currently researching and developing the concept of unmanned vessels. It will explain the reasons that lead these parties to explore in this direction.

In this respect, the idea of what it is going to be, its characteristics, the way it will operate and its technical features will be described. Moreover advantages and disadvantages in comparison to conventional vessels will be considered from a safety, security, environmental friendliness; cargo efficiency cost efficiency and legal perspective.

A brief overview of the successful deployment of unmanned systems technology in parallel industries such as the Naval will be provided. The example of the successful integration of unmanned systems in complex defence tasks is of significance importance as it can potentially provide a useful precedent for the shipping industry.

Finally in contrast to the advantages described, the present point of research will also provide an account and describe the nature of the common shortcomings that both projects face. An overview of future challenges to overcome will also be addressed.

It is important to highlight that the research of this academic paper will not explore in depth the technical details of the projects. Therefore the purpose is to provide an outline clear enough to understand its mode of operation and thus analyse it from a legal perspective.

The aim of this chapter is to provide a thorough description and understanding of the unmanned vessel project. In order to analyse any legal consequence it is essential first to understand first the “modus operandi” of the project. Hence, this section will provide all the necessary elements to help answer the legal questions that this type of constructions will give rise to under the international instruments. The shipping industry has two main parties that are currently exploring and developing vessels to be autonomous: Rolls-Royce and MUNIN.

2.2 Rolls-Royce

The first entity researching into the answer on how to eliminate the downsides that the human element produces on board traditional vessels is the British engineering company Rolls-Royce Holdings Plc., “This company is known as a market leader in developing and providing automation and control systems, propulsion, stabilization and manoeuvring systems, ship design systems, engines, deck machinery and on board equipment for specialist vessels”⁷ “This developer has, designed manufactured and integrated all of these complex systems in more than 30.000 vessels”.⁸ After years of being a marine industry leader this company has accumulated very useful feedback and experience about ships, systems, equipment, understanding their complexities and weaknesses. Among the complexities and drawbacks manned vessels have, the research of this thesis highlights the following:

2.2.1 Human Factor

On the first place, this party has performed a careful assessment of a series of disadvantageous consequences produced by the presence of the human factor on board current fully manned vessels. From the point of view of safety, the company’s VP of Innovation, Engineering & Technology Oskar Levander claims that most marine accidents are a consequence of human error derived from fatigue and loss of concentration of the crew becoming tired.⁹ These facts are confirmed by a recent report released by Allianz Global Corporate & Speciality a Munich based global marine and transport insurer. Published twelve months after the *Costa Concordia* accident took place, one of the most relevant findings of this press release was, that human error still remains the key factor in most of the marine casualties.¹⁰

⁷ Rolls Royce Marine Products <http://www.rolls-royce.com/marine/products/index.jsp> accessed 12th of August 2014.

⁸ Ibid p.2.

⁹ Ibid p.1.

¹⁰ Allianz Global Corporate & Speciality <http://www.agcs.allianz.com/about-us/news/agcs-safety-and-shiping-review-2013/> press release 8th March 2014, accessed 24th of March 2014.

2.2.1.1 Labour Costs

The second problem this company analyses are the expenses derived from employing crew on board. “Cargo transport companies face the situation of having to pay considerably high salaries to crewmembers willing to spend months at sea”.¹¹ According to findings of Moore Stephens LLP, an industry consultant, having crew on board can produce expenses for up to a figure that amounts to 44 per cent of the total operating expenses for a large cargo container vessel”.¹²

2.2.1.2 Overheads and Related Expenses

Thirdly, the design of traditional fully manned ships includes the need of providing not only a command bridge structure where the crew lives but also the infrastructure to support it, such as: cabins, electricity, heating, air conditioning system, kitchen, fresh water, sewage systems and lifeboats. According to Oskar Levander, the infrastructure to support the crew makes the vessel heavier and more expensive to build and maintain.¹³ Another consequence is that the aforementioned appurtenances to support the crew also take up a considerable amount of storage capacity and hinder an efficient distribution of the cargo. Traditional vessels are therefore heavy constructions, which burn fuel in an inefficient way. All the above-mentioned characteristics of fully manned vessels trigger the operation maintenance and repair costs making the construction less environmental friendly¹⁴. From this environmental but also legal perspective there is additional disadvantage that arises from this type of ships. The fact of the crew on board producing waste such as garbage and sewage.

¹¹ Ibid, p.1.

¹² Jane Wakefield, Rolls Royce imagines a future of Unmanned Ships <http://www.bbc.com/news/technology-26438661>, 5 March 2014, accessed 18th of June 2014.

¹³ Isaac Arnsdorf, Rolls-Royce Drone Ships Challenge \$375 Billion Industry: Freight, February 25th, 2014 <http://www.bloomberg.com/news/2014-02-25/rolls-royce-drone-ships-challenge-375-billion-industry-freight.html> accessed on the 3rd of March 2014.

¹⁴ Ibid.

The final weakness Rolls Royce found in manned vessels is their vulnerability to piracy. Article 101 of the United Nations Convention on the Law of the Sea (UNCLOS) provides the following definition of this term:

“Piracy consists of any of the following acts:

a) any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed

(i) on the high seas, against another ship or aircraft, or against persons or property on board such or aircraft;

(ii) against a ship, aircraft, persons or property in a place outside the jurisdiction of any state;

b) any act of voluntary participation in the operation of a ship or of an aircraft with knowledge facts making it a pirate ship or aircraft;

*c) any act inciting or intentionally facilitating an act described in sub-paragraph (a) or (b)”.*¹⁵

From the point of view of the company, aside from the cargo, human presence on board also means an attractive target when it comes to piracy attacks as in most cases crewmembers are held hostages or kidnapped until ransom is paid. The human factor on board again exposes the vessel to this type of threats that mean a huge financial and emotional effort to deal with when they have to be settled¹⁶.

After this initial assessment, research suggests the company’s conclusion was that the traditional scheme of having crew on board vessels is very advantageous but at the same time it can make them unsafe, expensive, unreliable, inefficient for cargo purposes, polluting and vulnerable to piracy attacks.

In this respect, Rolls Royce Marine Engineering and Technology established a division named Blue Ocean Team. This section is in charge of marine innovation by understanding and delivering the feasibility of future ship design concepts, machinery concepts and mari-

¹⁵ United Nations Convention on the Law of the Sea, Part VII. High Seas. 10th of December 1982.

¹⁶ Leslie Edwards, Maritime piracy and kidnapping in West African waters, The Swedish Club, Triton magazine no. 3 December 2013, p. 8.

time technology. The purpose of this team is researching into methods and technologies to mitigate against the disadvantages traditional manned vessels have.¹⁷ *“As a consequence of rapid development in the recent years technology had progressed so fast that most of the steering and control of modern ships is already automated”*¹⁸. From this point, Rolls Royce explored the possibility of relocating the captain from the bridges of the ship to on shore operating facilities. The operation of the vessel is transferred ashore through the use of modern marine automated technology.¹⁹ This latter concept will be further discussed in the following heading.

2.3 Rolls Royce description of the unmanned vessel and its operation:

Rolls Royce’s Blue Ocean development team has announced the research project, which is currently being developed at its shipyards in Ålesund, Norway. The company’s head of Innovation, Engineering and Technology department describes the two research projects Rolls Royce is involved in.

The first one is an “autonomous ship” equipped with automatic navigation, collision avoidance systems and automatic engine control. This vessel is not necessarily unmanned as it can be partly manned housing maintenance and repair crew.

The second project refers to an “unmanned ship” with no one on board. This craft does not sail necessarily under automatic navigation, as it can be remote controlled from dry land control centres.²⁰ This concept relocates the captain from the bridges of the ships to on shore remote control command centres²¹. The human factor is still present on shore and is

¹⁷ Ibid, p. 4.

¹⁸ Rolls-Royce plans remote-controlled ships with no captain or crew on board HITC Business, Industry & Commerce <http://hereisthecity.com/en-gb/2014/05/31/rolls-royce-plans-remote-controlled-ships-with-no-captain-or-cre/>, accessed 12th October 2014.

¹⁹ Ibid, p. 1.

²⁰ Thomas Porathe, Hans-Christoph Burmeister, The MUNIN Project, Compit conference, Cortona Italy 15-17 April 2013 <http://www.unmanned-ship.org/munin/wp-content/uploads/2013/04/COMPIT-2013-presentation-Porathe-et-al-MUNIN.pdf>, accessed 22nd of September 2014.

