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Contents

Review on the future of Autonomous Vessels

The world is interconnected through global trade on the basis of a transportation industry. And, it will continue to grow, with a predicted rise of nearly a third in seaborne-trade towards 2030, In other words, the ocean will experience substantial increases in traffic, pressure will get much higher and risk of marine accidents and incidents at sea will persist.

This in fact has urged businesses to invest in automation underpinned by transformational technologies of Artificial Intelligence (AI) and machine learning, as the ultimate solution to improve productivity, efficiency and safety by eliminating human errors.

By definition, the term ‘autonomous shipping’ is mainly used to describe a self-sailing crewless vessel, but there are actually various autonomy levels. According to Lloyd’s Register, autonomy levels (AL) ranges from ‘AL0’ meaning traditional manned ship to ‘AL6’ referring to a fully autonomous ship with the operating system being able to calculate all the consequences and risks, and make decisions by itself, without any human interference.

Attractive benefits of autonomous and unmanned ships is increasingly being identified and discussed among maritime businesses. According to research, while cheaper labour cut cost by 60%, automation could cut labour costs by 90%.
As stated by Rolls-Royce “Many facilities and systems on board are only there to ensure that the crew is kept fed, safe, and comfortable. Eliminate or reduce the need for people, and vessels could be radically simplified.”
According to studies, the removal of the accommodation structure can result in a 6% reduction of fuel and another 5% reduction in construction costs, while opens up for more cargo space and thus higher freight income.
Increase human safety, monitor cargo conditions, saving headcount, monitoring the machinery performance, increase cargo capacity and reduce human errors

But despite the potential benefits especially the operational savings, first, there will be a large capital expenditure in initially investing in the technology, especially in the early stages of its development.

Secondly, there are unanswered legal questions — companies don’t yet know how international laws will apply to vessels that have no humans on them, as implementation of unmanned ship is illegal according to the minimum crew requirements regulation. Also, who is liable if an accident takes place?

What would happen if there are problems requiring immediate attention — such as cyber-attack, machinery maintenance or breakdown, or sudden changes in routes due to unforeseen events,

Automation and AI will become so ubiquitous that displaced workers will have nowhere to go with their current knowledge and competences. As a result, it will pose a serious threat on many economic and social issues. Society cannot afford to presume that this digital revolution will create jobs as quick as eliminating them.

Automation and AI is the future that we cannot avoid, but would unmanned ships become one, we are not so certain. However, the industry still need to act now in order to prepare our current and future workforce — such as reforming education, boosting training programs that support seafarers to work with AI and automation.

Editorial Board

Comparative Analysis of Port Security Risk Assessment Approaches

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Abstract:

Ports constitute crucial intermodal nodes in the freight and passenger transport network as well as important border control points. Therefore, their security, and efficient operation are of paramount importance. not only because of their critical transport functions but also because of their specific role, as control points, in the national, regional and global security. Port security assessments provide the foundation for the effective implementation of the maritime security measures at port /port facilities. There are different types of risk and important factors which affect risk assessment. The latter can range from very simple to very complex assessment using a broad set of tools and information. The main key to port security risk assessment is choosing the right approach to provide the needed information without overworking the problem. This paper aims to focus on the process of port / port facility risk-based security assessment. In this study, a descriptive methodology will be used in order to analyze the basic concepts related to maritime security and risk assessment. In addition, available risk assessment approaches used in this field will be evaluated, with an analytical vision to describe the controlling parameters in these approaches. The structure, salient features and merits different approaches will be introduced and discussed. Furthermore, a comparative analysis will be conducted among the selected approaches highlighting and identifying the most important parameters and criteria used to evaluate risks in each method. As a main finding of this study, it is clear that the differences in parameters included in the selected approaches affect their potential capabilities and suggest that an exhaustive investigation be made to study how effective each parameter is. More importantly, it addresses the urgent need for a more comprehensive maritime security risk-based methodology that integrates the advantages and overcomes the shortcomings of the currently used approaches.

Keywords: Maritime security, Ports, Threat, Risk assessment approaches.

