Autonmous surface ships, in view of existing legislation, and the need for a new governance

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ABSTRACT: The race of autonomous vehicles is moving with fast leaps either on land, airborne, underwater and recently waterborne as well. Maritime Autonomous Surface Ships are expected to make its first test on 2018 in Finland. The first commercial vessel is M/V Yara Birkeland, first she intended to operate with minimal crew before turning to fully autonomous on 2018. The main issue concerning the applicability of Autonomous ship and the introduction to the maritime industry is not related to technicality, as a big percentage of technical knowledge already exists, but is related to the legal and regulatory framework which will govern and regulate the operational aspects.
The main issue to concentrate on is liability issues, both financial and criminal liability. Though financial liability will be solved without much of a change, sadly a higher value of compensation will be involved. It will make insurers more reluctant to give the same existing terms as of the conventional ships, because there will be no one onboard to intervene in case of machinery failure, which is a weak point in comparison with crewed ships, but in the end, it will be adjusted to a higher insurance premium.
This paper discusses the real complication related to criminal liability which results from collision cases developing to death of crew, where the punishment may include imprisonment. How can the punishment be imposed, if there is no Captain onboard to arrest, and the supposed to be Captain is sitting thousands of miles away in a control center and responsible for possibly more than one ship at a time. In addition, it aims to explore the expected conflict of law due to the integration of Autonomous ship into maritime industry.
KEYWORDS: **autonomous surface ship, criminal liability, financial, conflict of law, control center.**

1. INTRODUCTION

Shipping is one of the world's major global industries, and the importance of shipping stems from the fact that more than 90% of world trade is shipped by sea (IMO, 2010). In addition, the maritime industry is organized through a group of international instruments such as; Conventions, Resolutions, Decrees, and Codes that give great cares for three elements; ports, ships, and personnel. Even though, the International Maritime Organization (IMO) prove statistically that more than 80% of the marine casualties occur because of human errors, which gives more emphasis to the importance of human element engaged on jobs either at ports or onboard ships (IMO, 2010). More recently, there have been general concerns among maritime stakeholders that human error is the most contributing factor in causing accidents. By reviewing USA, UK, Canada and Australian accident database clarifies that human error continues to be the dominate factor in maritime accidents and reveals that in 70% of recorded incident (ABS, 2004). Fatal accidents' Statistics have determined that work on deck, for example mooring operations, is 5 to 16 times more dangerous than jobs ashore (Primorac, & Parunov, 2016).

Although, Commercial vessels are provided with electronic navigation tools that report the location of the vessel (e.g. Global Positioning System (GPS)) and distance to other vessels, their trajectory and velocity as well as the expected route (e.g. ARBA, radar and Automatic Identification System (AIS)), and electronic schematics are used. In addition, ships are routed by drawing a route in the electronic chart, so the Autopilot keeps the ship on this predefined track, but still they used the manual control of the rudder and the main

engine to maneuver or to handle the error events. This gives a great emphasis and efforts to identify the importance of Autonomous ships to reduce the number of accidents.

2. POTENTIALS OF AUTONOMOUS SHIPS

Recent years have witnessed rapid progress in the development and use of Autonomous and semiautonomous vehicle technology known as Unmanned Arial Vehicle (UAV). The initial development of technology was largely driven by military applications, but it is now progressively used in the civilian world. Not surprisingly, one of the first civil applications of this technology occurred in the maritime industry with the advent of unmanned vehicles, underwater. However, until recently, advances in unmanned vehicle technology have not reached the surface of the water.

In parallel, Lloyds Register, (2016) classified the levels of autonomy concern merely navigation-related aspects as shown in table (1) (Lloyds Register, 2016).

In the same vein, the Maritime Safety Committee (MSC) of IMO agreed in June to undertake a process to determine the regulatory scope for its identification and the need to modify the regulatory framework to enable the safe and environmental operation of Maritime Autonomous Surface Ships (MASS) within existing IMO instruments. The objective is to identify IMO regulations which:

- preclude unmanned operations as currently drafted,
- would have no application to unmanned operations,
- do not preclude unmanned operations but may need to be amended.