²¹ The Economist, Ghost Ships, Technology Quarterly issue March, 8 2014 <http://www.economist.com/news/technology-quarterly/21598318-autonomous-cargo-vessels-could-set-sail-without-crew-under-watchful-eye> accessed 19th September.

formed by a new generation of highly trained captains also known as operators. The vessel is steered and commanded from the remote interactive control stations on shore with the aid of a comprehensive computerized monitoring systems²². Further the communication with the ship is performed via satellite signal. Because of this scheme, a single operator (or a team of operators) is able to simultaneously steer and monitor more than one vessel taking the same route²³. With dozens of high sensitivity cameras around it, a full image is available, including a bird's-eye view of the vessel in relation to its surroundings²⁴. Once the ship approaches port, on board cameras are activated in order to simulate "360 degree views from a vessel's bridge". The assistance of high sensitivity and long range cameras and sensors allow the captain to spot any floating objects better than the human eye.²⁵

In conclusion, Rolls Royce has identified every downside of the traditional fully manned vessel and the answer to solve that series of problems was to shift the crew or human factor from the vessel to on shore remote operation centres. According to their proposed scheme, the human factor and monitoring is still present in the command and steering of the ship only it has been shifted ashore and perfected by the aid of satellite interactive computerised remote controlling systems and 360-degree long range cameras.

The logic behind the company's idea took into account the progress of this type of technology employed in other industries such as the Naval where unmanned boats are being successfully deployed for counter sea-mine, escorting and patrol missions²⁶. In this same direction, unmanned aircraft have already flown several missions and civilian operations. Finally driverless cars and public transport have employed this type of technology. Social acceptance towards unmanned systems is growing subsequently remote-controlled ships could set sail without a crew.²⁷

²² Ibid, p.5.

²³ Ibid, p.1.

²⁴ Ibid p. 4.

²⁵ Ibid p.5. Michael Carroll, Are Unmanned Vessels the future of the Ocean?

<http://www.newsweek.com/2014/07/11/are-unmanned-vessels-future-ocean-257091.html> 3rd July 2014, accessed 17th July 2014.

²⁶ Navy's Self-Guided, Unmanned Patrol Boats Make Debut <http://abcnews.go.com/US/wireStory/navy-guided-unmanned-patrol-boats-make-debut-25972159> October 5th, 2014.

²⁷ Ibid, p.7.

In other words modern marine technology will allow having remote crew-less ships in the seas. Among the advantages that Rolls Royce's Blue Ocean development project has developed claims the following can be listed:

2.3.1 Safer Vessels

"Is it better to have a crew of 20 sailing in a gale in the North Sea, or say five in a control room on shore?" asked the VP of Innovation Engineering Technology of Rolls Royce.²⁸

Command monitoring and navigation of the ship will still be performed by people with the assistance of remote interactive control stations and a satellite comprehensive computerized monitoring systems. This will not only be able to predict long and short range obstacles but it will also make the steering more precise thus considerably reducing the probability of marine casualties. Factors such as fatigue and loss of concentration will no longer be an issue as the company plans to have a shift system for teams of captains or operators on dry land. Another contribution to safety is the fact that seafarers will no longer be on board but on dry land.²⁹

"Remote-control shipping will also make a captain's life more appealing as they will no longer have to leave their families for months on end," Levander said. "We can provide the possibility of working in shipping but doing it from an office near your home where you can drive back home after a day's work."³⁰

When reaching port, remote controlled ships will also be safer form the point of view that they are equipped with dozens of on board long range high sensitivity camera systems that will allow operators to visualize a live multi angle picture sharper than the human eye.³¹

2.3.2 Cost efficiency

²⁸ Ibid, p.5.

²⁹ Ibid, p.1.

³⁰ Ibid, p.1

³¹ Ibid, p.5.

From the point of view salaries, it is less expensive to have an operator traveling from his home to the facility where the remote control centre of the vessel is located than having crewmembers on board a vessel overseas for months.³²

A ship with no crew will eliminate many operational costs such salaries of crew, cooks, and doctors. In addition it will also allow cutting costs derived from the need of providing fresh water, electrical power, heating and air conditioning systems and lifeboats for the crew.

From a technical point of view, shipbuilding will be cheaper as vessels will need no command bridge structure, appurtances and equipment to support the crew. The fact of removing the aforementioned infrastructure will allow lighter vessels with better distributed and increased cargo capacity³³. The ships would be 5 percent lighter before loading cargo and would burn 12 percent to 15 percent less fuel. In this regard, unmanned craft will not only cut costs and boost revenue but it will also be more fuel and environmental friendly³⁴.

2.3.3 The potential of a pirate seizure and hijack is significantly reduced

In the words of Oskar Levander *“If you take the crew off you have much less interest for the pirates because you don’t have hostages. Even if they do get on board what are they going to do? You can remotely shut down the ship. They can sit there on the ship in the middle of the ocean but they cannot steer it – you can drive them to the nearest military base.”*³⁵

From the point of view of piracy, unmanned vessels will no longer be attractive to pirates as the drawings that the company has released, show a sealed deck design that makes it impossible for potential intruders to access it. On the other hand, the fact that they are crew-less means those pirates will not be able to hold any hostage situation.

³² The Economist, Ghost Ships, Technology Quarterly, issue March, 8 2014
<http://www.economist.com/news/technology-quarterly/21598318-autonomous-cargo-vessels-could-set-sail-without-crew-under-watchful-eye> accessed 19th September.

³³ Clark Estes Adam, Gizmodo, Rolls Royce is designing giant drone ships to sail the high seas
<http://gizmodo.com/rolls-royce-is-designing-giant-drone-ships-to-sail-the-1530534477> 25th of February 2014, accessed 15th of October 2014.

³⁴ Ibid, p. 5.

³⁵ Ibid, p. 1.

2.4 MUNIN Project, the second party involved in the unmanned vessel research

During the past two years, the European Union has realized the potential opportunities that automated vessels present for the maritime transport industry. Under this context this body decided to fund its €3.8million Maritime Unmanned Navigation through Intelligence in Networks Project (MUNIN).³⁶The MUNIN consortium consists of eight parties with shipping, technical and engineering backgrounds based in northern europe. The composition of the consortium is sorted in such manner that every area of the project research is covered. This consortium represents the second party looking to explore and develop the concept of an autonomous vessel.³⁷

Under this programme, an automated vessel is defined as, “*a vessel primarily guided by automated on-board decision systems but controlled by a remote operator in a shore side control station*”.³⁸

The plan aims to verify the safety and feasibility of how far can all the functions of a ship be automated. In the words of Ornulf Jan Rødseth, the MUNIN coordinator, “this scheme has established both a short and a long-term objective. The first one looks into the possibility of reducing the crew number to one or two, as most of the commanding of the vessel will be performed from an on-shore remote station. The second stage expects to completely eliminate maritime disasters thanks to the aid of automated technology in navigation”.³⁹

The project’s scope combines the following objectives:

- a) Develop the technology needed to integrate to the autonomous and unmanned ship.
- b) Verify and validate the concept through tests in different scenarios and critical situations.

³⁶ Ibid p. 7.

³⁷ The MUNIN Consortium <http://www.unmanned-ship.org/munin/partner/> accessed 17th July 2014.

³⁸ *The Maritime Unmanned Navigation through Intelligence in Networks* project page <http://www.unmanned-ship.org/munin/> accessed on the 21th August 2014.

³⁹ Ibid, p.7.

- c) Collect information to analyse how legislation and commercial contracts need to be adapted for autonomous and unmanned vessels.
- d) Provide an economic, legal and security assessment of how the results will impact the European shipping competitiveness.
- e) Demonstrate the direct benefits in terms of technical reliability, efficiency, safety and sustainability.⁴⁰

Although full autonomy applied to a vessel might be difficult to achieve in the near future, the research conducted will benefit the maritime transport in the short term⁴¹.

At this initial stage of research the first type of construction MUNIN is developing is an unmanned slow steaming deep sea dry bulk carrier meant for low risk cargo. Among the technological devices that will be tested and implemented, the following can be listed, advanced sensors systems, autonomous navigations systems and shore control centres.⁴²

Between the 1st and 3rd of September of 2014 the first test of the prototype system was conducted by the MUNIN Project consortium at the Maritime Simulation Centre Warnemünde (MSCW). Three ship handling simulators were connected and eight scenarios were reproduced to assess the current state of the prototype systems. The results after this initial test indicate that although there is still a lot of work ahead many valuable data was recorded which would be used for further development. A second simulation test round at MSCW is scheduled for the third week of February 2015.⁴³

2.4 Unmanned systems have successfully been deployed by The United States Navy

A view to parallel industries such as the Naval can provide a precedent regarding the deployment of unmanned systems. A Canadian company named Textron Systems specialized in developing and integrating unmanned systems has successfully designed and tested what

⁴⁰ MUNIN Objectives and impact, <http://www.unmanned-ship.org/munin/about/munins-objectives/> accessed 21th October 2014.