1- Introduction

The world seaborne trade continues to grow and constitutes the arteries of global trade; since 1945 it has doubled every decade (Milena and Witold, 2015). In the current economy roughly 90% of all world trade is transported by the shipping industry (Alcaide and Llave, 2020). the importance of maritime transportation to the world economy is evident. As such, global economic inter-dependency among nations is largely reliant on the success of the maritime industry (Lim et al., 2018).

Although several studies on maritime security have been undertaken, both academic and industrial, work dedicated to port security has, so far, been rather theoretical or technical in nature. This might be due to ports' complexity. Contrary to maritime transport modes, ports facilitate a complex transport system where there are train, truck and ship flows as well as cargo and passenger flows; thus tackling port security is challenging (Ng and Vaggelas, 2013).

As such, it has become critical to effectively and efficiently evaluate and manage their risks in order to protect the people and the environment, along with maintaining the quality and performance. Singh (2013) suggested that after identifying the threats, it is imperative to evaluate them and determine which security measures are required to manage risks. Therefore, a risk assessment approach needs to be conducted involving every aspect related to this industry, such as ships, port facilities and other objects (Parra et al., 2018).

During the 1990s, the International Maritime Organization (IMO) started to focus on the interface between a port and ships from the point of view of security. After the terrorist attacks of September 11, 2001, the focus was transformed to a wider concept of security, including regulations regarding the physical security of ports and ships (Faz and Orive, 2017).

In response to the growing concern for the security of ships and ports, the IMO set up new security regulations implemented in the new Chapter XI-2 of the International Convention for the Safety of Life at Sea (SOLAS) and in the International Ship and Port Facility Security Code (ISPS Code) on the minimum-security arrangements for ships and port facilities. The ISPS Code has been designed with risk–based approach. In this context, one of the most important objectives of this code is to provide a methodology for security assessment so as to have in-place plans and procedures to react to changing security levels and to ensure confidence that adequate and proportionate maritime security measures are to be taken when necessary (Alcaide and Llave, 2020).

This paper aims to focus on the process of port/port facility risk-based security assessment. In this study, a descriptive methodology was used in order to analyze the basic concepts related to maritime security and risk assessment. The structure, salient features and merits of the chosen approaches were introduced and discussed. In addition, a comparative study was conducted among the selected methodologies clarifying the pros and cons and identifying the most important parameters and criteria used to evaluate risks in each method.

2. Literature review

In preparing for the writing of this section relevant areas of literature have been examined and selected literature summarized. This critical review is two-fold; it reviews broadly literature concerning the general concepts of risk assessment, then converges more specifically towered literature concerning port security assessment requirements and port security risk assessment approaches in particular.

2.1 Risk assessment and its related notions

According to Parra et al., (2018) a "hazard" is a condition, characteristic or situation which exists and has the potential to cause harm. This state might also potentially lead to an undesirable event generating risks to people, environment or corporations (Aven, 2016; Cameron et al., 2017; Kwesi-Buor et al. 2016; Singh, 2013; Sullivan and Gianotti, 2017). In other words, it is the "potential" or "possibility" to cause damage to individuals, environment and infrastructure.

On the other hand, "Threats" are situations that can trigger a hazardous source and raise the risk probability in a system or infrastructure (Singh, 2013). An "event" is an occurrence that has associated causes and consequences. Events depend on other conditions and, therefore, comprise different potential outcomes which vary in severity (Aven, 2016). “Accidents” are unplanned and unintended events which can cause damage to people or entities (Kwesi-Buor et al., 2016). In order to avoid accidents hazards, threats and risks need to be identified and/or evaluated .

Risks are unwanted, negative probabilities of occurrence of an event that can cause an accident, loss or damage (Aven, 2016). An easier view of this definition was given by Singh (2017) and supported by Sullivan and Gianotti (2017) who represented the relationship of the probability and the consequence of a risk with the following formula:

$$R = P \times C$$

where R is the risk, P is the probability of occurrence of a hazardous scenario and C is the consequence(s) of occurrence of that scenario (Dong and Cooper, 2016). Some risk assessment techniques begin the process of analysis with a well-defined “undesirable or top event”; for instance, the total failure of a system and inability to perform its functions (Parra et al., 2018).