By agreeing to undertake this exercise, IMO intends to play a proactive role in ensuring a coherent international approach in this area. This approach actively supported by International Union of Marine Insurance (IUMI) during the MSC meeting. The scope determination process is not scheduled to be completed until June 2020, and only after this date will work begin on a possible modification of the current rules or a separate code related to the MASS. This means that there will be years before IMO will decide on any adjustments, the result is uncertain (Hammer, 2017). During the discussion, several Member States expressed their support for the views expressed by the International Transport Workers' Federation (ITF), which urged a more holistic approach in determining the scope of the entire human element and the technical and operational aspects of MASS.

At the same time, new project plans have been announced in May, Yara and Kongsberg Maritime entered into a partnership to build the world's first fully electric and Autonomous container ship: Yara Berkeland. The operation is scheduled to begin in the latter half of 2018, shipping products between three ports in southern Norway. Yara Berkeland will initially operate as a manned ship and move to remote operations in 2019 and is expected to be able to perform completely independent operations as of 2020.

Table (1). Autonomy levels (AL) adapted from Lloyds Register

Description	Operator role
AL 0: Manual steering. Steering controls or set points for course, etc. are operated manually.	The operator is on board or performs remote control via radio link.
AL 1: Decision-support on board. Automatic steering of course and speed in accordance with the references and route plan given. The course and speed are measured by sensors on board.	The operator inserts the route in the form of "waypoints" and the desired speed. The operator monitors and changes the course and speed, if necessary.
AL 2: On-board or shore-based decision support. Steering of route through a	Monitoring operation and surroundings. Changing course

sequence of desired positions. The route is calculated so as to observe a wanted plan. An external system is capable of uploading a new route plan.	and speed if a situation necessitates this. Proposals for interventions can be given by algorithms.
AL 3: Execution with human being who monitors and approves. Navigation decisions are proposed by the system based on sensor information from the vessel and its surroundings.	Monitoring the system's function and approving actions before they are executed.
AL 4: Execution with human being who monitors and can intervene. Decisions on navigation and operational actions are calculated by the system which executes what has been calculated according to the operator's approval.	An operator monitors the system's functioning and intervenes if considered necessary. Monitoring can be shore-based.
AL 5: Monitored autonomy. Overall decisions on navigation and operation are calculated by the system. The consequences and risks are countered insofar as possible. Sensors detect relevant elements in the surroundings and the system interprets the situation. The system calculates its own actions and performs these. The operator is contacted in case of uncertainty about the interpretation of the situation.	The system executes the actions calculated by itself. The operator is contacted unless the system is very certain of its interpretation of the surroundings and of its own condition and of the thus calculated actions. Overall goals have been determined by an operator. Monitoring may be shore-based.
AL 6: Full autonomy. Overall decisions on navigation and operation are calculated by the system. Consequences and risks are calculated. The system acts based on its analyses and calculations of its own capability and the surroundings' reaction. Knowledge about the surroundings and previous and typical events are included at a "machine intelligent" level.	The system makes its own decisions and decides on its own actions. Calculations of own capability and prediction of surrounding traffic's expected reaction. The operator is involved in decisions if the system is uncertain. Overall goals may have been established by the system. Shore-based monitoring.

Source: Lloyds Register, (2016)

In the case of the above-mentioned navigation, the vessel's machines must be both reliable and practically reliable to achieve a highly automatized vessel that works very well. The propulsion mechanism is critical to maneuvering and possibility of navigating. To improve safety at sea when Autonomous ships sail, changes are needed in COLREGS as well as a solution for communication between vessels. Also, on-board maintenance is something that needs to be changed to avoid a propulsion breakdown. Preventive maintenance and redundancy will reduce the risk of mechanical failure. Even though, the risk of accidents is still existing, one of the major accident which need to be considered is Collision. To make autonomous vessels consistent with legislation, some changes must be made. These changes are not great, but all seafarers must be aware of the new regulations.