⁴¹ Ibid.

⁴² Burmeister Hans Christoph, MUNIN The unmanned dry bulk carrier, MUNIN SMM 2014, Hamburg, 10 September 2014, <http://www.unmanned-ship.org/munin/wp-content/uploads/2014/09/MUNIN-WS@SMM-140909-3-Introduction-to-MUNIN-HCB.pdf> accessed 18th September 2014.

⁴³ Laura Walther, MUNIN's 1st Simulation Test Round, <http://www.unmanned-ship.org/munin/munins-1st-simulation-test-round/> accessed 8th of October 2014.

is known as Fleet-class Common Unmanned Surface Vessels (CUSV). A type of vessel controlled by a remote operator from a control station located ashore or on board another vessel with the purpose to conduct collaborative unmanned mine-hunting and mine neutralization missions.⁴⁴

On 8 October 2014 Textron Unmanned Systems signed a U\$S 33.9 million contract with the U.S. Navy to provide the Littoral Combat Ship (LCS) with an unmanned mine counter-measures device.⁴⁵

The LCS is a class of relatively small surface vessel employed by the United States Navy. Built by Lockheed Martin, its intended for operations close to shore. This vessel was "envisioned to be a networked, agile, stealthy surface combatant capable of defeating anti-access and asymmetric threats in the littorals."⁴⁶

The CUSV will integrate the LCS's mine counter-measures bundle. The Fleet class will support the Unmanned Influence Sweep System (UISS), a long endurance, semi-autonomous minesweeping capability that will provide LCS with a standoff capability to counter magnetic and acoustic mines. If exercised, additional contract options could total \$118 million. The Navy will procure up to 52 UISS packages, including six for training.⁴⁷

In conclusion, the parallel deployment of modern unmanned systems for naval purposes can be considered a successful precedent towards its integration to the maritime shipping industry. As with many technologies, unmanned ship innovation could shift from naval to everyday commercial applications.⁴⁸

2.5 Shortcomings of the Unmanned Vessels, common problem to MUNIN and Rolls Royce project

The aforementioned schemes present a main shortcoming in common. As it happens with the case of pilotless aircraft and pilotless automobile industries, the obstacle to overcome is not so much the technological but the regulatory one. Proved and reliable systems will be

⁴⁴ Textron Systems Awarded Contract for Unmanned Mine Countermeasures System, <http://www.navaldrones.com/CUSV.html#contract> 8th October 2014 accessed 10th October 2014.

⁴⁵ Ibid

⁴⁶ Littoral Combat Ship Class – LCS, United States Navy Fact File, http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1650&ct=4 1st August 2014, accessed 17th August 2014.

⁴⁷ Ibid, p. 3.

⁴⁸ Ibid, p. 7.

needed to conform to existing regulations.⁴⁹ The maritime transport industry has clearly seen a technological break-through with unmanned vessels but this project still has a main obstacle to overcome. It needs to be followed by the proper international regulatory framework.

3 Legal aspects

The topic of this thesis therefore will focus on the legal consequences that the unmanned vessels will give rise to.

In this point one of the core matters of this thesis will be considered. A series of International Regulatory challenges that these type of vessels must overcome before they can sail will be analysed.

For the sake of brevity the present research will not provide a review of every international convention applicable to ships; instead the analysis will be narrowed to the ones concerned mainly about safety such as SOLAS,

The approach will be to examine if unmanned vessels comply with key central regulations of present legal framework. Arguments and reasons for and against will be provided and finally the conclusion if they need the need to be amended and updated in order to regulate this type of ships will be considered. Conclusion will be if the rule can be complied or not or if it would be need to be amended to rule unmanned vessels. Solutions will be proposed in this regard.

Starting point of the analysis of this project from a legal perspective:

3.1 Legal definition and characteristics a vessel must gather from a Scandinavian legal perspective:

In this point the concept of what is a vessel will be analysed. However, it is first necessary to discuss the ordinary definition of a vessel.

⁴⁹ Ibid, p.7.

The book *Scandinavian Maritime Law – The Norwegian Perspective* provides an updated legal definition of what is a vessel⁵⁰. It describes how legislators in general haven't concerned themselves about establishing an exact definition, as it is a well-established concept. Nevertheless, this type of constructions can be identified by certain characteristics that they have in common. These can be practical in cases where there is uncertainty.

- a) *A vessel is a floating construction, with its own capability to float attributable partly to its hollow hull design. A log raft therefore would not be a ship.*
- b) *The construction must be intended for, and capable of, moving on or through the water. Thus a submarines and hydrofoils are ships but seaplanes would not fall under this specification. Even though a seaplane can move on water, its primary purpose is to fly.*
- c) *The construction must have certain minimum dimensions. It must be capable of carrying passengers or goods, and it cannot be too small. Many small vessels such as rowing boats kayaks, etc. are thus excluded.*

As we can see this current definition based on a set of technical specifications common to this kind of construction from the perspective of our topic initially rules out any kind of human factor involved in its operation.

Under this context we can now ask ourselves what is an autonomous vessel and determine if this answer falls under the wording of the aforementioned Scandinavian definition.

It can be noticed that the main distinction that characterizes the deployment of this revolutionary type of ships is its automated guiding system as for the rest they comply with every specification that these types of constructions have.

In the first instance the concept of an autonomous vessel accords simply with the basic requirements of the definition set out in terms of the Scandinavian legal sources. However, why is this concept legally controversial or rather on the face of it is there any legal issues with an autonomous vessel if it accords to the basic legal definition. The obvious question would appear to be negative.

⁵⁰ Thor Falkanger, Hans Jacob Bull, Lasse Brautaset, *Scandinavian Maritime Law – The Norwegian Perspective* 3rd ed. Universitetsforlaget 2011, p.44.

3.2 International Conventions:

“Unmanned ships are illegal under international conventions, which set minimum crew sizes. If they don’t comply with such rules, they’d be considered unseaworthy and ineligible for insurance”, says Andrew Bardot, executive officer of the International Group of P&I Clubs, whose members insure 90 percent of the global fleet⁵¹.

However, as is also the case with pilotless aircraft and driverless cars, it is not so much a technological challenge that has to be overcome before autonomous ships can set sail, but regulatory and safety concerns. As in the air and on the road, robust control systems will be needed to conform to existing regulations⁵²

One of the main problems with an autonomous vessel is that it is expected to have no crew. This has severe implications from the Safety point of view. Its one of the Maritime transport industries main concern.

3.2.1 SOLAS Convention

The first and most important is the safety of life at sea convention (SOLAS). Its first version entered into force in 1914 after the Titanic disaster. Followed by numerous amendments and updates, the 1974 version is in force today. Its main purpose is to establish minimum safety standards for the construction, equipment and operation of merchant ships. Under this scheme, the Flag States are in charge of ensuring that ships under their flag fulfil these requirements. Once those requirements are in place a certificate is issued. If there are clear grounds for suspecting that a ship or its equipment are in breach of the requirements, a provision known as *Port State Control* allows the Contracting Governments to inspect ships of other Contracting states⁵³.

⁵¹ Ibid, p.5.

⁵² Ibid, p.7.

⁵³ IMO, International Convention for the Safety of Life at Sea (SOLAS), 1974
[http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-\(SOLAS\).-1974.aspx](http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS).-1974.aspx) , accessed 14th of October 2014.

From the perspective of the unmanned vessels, a discussion regarding the compliance of every regulation included in the SOLAS convention is beyond the scope of this thesis. Instead a few central rules and the importance placed on them will be examined.

One of the key points and also one main concerns society and the maritime industry have regarding unmanned ships is if they will be safe enough. Furthermore, safety is one of the main features claimed by Rolls-Royce and MUNIN for this type of ships.

“Unmanned ship systems can autonomously sail on intercontinental voyages at least as safe and efficient as manned ships.”⁵⁴

“It’s a given that the remote controlled ship must be as safe as today,” Levander said. “But we can actually think it can be even much safer than today”⁵⁵

From this safety perspective, this research considers it is relevant to consider the analysis of this project under the terms established by SOLAS convention chapter V, *Safety of Navigation* for all vessels at sea⁵⁶

“Regulation 1 Application: Unless expressly provided otherwise, this chapter shall apply to all ships on all voyages, except:

1) warships, naval auxiliaries and other ships owned or operated by a Contracting Government and used only on government non-commercial service; and

2) ships solely navigating the Great Lakes of North America and their connecting and tributary waters as far east as the lower exit of the St. Lambert Lock at Montreal in the Province of Quebec, Canada(...)⁵⁷”

The findings in heading 2.1 proved that despite the fact that unmanned ships does not carry any crew this type of construction still complies the requirements of the definition, therefore it falls under the wording of “ship”. Hence this chapter is also applicable to unmanned vessels.