As a concept of risk management (RM), Fransas et al. (2012) define RM as a process of handling risk in a conscious fashion. Moreover, the application of risk management methodologies has proven to be an effective and consistent way to mitigate risk and to avoid the danger of purely intuitive or experimental decision-making. The industry in general has developed several guidelines and standards defining different approaches to RM with the intention of handling risks associated with its particular requirements.

According to Parra et al. (2018), a RM process aims to help in addressing these issues based on a structured approach to aid the decision-making process. Typically, this RM framework has four main phases; hazard namely: identification, risk assessment, risk mitigation and risk monitoring (Mokhtari, 2012). In the same context, Zaili et al (2014), define risk assessment as the central part of the risk management process. The objective of risk assessment is to provide information on which decisions may be made about proposed actions, the adequacy of risk controls and what improvements might be required. This identifying potential hazards or threats, estimating the likelihood that these hazards or threats can cause adverse effects, assessing the possible consequences and developing control measures to reduce or eliminate the risk that these hazards or threats impose.

2.2. Risk Assessment Approaches to Maritime Security

Port/port facility security assessment is an essential and integral part of the process of developing and updating the port / port facility security plan. Contracting governments are required to conduct Port Facility Security Assessments (PFSAs) themselves or to authorize a Recognized Security Organization (RSO) to perform PFSAs for the government. If the PFSA is not performed by the government, the government is required to review and approve the assessment (IMO, 2012). Regardless of who performs the PFSA, the ISPS Code requires that the team members for the assessment either have specific skills or be able to draw on other resources that can provide those skills, The ISPS Code requires that the PFSA include at least the following elements:

- identification and evaluation of assets and infrastructure it is important to protect,
- identification of possible threats to the assets and infrastructure and the likelihood of their occurrence, in order to establish and prioritize security measures,
- identification, selection, and prioritization of countermeasures and procedural changes and their level of effectiveness in reducing vulnerability, and
- identification of weaknesses, including human factors in the infrastructure, policies, and procedures.

According to American Bearu of Shipping (ABS) Consulting (2003), the U.S. Coast Guard (USCG) has developed an approach that will develop three types of security assessments. The USCG Captain of the Port for each of the U.S. ports is responsible for putting together a port security committee that will provide the stakeholder input to allow the USCG to perform a port security assessment. The approach for that information is the outcome of a process of