3. IMPLEMETING COLREG 72 BY AUTONOMOUS SHIPS

The International Regulations for Preventing Collisions at Sea, (COLREG 72) is attempted to avoid collisions at sea by all types of ships and in all situations and state of the sea, as this set of standard

regulations describes the duties to keep clear and the visual and sound signals to be used by ships. However, in the complicated situations, a set of regulations may become complex and misinterpretations by Officers Of the Watch (OOW) and captains as well, which may lead to collision among ships at sea or at anchor. Even though, sailing in congested water make the decision taken by OOW or the captain about ship's maneuver based on their experience only may increase the risk of collision, thus equipment ashore such as Vessel Traffic Services (VTS) play an important role to increase the safety of navigation at sea (Roos, & Sandell, 2016).

Despite, Captains and OOW must act under several laws and legislations during navigating in the international voyages, so they need to be aware of different rules which are valid in different areas and ports. COLREG are usually the standards taken by most countries to create their own special rules for the waters under their jurisdiction, for example; according to Rule 2 of both the COLREGS and U.S. Inland Rules,

"*Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules .....*"

The objective is to ensure the operation of all ships, commercial, public or private vessels in accordance with the standard rules. But, are those rules unambiguously clear and understood by all navigators? Hard 2016 Illustrates, they are not perfectly clear and in various places are confusing, ambiguous and even contradictory. But what is most worrying is the danger it poses various uncertainties contained in the rules that can lead to collisions, loss of life, pollution and other undesirable results (Hard, 2016). Thus, are the autonomous ships will use the same COLREGS? Mast.et al, 2016 clarify that COLREGS would need to be adjusted to improve safety of navigation, and autonomous ships could carry distinctive lighting, day marks and their own rules for avoiding collisions, and also, they cannot give human assistance to other vessels in danger. To do this they need to be considered as a different type of ships in the regulations, while COLREGS will remain as it is for the manned ships. Only, autonomous vessels should be identified by specific lighting and day marks (Mast, et al., 2016).

Verification of the automatic functioning of the COLREG automatic system is a major challenge when it comes to achieving reliable support for the decision-support and, initially, autonomous navigation. Narrow water and vessels with limited maneuverability, for example because of their size and draught, pose a challenge - for OOW or for algorithms that would be able to ensure autonomous navigation (Lazarowska, 2017).

4. GENERAL AND OPERATIONAL LIABILITIES

The subject of autonomous ships and the consensus on what, if any, new or modifications to existing regulations are necessary is not so clear. Many parts are inter-linked and to itemize will not be easy, discussion at this title of the paper will be consolidated. The major complication arises because of the autonomous status of the vessel, the absence of crew onboard, the lack of labor to handle, monitor, operate, navigate, care, and maintain the vessel and the cargo onboard. First discussion here will handle the crew issue. The Maritime Labor Convention known as MLC2006, govern and regulate the relation between the ship-owner and seafarer (known earlier as seaman), drafting the conditions and rights of seafarer. In the case of MASS, does the land-based operator considered as a seaman, he may hold a master license or a bridge navigation license but he is not existing onboard, in case the operator suffer an injury during performing his task, will he be subject to compensation as per MLC 2006. To discuss the complication legally, the definition of seaman must be clear. Recalling the case of The Buena Ventura the seaman was defined as anyone who contributes to the labors about the operation and welfare of the ship when she is in motion".

The seaman status was extended to cover a wireless telegraph operator, while In Norton v. Warner Co. (Norton, 1944) the Supreme Court denied compensation to a worker on a barge that had no motive power, finding him to be a member of the crew of a barge that could not actually navigate. Since the barge worker was conducting work that was similar to the work conducted on vessels in navigation, the Court reasoned

that he was a member of the crew. This conflict is existing where the ship is manned and operable, which still the definition of seaman is not so clear, this conflict will escalate more due to none existence of crew onboard autonomous ships and the supporting services rendered to the vessel by other personnel. The concern is about the navigational part, the other part in relation to cargo operation. The carrier duty of care and the vessel seaworthy, many rules connect the manning level and seaworthiness taking for example, Hague Visby rules. The owner of the ship may not get the benefit of the exclusion clause, as per rule 13 the owner will be held liable for cargo claims if they did not exercise due diligence making the ship seaworthy before the voyage starts.