“Regulation 4 Navigational warnings

⁵⁴ Ibid, p.11.

⁵⁵ Ibid, p5.

⁵⁶ International Convention for the Safety of Life at Sea (SOLAS), 1974.

⁵⁷ Ibid, p. 14.

Each Contracting Government shall take all steps necessary to ensure that, when intelligence of any dangers is received from whatever reliable source, it shall be promptly brought to the knowledge of those concerned and communicated to other interested Governments.”

In the terms of compliance with this regulation Rolls-Royce would be able to argue that the unmanned vessel is steered and commanded from a remote interactive control station on shore with the aid of a comprehensive computerized monitoring system⁵⁸. Furthermore the communication with the ship performed via satellite signal would provide through dozens of high zoom cameras around it, a full image is available, including a bird's-eye view of the vessel in relation to its surroundings⁵⁹ the assistance of high advanced technology cameras and sensors allow the captain to spot any floating objects better than the human eye.⁶⁰

Furthermore the MUNIN project could claim that their dry bulk carrier under current development is equipped with an Advanced Sensors System that incorporates what a device named electronic lookout for small object detection and weather phenomena.

Aided by the devices described the remote operator of the vessel is permanently enabled to perform an efficient intelligence of any potential dangers at sea and promptly bring it to the knowledge of those concerned and communicated to other interested Governments. Therefore, both developers of the unmanned vessel would have arguments that would allow their projects to comply with this safety regulation.

“Regulation 14 Ships Manning:

1. *Contracting Governments undertake, each for its national ships, to maintain, or, if it is necessary, to adopt, measures for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned.*

⁵⁸ Ibid, p. 5.

⁵⁹ Ibid, p. 7.

⁶⁰ Ibid, p.5.

2. *For every ship to which chapter I applies, the administration shall:*
- .1 establish appropriate minimum safe manning following a transparent procedure, taking into account the relevant guidance adopted by the organization⁶¹; and*
 - .2 issue an appropriate minimum safe manning document or equivalent as evidence of the minimum safe manning considered necessary to comply with the provisions of paragraph 1.(...),’⁶²*

It can be interpreted from this regulation that contracting governments undertake the obligation of ensuring that every ship is sufficiently and efficiently manned in order to be considered safe under the terms of this regulation.

If unmanned vessels are analysed in the same manner, at first the expression “unmanned” seems to contradict the wording of the regulation leading to interpret the inverse i.e. an unmanned craft is considered insufficiently and inefficiently manned therefore unsafe from the point of view of life at sea. Consequently, this argument could hinder the compliance of this regulation for unmanned vessels.

Alternatively the parties involved in the development of unmanned craft could potentially argue that unmanned vessels are sufficiently manned and equipped in terms of safety of life at sea since the manning element is fulfilled remotely by human operators from the control command centres. Moreover it could be argued that the aid of modern marine technology in the steering and command of the vessel in combination with the remote operation performed by a person could meet the “efficiently” requirement. In conclusion, the “sufficiently manned” requirement would be complied by the remote operation and the “efficiently manned” requirement would be fulfilled by the comprehensive computerized systems that aid the steering and command of the craft.

With reference to point 2.2 of the present regulation in the hypothetical case that unmanned vessels accomplish the requirement of being sufficiently and efficiently manned as de-

⁶¹ SOLAS Guidance on Chapter V – Safety of Navigation <https://mcanet.mcga.gov.uk/public/c4/solasv/index.html> accessed 18th of October 2014. Principles of Safe Manning adopted by the Organization by Resolution A.1047(27).

⁶² Ibid, p.14.

scribed in paragraph 1 an appropriate safe manning document should be issued by the administration for this type of vessels.

From the perspective of the unmanned vessels, the point of discussion would be if they are considered to fall under the wording of this regulation. In other words, the analysis would be if a vessel remotely commanded and steered from a shore control centre by a human aided by remote marine technology can be considered to meet the “*sufficiently and efficiently manned*” requirement this Regulation sets forth.

On the contrary, in the case that unmanned vessels are not considered to be “*sufficiently and efficiently manned*” this regulation would need to be updated.

In relation with SOLAS Chapter V, Regulation 13, the Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) of 1978 as amended was adopted. This convention covers a comprehensive set of international regulations regarding training and certification of personnel. It establishes minimum requirements for training, qualifications and seagoing service for masters and officers and for certain categories of ratings.⁶³

The solution proposed by this research in for the case that unmanned vessels are not considered to comply with Regulation 13 of the SOLAS Chapter 5 would be to amend it bringing the Convention up to date with technological developments. Likewise, such amendment should be extensive to the STCW Convention.

“Regulation 5 Meteorological services and warnings

1. Contracting Governments undertake to encourage the collection of meteorological data by ships at sea and to arrange for their examination, dissemination and exchange in the manner most suitable for the purpose of aiding navigation. Administrations shall encourage the use of meteorological instruments of a high degree of accuracy and shall facilitate the checking of such instruments upon request. Arrangements may be made by appropriate

⁶³ IMPLICATIONS OF THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA FOR THE INTERNATIONAL MARITIME ORGANIZATION Study by the Secretariat of the International Maritime Organization (IMO), http://www.imo.org/blast/blastDataHelper.asp?data_id=23755&filename=6.pdf LEG/MISC.6 10 September 2008, accessed 6 September 2014.

national meteorological services for this checking to be undertaken, free of charge to the ship.

2. In particular, Contracting Governments undertake to carry out in co-operation, the following meteorological arrangements:

.1 To warn ships of gales, storms and tropical cyclones by the issue of information in text and, as far as practicable, graphic form, using the appropriate shore-based facilities for terrestrial and space radio communications services.

.2 To issue, at least twice daily, by terrestrial and space radio-communication services, as appropriate, weather information suitable for shipping containing data, analyses, warnings and forecasts of weather, waves and ice. Such information shall be transmitted in text and, as far as practicable, graphic form, including meteorological analysis and prognosis charts transmitted by facsimile or in digital form for reconstitution on board the ship's data processing system.

.3 To prepare and issue such publications as may be necessary for the efficient conduct of meteorological work at sea and to arrange, if practicable, for the publication and making available of daily weather charts for the information of departing ships.

.4 To arrange for a selection of ships to be equipped with tested marine meteorological instruments (such as a barometer, a barograph, a psychomotor and suitable apparatus for measuring sea temperature) for use in this service, and to take, record and transmit meteorological observations at the main standard times for surface synoptic observations (i. e. at least four times daily, whenever circumstances permit) and to encourage other ships to take, record and transmit observations in a modified form, particularly when in areas where shipping is sparse.

.5 To encourage companies to involve as many of their ships as practicable in the making and recording of weather observations; these observations to be transmitted using the ship's terrestrial or space radio communications facilities for the benefit of the various national meteorological services.

.6 The transmission of these weather observations is free of charge to the ships concerned.

.7 When in the vicinity of a tropical cyclone, or of a suspected tropical cyclone, ships should be encouraged to take and transmit their observations at more frequent intervals whenever practicable, bearing in mind navigational preoccupations of ships' officers during storm conditions.

.8 To arrange for the reception and transmission of weather messages from and to ships, using the appropriate shore-based facilities for terrestrial and space radio communications services.

.9 To encourage masters to inform ships in the vicinity and also shore stations whenever they experience a wind speed of 50 knots or more (force 10 on the Beaufort scale).

.10 To endeavour to obtain a uniform procedure in regard to the international meteorological services already specified, and as far as practicable, to conform to the technical regulations and recommendations made by the World Meteorological Organization, to which Contracting Governments may refer, for study and advice, any meteorological question which may arise in carrying out the present Convention.

3. The information provided for in this regulation shall be furnished in a form for transmission and be transmitted in the order of priority prescribed by the Radio Regulations. During transmission “to all stations” of meteorological information, forecasts and warnings, all ship stations must conform to the provisions of the Radio Regulations.

4. Forecasts, warnings, synoptic and other meteorological data intended for ships shall be issued and disseminated by the national meteorological service in the best position to serve various coastal and high seas areas, in accordance with mutual arrangements made by Contracting Governments, in particular as defined by the world Meteorological Organization’s system for the preparation and dissemination of meteorological forecasts and warnings for the high seas under the global maritime distress and safety system (GMDSS). ”⁶⁴

Weather conditions are a key point in the research of the unmanned dry bulk carrier prototype MUNIN is currently developing. This fact is of relevance not only from a safety perspective but also from a fuel efficiency perspective. In this regard, during deep-sea navigation it is crucial to avoid unfavourable weather conditions. For this reason this developer plans to implement a state of the art application named “Advanced Sensors System”⁶⁵. This device is able to sense relevant weather and traffic data to ensure navigation and contribute to planning a route.