assessment is defined in the USCG guidance document for port security, "Navigation and Inspection Circulars (NVIC) No. 9-02, USCG" (USCG, 2002).
However, the USCG also requires individual facilities, which serve international ships that are subject to the ISPS Code requirements, to perform their own "facility security assessment." In addition, the USCG has expanded the scope of U.S. regulations to require ship and port facility security assessments for many vessels and facilities that do not fall under the ISPS Code requirements. The USCG guidance for performing facility security assessments is provided in "Recommended Security Guidelines for Facilities, NVIC No. 11-02, USCG". On the other hand, the USCG developed (NVIC) No. 10-02, for all vessel operators and owners. This circular has been developed to assist vessel operators and owners to align with the security requirements being developed by the (IMO) and reflect good security practices for all vessels (Meledez, 2004).
The ILO/IMO Code of Practice on Security in Ports (ILO, 2004) develops another tool named Threat and Risk Analysis Matrix (TRAM) to provide smaller ports with few significant facilities and ports located in isolated areas with a practical risk assessment and management tool. It is a 10-step methodology which produces a risk score for each identified threat scenario as a basis for assigning priorities to security measures identified in an action plan (ILO, 2004).
According to United States Government Accountability Office report to congressional requesters (US.GAO, 2011), From 2001 to 2006, the USCG assessed maritime security risk using the Port Security Risk Assessment Tool (PSRAT), which was quickly developed and fielded after the terrorist attacks of September 11, 2001. PSRAT served as a rudimentary risk calculator that ranked maritime critical infrastructures and key resources with respect to the consequences of a terrorist attack and evaluated vessels and facilities that posed a high risk of a transportation security incident. While PSRAT provided a relative risk of targets within a port region, it could not compare and prioritize version of the TRAM tool described above. It is a multi-step automated tool created as a Microsoft Access 2000-based application (US. GAO, 2011).
Recognizing the shortcomings of PSRAT that had been identified by the USCG in 2005, the USCG developed and implemented Maritime Security Risk Analysis Model (MSRAM) to provide a more robust and defensible terrorism risk analysis process. MSRAM is a risk-based decision support tool designed to help the USCG assess and manage maritime security risks throughout the USCG's area of responsibility. Similar to all security models, the model consists of three variables: threat, vulnerability and consequence. Data for each of these variables are collected from offices and components throughout U.S. Department of Homeland Security (DHS), as well as from other data sources, and then, using the model, ports are ranked and assigned a corresponding relative risk score (US. GAO, 2011).
In the same context, the IMO issued guidance to assist national authorities in undertaking risk assessments named "Framework for Conducting Security Assessments" (FCSA) in December 2008. Although this guidance was aimed at non-SOLAS vessels, the methodology and the principles on which it is based are equally applicable to SOLAS port facilities and ships (IMO, 2012).
Noting the scarcity of studies on port security risk assessment which can provide solutions to enhance the quality of security assessments, Yang et al. (2014) proposed a quantitative security risk analysis using fuzzy evidential reasoning (FER) approach. This approach is applied to quantify port facility security risks and to conduct the cost benefit analysis for the evaluation of Risk Control Options (RCOs). The study aimed to ensure that the Ports Facility Security Plans (PFSPs) under the ISPS security regime are rational to the risks faced by ports and can be cost-effectively implemented by operators. Given that rational risk analysis is difficult to achieve with often uncertain and incomplete qualitative data, the authors suggest standardizing the way expert opinion is used to complement the lack of objective security

relative risks of various infrastructures across ports, among other limitations. PSRAT is a more sophisticated

failure data (Yang et al. 2014).

Bruno (2016) has shown three prominent risk assessment methodologies used: firstly, Maritime Security Risk Analysis Model (MSRAM), secondly, Criticality, Accessibility, Recuperability, Vulnerability, Effects and Recognizability (CARVER) matrix, and finally Operational Risk Management (ORM). While these three risk assessment methodologies contribute accurate risk assessments, the current risk methodologies are not readily replicated for use by the first-responders responsible to react to mass casualty events. As such, Bruno's study identified the most relevant contributions made by each of the respective models and introduced a hybrid-matrix to be utilized on a reproducible, trainable level for first-responders in times of potential mass causality resulting in an effective security investment.

Faz and Orive (2017) have presented a methodology for improving the scoring of the risks to ports and understanding their real scope. This was accomplished by examining the key methodologies related to infrastructures in general and commercial ports in particular. After comparing the characteristics of the selected methodologies, the study discussed the results of a survey of experts at Spanish ports and an analysis of almost two years of security statistics, the goal being to obtain realistic information about the importance of the various risks in order to specify suitable countermeasures and evaluate their costs. The results have enabled the identification of several new parameters that must be considered when assessing the risks to ports, as well as enhancements to the definitions and use of some of the existing parameters.

Although there are many approaches supporting PSRA, they are not comprehensive; gaps still exist, which affect port security diversely. One of these gaps is uncertainty associated with security risk assessment and inadequacy of implemented approaches to properly assess these risks. Consequently, port security plans effectiveness is questionable, which may increase vulnerability of port to security breaches. Differences in effective each parameter is.

3. Structure of Selected Port Security Risk Assessment Approaches

Out of the numerous methodologies used in port security risk assessment, three widely used methodologies were introduced and reviewed herein by conducting an in-depth study of each methodology. Detailed description and characterization of the required steps to calculate and determine risk score were introduced. The first approach is the USCG RBDM model, followed by the TRAM model and the third approach is the RAMT model .