Sampling the case of Hong Kong Fir Shipping Co. v Kawasaki Kisen Kaisah, where it was confirmed by the court that, an insufficient and incompetent crew can cause a vessel to be unseaworthy. Therefore, how about if there is no crew onboard, if the vessel proven to be unseaworthy then as a result insurer will not be willing or even decline from covering the vessel.

However, in the Hong Kong fir the judge commented if the crew has been efficient and competent the ship may have been seaworthy, so does this open a way to freeing owner from liability by proving that the operator thousands of kilometers away is competent enough to perform the voyage and giving the vessel a seaworthy status!

To focus the point more, Art III (2) of The Hague/Hague Visby Rules provides that “the carrier shall properly and carefully load, handle, stow, carry, keep, care for, and discharge the goods carried” (The Hague Rules, 1968). The carrier through his Master, is obliged to be careful and skillful in stowing and protecting each part of the cargo. All reasonable precautions to be taken to protect the cargo and if damage occurred then all precautions and measures should be taken to prevent further development of damage, this should be performed physically onboard during the voyage and need labor to do so. Through sensors, the detection of damage may be available, but the prevention of the damage to develop may not be possible, so the care part may not be performed properly. Looking for the warranty term, in general, the implied warranty of seaworthiness is an absolute duty that the ship owner extends to seamen, and to the cargo that it transports. If talking that an Autonomous ship does not have seamen or crew, so it is important to discuss whether Autonomous ships can be considered seaworthy. The ship owner of an Autonomous ship extends the warranty of seaworthiness of their vessel to those who entrust their cargo to him, and he may be found strictly liable for any injuries that result from unseaworthiness (Barlow, 2014).

The seaworthiness of Autonomous vessels is a curious topic that highlights more aspects of maritime law in need of revision. The question is simple: if unmanned ships does not have a crew, are they considered unseaworthy? reviewing the Carriage of Goods by Sea Act (COGSA), Although divides the concept of seaworthiness into three categories, only one of which uses the term "seaworthy", all three categories are aspects of "seaworthiness". Thus, under § 1303:

(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, refrigerating and cooling chambers, and all other parts of the ship in which goods are carried, fit and safe for their reception, carriage, and preservation (Francesca, 2006).

It would be very easy to claim that MASS vessels which has no crew onboard to be inadequately manned, the cases with COGSA, Hague Visby rules and alike in relation to seaworthiness will not be easy to apply in the existing phase to MASS. The United Nations Convention on the Law of the Sea UNCLOS stated that, it is the duty of the flag state to monitor a vessel flying its flag to ensure adequate manning of vessels as per international standards. SOLAS convention requires ships and their flag states to issue

minimum safe manning documents. All these arguments may hold water, but with admission of new technologies, it might be considered that MASS without crew is liable to less error and possibly pass as a seaworthy vessel, but with a shift of responsibilities, the liability and limitation of liability will be further highlighted.

Accident concerning ships in a collision or Alison may develop casualties and economic losses, which needed to be compensated. In case of accident involves a MASS sent to court, and found liable, liability part will be directed to the owner of the MASS, where the owner will try to deflect the liability to another parties. The burden of proving that the act caused the accident was not his fault or without his knowledge is his part. If the owner can prove this, then he can limit his liability, but how the owner can prove this if he was not onboard or involved of the decision-making process during the accident or doesn't have the ability to collect data as of what happened during the accident. Keeping in mind that MASS is operated in a fully autonomous mode. Arguably, if the owner could proof that that ship was in autonomous mode and he or his operator at the control center were not consulted before the action is taken by the ship, this will lead to another argument as of the decision of going into full autonomous mode was taken by the operator.