In this regard the information described in paragraph 1 and paragraph 2.4 of this regulation is equivalent to the data collected by the MUNIN Advanced Sensors System. Therefore the application proposed by this developer would meet the requirements set by this regulation. Regarding paragraph 2 of this regulation onwards, the arrangements to broadcast, communicate and transmit weather readings and possible warnings, the findings of this research suggest that such procedure would not mean an obstacle in terms of compliance as existing procedures implemented in current standard vessels can be employed.

The findings of this research regarding this regulation consider that MUNIN has grounds that would lead to the compliance of this regulation. In addition the forecast of the results found by this modern weather device would mean a positive externality for the maritime industry as masters, companies, meteorological stations and services would benefit with precise weather readings performed by this state of the art application.

⁶⁴ Ibid, p.14.

⁶⁵ Ibid, p.11.

“Regulation 19 Carriage requirements for shipborne navigational systems and equipment”⁶⁶

This regulation requires that certain vessels must be equipped with Automatic Identification Systems (AIS) a tracking system used on ships capable of identifying and locating nearby vessels by electronically exchanging data with other ships and to coastal authorities automatically. The AIS system provides information such as identification, position course and speed of the vessel.

The regulation requires AIS to be fitted aboard all ships of 300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size.⁶⁷ MUNIN an Rolls-Royce have not disclosed the specifications regarding the development of their unmanned dry bulk carrier that would allow this research to analyse under which tonnage category it would fall according to the terms of this regulation. Despite this, it would be correct that unmanned vessels were required to equip this system to enhance the safety of navigation.

“2.10 Ships engaged on international voyages shall be fitted with an Electronic Chart Display and Information System (ECDIS) as follows:

2.10.3 cargo ships, other than tankers, of 10,000 gross tonnage and upwards constructed on or after 1 July 2013;

2.10.4 cargo ships, other than tankers, of 3,000 gross tonnage and upwards but less than 10,000 gross tonnage constructed on or after 1 July 2014;”

Additionally, Regulation V/19 also obliges all vessels to be equipped with an Electronic Chart Display and information system (ECDIS). Irrespective of size, all ships must carry nautical charts and nautical publications in order to plan and display the intended route and

⁶⁶ Ibid, p.14.

⁶⁷ IMO, Maritime Safety, AIS transponders, <http://www.imo.org/OurWork/Safety/Navigation/Pages/AIS.aspx> accessed 22nd September 2014.

to plot and monitor positions throughout the voyage. The ship must also be equipped with back-up arrangements if electronic charts are used fully or partially.⁶⁸

“It’s a given that the remote-controlled ship must be as safe as today,” Levander said. “But we actually think it can be even much safer than today.”⁶⁹

One of the pillars behind the development of unmanned vessels is safety. The developers of this project aim to make these vessels as safe as the manned ones in this regard they aim to comply with the whole extent of safety standards. Unmanned vessels equipped with ECDIS and AIS systems not only would be able to assist the remote operator for safely commanding the craft but would also comply with the requirements of this safety regulation and finally, address one of the maritime industry’s concern which is the safety of these type of ships.

With reference to AIS, it would be correct that unmanned vessel transmit through the signal they emit the fact that they are unmanned. In other words, it would be correct that other vessels in nearby locations differentiate a manned vessel from an unmanned one in the AIS screen.

“Regulation 33 Distress Situations: Obligations and Procedures

1. The master of a ship at sea which is in a position to be able to provide assistance on receiving information from any source that persons are in distress at sea, is bound to proceed with all speed to their assistance, if possible informing them or the search and rescue service that the ship is doing so. This obligation to provide assistance applies regardless of the nationality or status of such persons or the circumstances in which they are found. If the ship receiving the distress alert is unable or, in the special circumstances of the case, considers it unreasonable or unnecessary to proceed to their assistance, the master must

⁶⁸ Ibid, p.17.

⁶⁹ Ibid, p.5.

enter in the log-book the reason for failing to proceed to the assistance of the persons in distress, taking into account the recommendation of the Organization, to inform the appropriate search and rescue service accordingly.

.1 Contracting Governments shall co-ordinate and co-operate to ensure that masters of ships providing assistance by embarking persons in distress at sea are released from their obligations with minimum further deviation from the ships' intended voyage, provided that releasing the master of the ship from the obligations under the current regulation does not further endanger the safety of life at sea. The Contracting Government responsible for the search and rescue region in which such assistance is rendered shall exercise primary responsibility for ensuring such co-ordination and co-operation occurs, so that survivors assisted are disembarked from the assisting ship and delivered to a place of safety, taking into account the particular circumstances of the case and guidelines developed by the Organization. In these cases the relevant Contracting Governments shall arrange for such disembarkation to be effected as soon as reasonably practicable.

2. The master of a ship in distress or the search and rescue service concerned, after consultation, so far as may be possible, with the masters of ships which answer the distress alert, has the right to requisition one or more of those ships as the master of the ship in distress or the search and rescue service considers best able to render assistance, and it shall be the duty of the master or masters of the ship or ships requisitioned to comply with the requisition by continuing to proceed with all speed to the assistance of persons in distress.

3. Masters of ships shall be released from the obligation imposed by paragraph 1 on learning that their ships have not been requisitioned and that one or more other ships have been requisitioned and are complying with the requisition. This decision shall, if possible be communicated to the other requisitioned ships and to the search and rescue service.

4. The master of a ship shall be released from the obligation imposed by paragraph 1 and, if his ship has been requisitioned, from the obligation imposed by paragraph 2 on being

informed by the persons in distress or by the search and rescue service or by the master of another ship which has reached such persons that assistance is no longer necessary.

5. The provisions of this regulation do not prejudice the Convention for the Unification of Certain Rules of Law Relating to Assistance and Salvage at Sea, signed at Brussels on 23 September 1910, particularly the obligation to render assistance imposed by article 11 of that Convention.⁷⁰

6. Masters of ships who have embarked persons in distress at sea shall treat them with humanity, within the capabilities and limitations of the ship. ”⁷¹

This regulation establishes a general principle to every ship where masters of have the duty of responding to information of any source about persons in distress at sea. Once rescued persons must be treated in an humane way and must be delivered to a safe place.⁷²

After analysing this regulation this research found an evident question. As this regulation applies to all vessels, how would the hypothetical case be if the remote operator of an unmanned vessel would receive information about persons in distress at sea in terms of compliance. In other words the question would be how would the rules and exceptions of this regulation apply to unmanned vessels.

It is important to notice that this analysis will be performed with every information this research gathered from the unmanned vessel developers so far. It is possible the developers might be researching further devices or systems to deal with distress at sea situations. This academic paper has not found any so far.

⁷⁰ International Convention on Salvage 1989, London, 28th of April 1989 entered into force on 14th of July 1996.

⁷¹ Ibid, p.14.

Addressing the above-mentioned questions regarding the procedure a remote control vessel operator would need follow in case of receiving information concerning persons on distress at sea. The first paragraph of this regulation sets forth a general rule. The master or the remote operator in the case of unmanned vessels have the obligation of immediately proceeding to the assistance of survivors in distress at sea. From the research performed, it was found that so far the developers of unmanned vessels have disclosed no information regarding the procedure to follow under a distress scenario. On this subject, unmanned vessels are not equipped with devices or infrastructure that would enable the remote operators to deal with distress situations.

Although the general rule applies to unmanned vessels. This obligation would be impossible to fulfil since the vessel is unmanned and the remote operator is located in dry land. Due to the unmanned factor and the way they are constructed the present research has found that this type of constructions would not be not very useful under distress at sea situations unless they are equipped for the peril.

“(...)the master must enter in the log-book the reason for failing to proceed to the assistance of the persons in distress(...)”⁷³

Moreover, the exception to the general rule is provided in paragraph 1 third sentence and it would be applicable to unmanned craft. The term described, in order to be exempted from the rule is *“being unable”*. In this regard, the fact that the vessel is unmanned could exempt the remote operator from rendering assistance as long as this reason is recorded in the log-book and the rescue services are properly notified.

In conclusion, taking into account the difficulties that this type of ships face under a distress situation the present research will propose two alternatives in terms of compliance with this regulation.