3.1 Risk Based Decision Making (RBDM) Model

This approach consists of: (i) Criticality assessment, (ii) Threat assessment, (iii) Consequence assessment, (iv) Vulnerability analysis. After criticality, threat, consequence, and vulnerability assessments have been completed and evaluated in this risk-based decision process, key actions can be taken to better prepare against potential terrorist attacks. This approach for risk-based port security assessment can be further refined and tailored to specific ports or port facilities (ABS, 2003). Figure (1) depicts the RBDM structure.

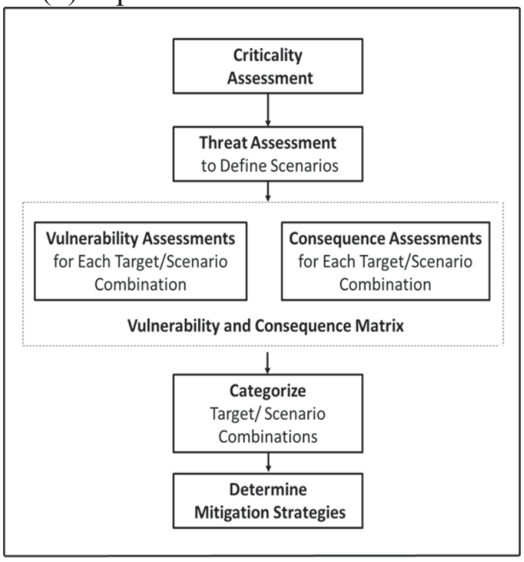

Figure (1) RBDM structure.
Source: ABS, (2003)

parameters included in these approaches affect their potential capabilities and suggest that an exhaustive investigation be made to study how

3.2. Threat and Risk Analysis Matrix (TRAM)

The purpose of this approach is to identify threats with a view to initiating and recommending countermeasures to deter, detect and reduce the consequences of any potential incident, should it occur. Such an analysis may be a valuable aid to allocation of resources, forward planning, contingency planning and budgeting .

The TRAM should be updated as often as changing circumstances may dictate to maintain its effectiveness. This task would normally fall under the remit of the designated authority, which should establish and maintain close links with security committees, and key commercial and industrial service partners and customers. In addition to the more obvious threats, the list of potential targets should be as comprehensive as possible with due regard to the function(s) of the port, legal, political, social, geographic and economic environment of the country, and the security environment specific to the port (ILO, 2004). Figure (2) illustrates TRAM structure.

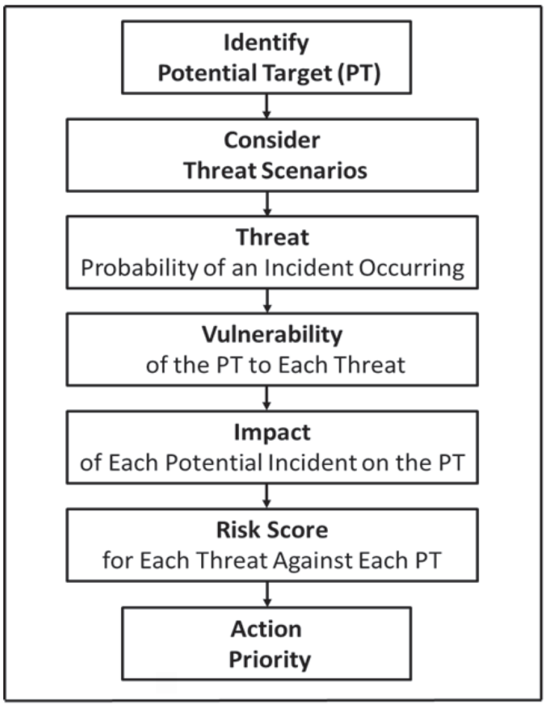

Figure (2) TRAM structure.
Source: ILO, (2004)

3.3 Risk Assessment and Management

main phases: (i) identifying the different threat scenarios and determining the likelihood of each occurring based on intent and capability (threat assessment). (ii) considering what the consequence of each threat scenario materializing would be and how much effect this would have (impact assessment). (ii) determining what the key assets are and how they can be exploited, examining the mitigating controls in place and their effectiveness and considering residual weaknesses (vulnerability assessment). (iv) making an assessment of the risk given all the factors noted in phases 1, 2 and 3 (Risk scoring). (v)developing action plans, where appropriate, to address weaknesses and mitigate identified residual risks (risk management) (IMO, 2012).