The decision taken by the MASS which led to accident surly was not intended while programming the artificial intelligence, the accident may occur due to malfunctioned equipment or wrong chain of orders in the artificial intelligence. The owner may partially scape from the strict liability and may bleed limitation of liability subject to channeling the liability to the software maker or the equipment maker. If the ship is newly built which, will be the always case since the idea still new, then the liability may be channeled to the builder (shipyard), but this maybe brushed away since there was a mooring test and a sea-trial performed and accepted by the owner and the classification society. Furthermore, this case may be accepted if the accident occurred during the guarantee period, which is subject to further discussions. The major buzzle will be if the liability channeled to the shipyard, which by turn will direct it to the vendor of the defected equipment. In this case will be a strict liability, but will the vendor be able to cover all the claims arise from a collision leading to a spillage of oil to the sea, taking example of the claim arise from Deep Horizon case at the Gulf of Mexico!

If the case of operating the vessel in autonomous mode will be considered by the lawmaker as an accepted case to limit liability, the owner of the vessel will deflect the liability to the ship itself, so in this case the ship will be considered as a person thinking of its own. However, in case of a criminal liability, if the ship is operating in an unmanned mode (where decision is taken from a remote location, which is manned and monitored around the clock) then the liability will be strict and can be channeled to the operator if the owner claim not knowing the decision taken during the accident. The arrest, if any may be performed against the operator, though difficult implementation due to different governing law between vessel location and operator in another jurisdiction, but this is not the core of the discussion. Nevertheless, if the case with a vessel on fully autonomous mode then the vessel will be considered as a unit capable of thinking by its own and accordingly will be (theoretically) considered as a person, this will raise the issue of action in rem and in personam at maritime law. At international maritime law the action against in rem is action taken against property of the same owner, as ship or another ship owned by the same owner. Action in personam is the action taken against a person in this case the owner himself.

The argument here is that to accept the idea of having artificial intelligence to operate the ship might not be so remote; especially that artificial intelligence is in a very progressive stage at the time being. But, if the full cluster of autonomous chain set in place where, MASS, docks, berths, ports, trucks all inter-connected in autonomous mode, the logistics behind the scene will be automated and in certain stage will be autonomous. The booking of cargo, booking of slots and spaces for cargo at the autonomous vessels will be also autonomous, accordingly contracting will be autonomous, so MASS may go into contracting of carry cargo from one place to another without interference from the actual owner. In this case the MASS is the owner, will this lead to suing MASS in perso

nam in case of claim. What will be the difference in this case between in rem and in personam, if both will lead to the arrest of the vessel it-self? Will the original owner held liable at this case, what about his other properties! The discussion may lead to limited liability or strict liability, if the claim rises to soaring amount same like the deep-water horizon will limitation of liability compensate enough.

5. Conclusion

MASS is an existing fact that needs to be dealt with sooner or later, but the sooner the better. The prototype has already passed the trial test in Finland. While the existing conventions handle conventional ships, there is still some ambiguity surrounding how MASS will be dealt with as shown within this paper. IMO had expressed the imminence of the MASS issue through the MSC on its 98th session which have put a Scoping exercise on Autonomous vessels. This exercise is to determine how the safe, secure and environmentally sound operation of MASS can be introduced in IMO instruments. The MSC also agreed that proper consideration should be given to legal aspects, including where would the responsibility lie in case of an accident involving a MASS. As well as its consequences to the cargo and the implications to the shore-side. It is anticipated that the work would take place over four MSC sessions, through to mid-2020. Submissions were invited to the next session (MSC 99, May 2018) (Hammer, 2017).

States are reluctant to accept the inclusion of MASS at their shipping sector due to the domestic regulatory and maritime law for clear reasons. One of the most important reasons is the fear of job losses in the shipping sector, but on the contrary, MASS will increase the labor forces related to shipping. For instance, developers, communications experts and technicians, builders, workers, ports operations, logistics which will need a massive work force. It may only shift the work force from one sector to another. The question here is whether States will begin to develop their legal system before hand in hopes of reducing expected accidents or wait for further technological development that might adapt to existing rules better.

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