The first hypothesis is to exempt unmanned vessels for mainly for practical reasons as there is no much help they can render as from the sketches released by one of the parties they are sealed designed constructions where the doors on them are only opened for loading or unloading the cargo. Even if unmanned craft would equip systems for dealing with distress

⁷³ Ibid, p14.

situations, the remaining question is how would this type of ship comply with the rule set by 1.1 i.e. “humane treatment” meant to provide further clarification of the duties and procedures under distress situations.⁷⁴ On this subject, how can an unmanned vessel be expected to fulfil the requirement of treating rescued persons humanely. Even if these ships would have the right equipment, as described in the paragraphs above, unmanned vessels are designed with no infrastructure to support crew.

The second hypothesis is that unmanned vessels are required by new IMO regulations to be equipped with efficient systems and plans to handle assist situations of distress at sea. Moreover this system would need to meet 1.1 of this regulation and Resolution MSC.167(78) Guidelines on the treatment of persons rescued at sea. If modern technology and design allowed developing an unmanned vessel those same resources could be used to develop a system and a plan for managing situations of distress at sea.

3.2.2 New SOLAS amendment for the recovery of persons from the water

From July 1st 2014 onwards SOLAS Regulation III/7-1 requires that every ship is prepared with specific plans and procedures for the recovery of persons from water. This amendment aims to ensure that every vessel is effectively equipped to serve, as a resource when rescuing persons from water or survival crafts is needed. The purpose of this regulation is not only to improve safety at sea but also to provide support to search and rescue coordinators for all kind of rescue operations. Special focus is made on situations where rescue capacity or access is limited.⁷⁵

For this purpose the International Chamber of Shipping (ICS) has developed the Recovery of Persons from the Water Guidelines - The Developments of Plans and Procedures⁷⁶ a

⁷⁴ Ibid, p.21.

⁷⁵ IMO Media Centre, SOLAS rules for ships to be able to recover persons from the water enter into force, Briefing: 24, July 1, 2014 <http://www.imo.org/MediaCentre/PressBriefings/Pages/24-SOLASamends.aspx#.VEu5EYuUc03>, accessed 20th October 2014.

⁷⁶ Recovery of Persons from the Water Guidelines for The Development Of Plans and Procedures <http://www.ics-shipping.org/docs/default-source/resources/safety-security-and-operations/recovery-of-persons->

series of guidelines to assist companies when preparing to comply with the new SOLAS Regulation III/17-1.

The first step this regulation follows is to assess the ship's life saving appliances or other useful equipment that can be used for rescue tasks such as liferafts, lifeboats, lifebuoys or first aid equipment.

The second step of these guidelines is to assess the suitability of each identified appliance taking into account the operations in which the vessel will operate and her characteristics such as, manoeuvre capacity of the ship, wind force, direction and effect of spray. All these variables are used as input for conducting a risk assessment and its result is used to determine if there is additional equipment is needed to prepare the vessel for rescue tasks.

The third step consists of identifying the equipment and designing plans, procedures and mitigating measures for potential situations. Such plans and procedures take into account elements such as: Training and drills, a source of illumination and, if required, power should available for the recovery area, hazards/risks related to the specific operation.

The general rule this regulation would require unmanned vessels to be efficiently prepared with plans and equipment to serve as a resource for recovering persons at sea.

It is important to notice that the developers of unmanned ships have not disclosed the way these vessels would proceed in case a person needs to be rescued from sea. What follows is the analysis of how these guidelines would apply to unmanned vessels and every step they would need to follow in order to achieve the safety standard. Compliance obstacles will also be taken into account in the case any is found.

First, an assessment of the vessels life saving appliances should be performed. Elements such as lifeboats, rescue boats, searchlights, cranes and derricks would then considered taking into account the operations and the conditions under which the ship would perform its route. Once these variables are collected a risk assessment should be conducted with them and its results analysed to consider if any supplementary equipment is required.

Finally, the additional equipment should be gathered and identified to design plans, procedures and measures to handle rescue situations at sea. On this matter training drills should be implemented to ensure the operator is familiar with the plans and procedures for the recovery of persons at sea.

Considering this recent amendment to the SOLAS Convention, after the analysis performed by his research the conclusion is that there would be no hindrances for unmanned vessels to comply every step this regulation to achieve the safety standard. There are two conclusions that can be drawn from the analysis of this recent amendment to the SOLAS Convention.

In terms of rescuing persons from the water Due to its unmanned characteristic, these types of vessels might not be as efficient as manned ones unless its developers implement a device that would outperform the manned ones. From a practical point of view if they are equipped with adequate plans and equipment they are still able to provide support for recovering persons from water.

Secondly from the compliance point of view these types of ships would have no hindrances in order to fulfil every step this regulation sets forth.

4 Seaworthiness

This has severe implications for example on the duty of seaworthiness which is a fundamental legal principle enshrined within the maritime legal instruments.

The aim of this point is to analyse unmanned vessels from seaworthiness perspective. This section will study the concept of seaworthiness and will assess how it applies to unmanned vessels. The present research will provide arguments for and against the compliance of this concept under the international conventions. Finally it will suggest alternatives that member governments could take into consideration when debating the proposals to regulate unmanned vessels.

Seaworthiness is an aspect of governmental interest in Maritime Law⁷⁷. Its effect is connected with safety, marine insurance, chartering, carriage of goods by sea, pollution and liability. In this regard, several national laws and international conventions have addressed seaworthiness. From the point of view of the carriage of goods by sea conventions the concept is of such importance that if a vessel is unseaworthy it cannot be insured, it cannot be chartered therefore it cannot carry any goods.⁷⁸ It was in 1924 when the “Hague Rules”⁷⁹ introduced for the first time the concept of the carriers duty to exercise due diligence to make the vessel seaworthy and a basis for liability of the carrier:

“Article 3

1. The carrier shall be bound before and at the beginning of the voyage to exercise due diligence to:

(a) Make the ship seaworthy(...),”⁸⁰

Subsequently a protocol of amendments was introduced in 1968. In its amended version⁸¹, the “Hague Visby Rules”⁸² maintained the same position as its predecessor with reference to the carriers duty to exercise due diligence for making the ship seaworthy before and after the beginning of the voyage. In practice, these international conventions became very widely accepted. Hague Rules and Hague Visby Rules have become identified with the traditional maritime nations.⁸³

⁷⁷ Hannu Honka, Questions on Maritime Safety, and Liability, especially in the view of the Estonia disaster, p351.

⁷⁸ Ahmad Hussam Kassem, The Legal Aspects of Seaworthiness, Current Law and Development, Swansea University 2006.

⁷⁹ International Convention for the Unification of Certain Rules of Law relating to Bills of Lading (“Hague Rules”), and Protocol of Signature, *Brussels, 25th August 1924*.

⁸⁰ *Ibid*.

⁸¹ Thor Falkanger, Hans Jacob Bull, Lasse Brautaset, *Scandinavian Maritime Law – The Norwegian Perspective 3rd ed.* Universitetsforlaget 2011, p. 278.

⁸² The Hague-Visby Rules - The Hague Rules as Amended by the Brussels Protocol 1968 multilateral.

⁸³ *Ibid* “In the context of international maritime law, both Hague and Hague Visby Rules have become identified with the traditional maritime nations”.

4.1 Historical evolution of the concept of seaworthiness

This research will provide a brief overview of how the concept of seaworthiness has evolved from the common law to the international conventions of carriage of goods by sea.

In common law the definition of seaworthiness is as follows:

*McFadden v. Blue Star Line*⁸⁴ defined seaworthiness as “... that degree of fitness which an ordinary careful and prudent owner would require his vessel to have at the commencement of her voyage having regard to all the probable circumstances of it”.

Under the common law perspective the carrier had the absolute duty of providing a vessel that had the proper conditions for its purpose, which is to take the cargo and face the perils of the sea. From the approach the Hague/Hague-Visby Rules took the concept of seaworthiness has evolved from being an absolute obligation to being a duty of exercising due diligence to make the vessel seaworthy. Likewise, Hague Visby went a step beyond regarding the concept of seaworthiness as it provided further details about the factors that constitute seaworthiness⁸⁵:

“Article 3:

1) The carrier shall be bound before and at the beginning of the voyage to exercise due diligence to:

(a) Make the ship seaworthy;

(b) Properly man, equip and supply the ship;

*(c) Make the holds, refrigeration and cool chambers, and all other parts of the ship in which goods are carried, fit and safe for their reception, carriage and preservation.”*⁸⁶

As mentioned before, the updated concept of seaworthiness set forth by the Hague conventions sets forth the way the carrier is expected to behave during the period before and at the beginning of the voyage.

⁸⁴ *McFadden v. Blue Star Line*, [1905] 1 K.B. 697, at p 706.

⁸⁵ *Ibid*, p.26.

⁸⁶ *Ibid*.

The seaworthiness of unmanned vessels will be reviewed under the updated concept of seaworthiness established by the carriage of goods conventions.