Figure (3) shows RAMT structure.

Figure (3) RAMT structure
Source: IMO, (2012)

3.4. Comparison of Selected Approaches for Port Security Risk Assessment

Table (1) presents an analytical comparison of the three approaches with an explanation of the most important features. The comparison is based on the following characteristics: (i) approach technique, (ii) procedure, (iii) criticality assessment, (iv) threat assessment (v) vulnerability assessment, (vi) consequences assessment, (vii) risk equation, (viii) assessment outcome, (ix) mitigating action.

Table (1) Comparison of selected approaches for port security risk assessment

	Risk Based Decision Making Model (RBDM)	Threat and Risk Analysis Matrix (TRAM)	RISK ASSESSMENT AND MANAGEMENT TOOLS (RAMT)
Technique	Qualitative	Quantitative	Quantitative
Procedure	1) Perform a criticality assessment. 2) Conduct threat assessment to define scenarios by combining threats with credible attack scenarios. 3) Conduct consequence and vulnerability assessments for each target/scenario combination. 4) Categorize the target/ scenario combinations. 5) Determine mitigation strategies and implementation method.	1) Identify PT. 2) Consider threat scenarios. 3) The threat (probability) of an incident occurring. 4) Assess vulnerability of the PT to each threat. 5) Assess the impact (consequence) of each potential incident on the PT. 6) Tabulate and listing the risk score for each threat against each PT. 7) Prioritize actions to deal with each potential incident.	1) Threat assessment. 2) Impact assessment. 3) Vulnerability assessment. 4) Risk scoring. 5) Risk management.
Criticality Assessment	- Perform a criticality assessment to identify critical activities or operations. - This helps identify critical targets with the port. - The evaluation contains mission, the effect of destruction and the ability of the port to recover from its destruction. - Criticality should be rated according to the following scale: Critical/Moderate/Marginal.	- Identify potential target through assessment of: • functions and operations, • vulnerable areas, • key points or persons in the port • the immediate environs that may, if subject to an unlawful act, detrimentally impact on the security, safety of personnel or function of the port. - Criticality assessment scale not required.	- Criticality assessment scale not required.

Table (1) Comparison of selected approaches for port security risk assessment

	Risk Based Decision Making Model (RBDM)	Threat and Risk Analysis Matrix (TRAM)	RISK ASSESSMENT AND MANAGEMENT TOOLS (RAMT)
Threat Assessment	- Threat scenario focuses specifically on the possible action that may be taken against facility in the whole and provide detailed description of scenario types. - A target may prompt a few or many scenarios. - The number of scenarios is left to the judgment of the PSA team. - Care should be taken to avoid unnecessarily evaluating excessive numbers of similar scenarios or those that result in low consequences.	- Divided into 3 different levels. - Threat focuses of specific potential target in the facility. - The facility needs to determine the level of threats. - Consider threat scenarios from both internal and external sources to which the identified PT may be vulnerable. - The allocation of a particular threat score may be based on specific information received or the known characteristics of the PT.	- 4 level score to each threat scenario. - Identifying the different threat scenarios. - Determining the likelihood of each occurring based on intent and capability. - Assign the score should reflect the likelihood of each threat scenario occurring if there were no security measures or mitigating controls in place to prevent them.
Vulnerability Assessment	- 3 levels of vulnerability score high, medium, or low. - The criteria for scoring concentrated on the measures in place to provide protection against any possible threats. - Each vulnerability element for a given scenario should summarize into a single score for each target/scenario combination.	- 4 levels vulnerability scores and each score has their specific descriptor. - The criteria for scoring focus on levels of protection or security measures in place and the effectiveness of existing security measures as a general without specifying specific elements.	- 4 levels vulnerability scores translating the vulnerability assessment into vulnerability score. - It requires consideration of, on the one hand, an evaluation of targets' characteristics and, on the other, the early warning indicators, embedded monitors and existing mitigating controls.
Consequences Assessment	- 3 levels of consequences score high, medium, or low. - Each target/ attack scenario combination is evaluated in terms of the potential consequences of the attack .	- 5 levels of consequences/impact score and the criteria for the scoring are focuses on the nature of loss. - Provide flexibility to alter consequences score as well.	- 4 levels impact scores and each score has their specific descriptor. - Considering what the consequence of each threat scenario materializing would be and how much effect this would have.