On the hypothetical case that a carrier employs an unmanned vessel under the terms of the current international conventions of carriage of goods by sea he will need to comply with the seaworthiness requirement. On this matter it is relevant to analyse how Article 3 of the Hague Visby rules would apply to these types of vessels. The research will explore if unmanned vessels are able to meet the current requirements of seaworthiness. In other words this point will explore if unmanned vessels are seaworthy. Additionally, arguments for and against the compliance of the seaworthiness requirement will be analysed and a solution will be suggested at the end.

*“1) The carrier shall be bound before and at the beginning of the voyage to exercise due diligence to: (a) Make the ship seaworthy; (b) Properly man, equip and supply the ship;”*⁸⁷

Starting with the “manning factor”⁸⁸ as previously explained, the carrier will have the duty of behaving in a diligent manner in order to ensure that the vessel he is delivering for service is suitably manned, equipped and supplied. The first question to consider is, if an “unmanned vessel” can be considered *properly manned, equipped and supplied*. From this “manning perspective it is important to point out that one of the main concerns regarding unmanned vessels is its *“human seaworthiness”*.⁸⁹ On this matter, this latter concept will be also taken into consideration for the analysis that shall be performed.

At first the named “unmanned” seems to contradict the wording of the rule leading to interpret the inverse i.e. an unmanned craft is considered improperly manned, equipped and supplied therefore unseaworthy.

As discussed under Chapter V of SOLAS Convention⁹⁰, the parties involved in the development of unmanned craft would be able to argument that unmanned vessels are sufficiently manned, equipped and supplied in terms of seaworthiness for the following reasons: Firstly, unmanned vessels are not completely unmanned since they are remotely commanded and steered by manned shore site control command centres. On this matter the “manning” element would be correctly fulfilled. In other words

⁸⁷ Ibid, p.26.

⁸⁸ See discussion under heading 2.2.1 Solas Chapter V, Regulation 14 Ships Manning.

⁸⁹ Ibid p.26. *“this kind of seaworthiness is divided into physical seaworthiness, human seaworthiness and documentary seaworthiness.”*

⁹⁰ See heading 2.2.1 p.14

Secondly, the aid of modern marine technology, such as MUNIN's recently tested Advanced Sensor Module⁹¹ together with the aforementioned navigational and safety sensors implemented to search for objects and track vessels complies with the "*equipped and supplied*" requirement.

All in all, the aforementioned arguments would allow the developers of the unmanned vessel project to comply with Article 3 (b) of the Hague Rules.

On the contrary, in the case that unmanned vessels are not considered to be "*properly manned, equipped and supplied*" this regulation would need to be updated.

Article 3 (a) Make the ship seaworthy

Every modern marine technology device⁹² the unmanned vessel will implement such as its Advanced Sensor Module⁹³, its comprehensive computerized systems, the safety sensors and the remote shore operator are developments in the direction of preparing the vessel for efficiently transporting the cargo, safely sailing and facing the perils of the sea. In fact, the pictures Rolls-Royce has released show sketches of vessels with covered decks in order to carefully stow the cargo and protect it from the perils of sea.

Additionally safety at sea is one of the main reasons that has lead the developers of unmanned vessels to develop the described level of technology to be implemented in unmanned vessels. Closely related to seaworthiness, such safety also took into account every aspect related to the cargo such as holds. In conclusion the aforementioned behaviour also falls under the wording of "*exercising due diligence*" therefore the requirement is met.

Taking into consideration the above mentioned, a hypothetical carrier deploying unmanned vessels for the carriage of goods by sea would comply with the requirement of making the ship seaworthy during the period before and at the beginning of the voyage.

Considering the exposed reasons there would be no argument to assert that unmanned vessels are unseaworthy. On the contrary, a carrier employing unmanned vessels for service would have solid arguments in terms of compliance of the seaworthiness requirement. As the analysis reflects the behaviour carriers can have towards being diligent to make the vessel seaworthy allow them to fulfil the Hague Visby requirements.

Regarding Article 3.3 The described duty under this heading could be fulfilled by the remote operator. With respect to this duty no information has been disclosed so far on how this requirements can be performed in the case of an unmanned vessel.

⁹¹ MUNIN In-Situ Test, Fraunhofer CML.

⁹² See headings 2.3 2.4 for details regarding the modern marine technology devices.

⁹³ *Ibid.*

4.2 Seaworthiness under Charter Party contracts:

A warranty of seaworthiness is usually contractually implied in the charter party. This means that the vessel must be in such condition that allows to safely carry the cargo agreed in the charter party. If the ship does not meet such condition the owner shall be liable regardless of fault. Also, many Charter Parties address this point directly, for instance “*the vessel being tight, staunch and strong and in every way fit for the voyage*”. On this point, it is common practice for the owner to agree to exercise “*due diligence in making the vessel seaworthy*” as is the case with Intertankvoy 76 clause 1 (a)⁹⁴

*“1-Condition of the vessel: The vessel’s class as specified in part I shall be maintained during the currency of this Charter Party. The Owner shall (a) before and at the beginning of the loaded voyage exercise due diligence to make the vessel seaworthy and in every way fit for the voyage, with her tanks, valves (...) and flag.”*⁹⁵

In the terms of Shellvoy 5 Part II clause I: “*Owner shall exercise due diligence to ensure that the time when the obligation to proceed to the loading port (s) attaches and throughout the charter service-*

- (a) the vessel and her hull, machinery, boilers, tanks, equipment and facilities are in good order and condition and in every way equipped and fit for the service required; and*
- (b) the vessel has full and efficient complement of master, officers and crew; and to ensure that before and at the commencement of any laden voyage the vessel is in all respects fit to carry the cargo specified in part I(f)”*⁹⁶

If a vessel is not seaworthy upon arrival to port, the charterer faces two possible scenarios; the charterer can refuse to load until the shortcoming is solved. Or he can cancel the Charter Party if the unseaworthiness is of such degree that it cannot be solved on time. For the case that the seaworthiness is not likely to be solved the Charter Party can be cancelled. In many cases, owners tend to limit their obligation by agreeing to “*exercise due diligence in making the vessel seaworthy*”⁹⁷

⁹⁴ Ibid, p. 12.

⁹⁵ The Baltic and International Maritime Conference (BIMCO), Intertankvoy 76, Tanker Voyage Charter Party.

⁹⁶ BIMCO, Shellvoy 5 Voyage Charter Party, New Delhi 2009.

⁹⁷ Ibid, p.12.

The contractual duty of making unmanned vessels seaworthy does not differ considerably from making a traditional vessel seaworthy. The reasonable behaviour that takes a carrier or an owner to prepare the vessel for a specific voyage is also required for unmanned vessels. Therefore there is no hindrance to apply the same conduct performed on traditional vessels to unmanned ones.

4.3 Seaworthiness in Marine Insurance:

The Marine Insurance Act (MIA) of 1906 describes a Warranty of seaworthiness of the ship. “*A ship is deemed to be seaworthy when she is reasonably fit in all respects to encounter the ordinary perils of the seas of the adventure insured.*”

In the terms of this act, a broader concept of seaworthiness is employed; “all respects” requires the carrier to provide a seaworthy vessel efficient enough in every respect i.e. equipment, manning, for performing the voyage.

Under carriage of goods, the Hague/Hague Visby Rules and *McFadden vs. Blue Star* the requirement is to provide a vessel fit enough to carry the goods and that the carrier exercises due diligence in this regard. In contrast, the MIA describes the duty of providing vessel fit enough for the voyage. This contrast might lead to think that the concept of seaworthiness differs under these branches of Maritime Law but it doesn't. Although different branches of Maritime Law cover seaworthiness it remains a well-established concept in mercantile matters. Consequently, seaworthiness is “*the fitness of the vessel in all respects, to encounter the ordinary perils of the sea; that could be expected on her voyage, and deliver the cargo safely to its destination.*”⁹⁸

4.4 Seaworthiness under Norwegian Maritime Law.

In the 1994 amendment of the Norwegian Maritime code (NMC) Norway has aligned its statutory rules as far as possible with the Hamburg Rules⁹⁹ without derogating the Hague/Hague-Visby Convention.

⁹⁸ Ibid, p. 26.

⁹⁹ United Nations Convention on the Carriage of Goods by Sea (The Hamburg Rules) Hamburg, 30 March 1978 United Nations (UN).

Under this context it is relevant to analyse the Norwegian approach to this term. Seaworthiness is described in NMC Section 131

“Seaworthiness of the ship: The master shall before a voyage begins ensure that the ship is seaworthy, including that it is sufficiently equipped, manned and supplied with provisions and in proper condition for the reception, carriage and preservation of the cargo. The master shall see that the cargo is properly stowed, that the ship is not overloaded, that its stability is satisfactory and that the hatches are properly closed and battened down.

During the voyage the master shall do everything in his or her power to keep the ship in a seaworthy condition.”¹⁰⁰

This section clearly reflects the extent to which the NMC is aligned with both the Hamburg Rules and the Hague/Hague Visby Rules as NMC 131 first paragraph resembles Article 3 of the Hague Visby Rules while the second paragraph resembles the approach taken by the Rotterdam Rules as the carrier’s duty to provide a seaworthy ship is to be judged on the same basis as his duty towards the cargo, in this regard, both obligations are to run throughout the period of carriage.¹⁰¹

The term has two senses, a narrow and a broad one. Regarding the first sense, it is related to a technical sense i.e. the vessel must be in such condition that allows performing the contemplated voyage without endangering human life. This was the approach followed by the Seaworthiness Act of 1903, which has fallen into disuse today. Nowadays the requirements set forth by the Ship Safety and Security Act¹⁰² are followed instead. The purpose of the act is quite broad and covers matters such as life safeguard, health, property and environment. This act promotes quality assurance systems to different forms of shipping. It aims to establish a complete and document based and verifiable assurance system for all shipowners and vessels. Chapter 2 covers the shipowning companies duties, chapter 3 deals with technical and operational safety, and chapter 7 regards the rules for the scheme supervision.¹⁰³

Under the Norwegian perspective, seaworthiness is a term also employed in relation to cargo i.e. ”cargoworthiness”. A cargoworthy vessel will gather such a condition and suitability that it can be expected to load and transport and deliver the cargo undamaged. This term is related to the broad sense of the word seaworthiness, its meaning is related to the nature of

¹⁰⁰ The Norwegian Maritime Code, 24th June 1994 with later amendments up to an including Act 26 March 2010 no. 10, Marius, Scandinavian Institute of Maritime Law.

¹⁰¹ Samir Mankabady, *The Hamburg Rules on the Carriage of Goods by Sea*, A.W. Sijtoff International Publishing Company, 1978

¹⁰² Norwegian ship safety and security act, 2007

¹⁰³ *Ibid*, p.12.

the cargo to be transported and the particular voyage. For instance if bulk carriage is going to take place cleaning must be more extensive in comparison to general cargo. Unseaworthiness can arise at any stage of the voyage, if this is the case the carrier has the duty of due diligence with relation to the cargo under the ordinary rules to which is subject under section NMC Chapter V The Carrier's Liability for Damages section 275.¹⁰⁴

4.5 Documentary seaworthiness:

Considering the Carriage of goods by sea and Marine Insurance, the analysis of the seaworthiness of unmanned vessels, can be divided in 3 legal obligations independent of the type of vessel if its traditional or unmanned. A physical seaworthiness, a human seaworthiness and a documentary seaworthiness are 3 legal obligations that can be analysed under the concept of the seaworthiness. As it was previously exposed the potential shipowner of an unmanned vessel who intends to trade her would have no obstacles to comply with the first two types of seaworthiness i.e. the fitness and equipment of the vessel and her manning for an agreed voyage. In fact these legal obligations are applicable in the same way to tradition and unmanned vessels. There is hindrance though, there is an obligation that no matter the degree of due diligence that a shipowner can apply that it will not be fulfilled by unmanned vessels what makes them to be in breach of the documentary seaworthiness. The reason for the impossibility to comply with the documentary seaworthiness does not have to do with behaviour of the shipowner, or the carrier. The hindrance has its origins in the international conventions. So far there are no international instruments regulating unmanned vessels, as the IMO has not received yet any regulation proposal from the contracting governments therefore it is impossible to meet any certification requirements. As long as unmanned vessels are not covered by specific regulations, potential shipowners of unmanned vessels will be able to meet human seaworthiness and physical seaworthiness but not the documentary seaworthiness, which is as important as the rest. Documentary unseaworthiness due to the lack of international regulation originates a series of consequences for potential unmanned vessel owners. The fact that no international instrument specifically covers unmanned vessels produces a chain of consequences as classification societies cannot certify them. If a the vessel is not classed it cannot be insured, therefore it cannot sail, if it cannot sail it cannot be insured nor chartered.

¹⁰⁴ Ibid, p12.

4.6 Seaworthiness and the ISM Code

This point will explore a recent amendment to the SOLAS Convention Chapter IX in order to minimize human error and management deficiencies in companies involved in ship operation. It will briefly describe what the ISM Code is, how it works and the steps it follows. Finally the implementation and potential impact it can have on the seaworthiness of unmanned vessels will be explored.

The ISM Code is a system of international standards for the organization and transparency of companies operation with ships. Through these standards, the ISM Code aims to implement a safety management in order to train instruct and train the crew involved in the operation of a ship for potential emergency situations. What is distinctive about the ISM code is that it allows shipping companies to develop their own Safety Management System (SMS). This system does not attempt to impose how companies operations should their operations. Instead it requires them to assess potential downsides that may arise during operation. These deficiencies should be discovered reported and corrected. Through policies, instructions, procedures and an internal system of audits should be established in order to rectify any shortcoming.¹⁰⁵

In order to achieve them, a plan is established in order to meet them. First a thorough assessment of the operation of the vessel and its on shore management system is conducted during operation. Every shortcoming needs to be reported down in writing for further designing the necessary policy or procedure to correct it. Once designed such procedures instruct employees how to perform their duties and train them on how to react in an emergency situation.

The system follows three steps: Firstly, the manager must properly instruct his personnel on their duties (to produce the SMS). On the second place, the system requires keeping track of all records, reports and communications. Third a person is designated to perform as a link between the company and the ship.¹⁰⁶ By following this plan, relevant information regarding the operation of the ship is disclosed to interested parties ensuring transparency in everyday operation of the ship.

¹⁰⁵ Pambroides, George P., Holman, Fenwick & William, Articles, The ISM Code: Legal Implications, p. 56, London 1996.

¹⁰⁶ Ibid, p.32

The behaviour expected from a prudent unmanned shipowner ought to have¹⁰⁷ in compliance with the ISM Code is aligned with the fundamental principles of due diligence and seaworthiness. It is a further step towards the achievement these duties.

“It appears that this new system has the potential to of affecting the meaning of well established concepts like seaworthiness, due diligence”¹⁰⁸

Under this context, If a vessel is considered “unseaworthy” and this situation leads to an incident, such “unseaworthiness” will be considered the causal factor. In this regard, the shipowner’s defence for this case would be to prove that he exercised “due diligence” in providing a seaworthy vessel. Under the rules of the ISM Code, this analysis would be divided in two. Firstly, the content of the SMS will be assessed to find out if it applied policies and procedures to ensure safety. The second part of the analysis will be to assess the shipowners’s behaviour regarding the application of the SMS code.

The ISM Code and the unmanned vessels share the aim of enhancing safety at sea by minimizing human error. The new culture of transparent management that the ISM Code brings is possible to implement and comply by unmanned vessels. In fact it will allow the developers and potential shipowners of this craft to go a step further in safety management aspects.

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What is unique about the ISM Code is that it establishes a set of international standards to achieve safety and pollution prevention but it does not attempt to impose how shipping companies should run their operations in order to achieve those standards. The method to correct drawbacks and defects in the management of the company in order to achieve the standards must me designed by the company itself. In this regard, this goal oriented Code would be useful and practical tool to implement in unmanned vessels as international standards are established with the aim of organizing the management of the shipping company in order to increase safety at sea and prevent and minimize pollution prevention. The

¹⁰⁷ Simon Kvernal QC, Quadrant Chambers, “Seaworthiness under Contracts of Carriage by Sea and the Role of the ISM”, April 2006, London.

¹⁰⁸ Ibid p.32.

application of this system is perfectly suitable for the case of unmanned vessels as no major amendment of the Code would be required.

5 Conclusion

Although it's a recent development of marine technology, that looks very promising from a safety, environmental and commercial point of view there is still a lot of time ahead until these vessels sail. So far the contracting governments haven't put forward any contributions for the discussion of the regulation of unmanned vessels. In this regard the main obstacle that obstructs unmanned vessels from sailing is not a matter of technology development but the lack of a proper regulatory framework that covers them. This fact starts a chain reaction of hindrances, as classification societies cannot certify the vessels. If the vessel lacks of classification certificate it cannot be insured, if unmanned vessels cannot be insured they cannot sail therefore they cannot be chartered.

Many regulatory aspects have already been developed for traditional vessels and are applicable to unmanned vessels such as the ISM Code. On the other hand there are several international instruments that would need be amended bringing the Conventions up to date with technological developments.

From the point of view of safety both projects are already a success, as every safety discovery will contribute to improve safety at sea.

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