Table (1) Comparison of selected approaches for port security risk assessment

	Risk Based Decision Making Model (RBDM)	Threat and Risk Analysis Matrix (TRAM)	RISK ASSESSMENT AND MANAGEMENT TOOLS (RAMT)
Risk Equation	not required (risk matrix used)	Risk score = Threat x Vulnerability x Impact (consequences)	Risk score = Threat x Vulnerability x Impact (consequences)
Assessment Outcome	- The assessment outcome is derived from the matrix provided with reference to the scoring from vulnerability and consequences scoring. - It uses the 3 by 3 matrix and the outcomes are divided into 3 categories namely Document, considered or Mitigate.	- Assessment outcome is reflected as risk score. - The scoring is derived from multiplication of the scoring of threat, vulnerability and impact. The highest score scenario will be 60 and lowest 1. - Acceptable risk score is not mentioned thus it left with the port facility to determine. - Tabulating and listing the scores for each threat against each PT will assist in assessing the priority in which to deal with each potential incident.	- Risk scoring making an assessment of the risk given all the factors noted in phases 1,2 and 3. - Risk can be ranked into three broad categories - high, medium and low. - HIGH a residual risk score of 27 or more. - MEDIUM: a residual risk score of between 8 and 24. - LOW: a residual risk score of 6 or less.
Mitigating Action	- Further action to reduce vulnerability of the facility to identify threat is documented in Mitigation Implementation Worksheet and the only flexibility of scoring is available in the Vulnerability column. - After the mitigation strategy is identified, new mitigation result has to be worked out to demonstrate lower score.	- Mitigation available by reducing either vulnerability or impact score or both to reduce the risk score through specific mitigation activities/initiatives. - The TRAM for every potential target should be collated into one master matrix of similar threat scenarios and common security measures identified to give the maximum benefit.	- Risk management phase considers how best to address the weaknesses identified during the vulnerability and risk scoring stages and how to mitigate the risk effectively and practically on a sustainable long-term basis. - This can be achieved by all stakeholders working together to agree joint tactical action plans.

Source: Data are collected by author from different sources.

Tools (RAMT)

The methodology presented herein includes five

4. Results and Discussion

Based on the review comparison of the selected approaches, considerations related to determination of threat, vulnerability and consequences have come out, which should be identified and discussed .

Security threats like terrorism do not generate statistical patterns; therefore, it is difficult to assess likelihoods for these threats when there is insufficient information. In this sense, to perform a risk security assessment it will be necessary to assume a certain level of the threat represented for some credible threat scenarios and then focus the study to assess vulnerabilities, consequences, and critical points in order to manage security from elements that are under the control of the port or port facility.

Furthermore, confirmation on nature of likely threats to specific facility or even potential target(s) in the facility has to be considered from various viewpoint, as even though some or most of the threats identified during the assessment process may not have been experienced before by the port facility but they should not disregard similar occurrences surrounding the facility. For this purpose, the PFSO needs to obtain the assistance of external governmental security related agencies for confirmation of likely threats and determination of the corresponding threat scores.

An initial step for criticality assessment is considered in RBDM only with the purpose to identify activities, operations and infrastructure that are critical to a port. The criticality of these key elements is evaluated in the form of a function of three parameters; based on these parameters criticality is rated in three scales. On the other hand, criticality was replaced by identifying and evaluating the characteristics of a potential target in TRAM, but without mentioning of any scale; also, in RAMT criticality was not indicated or required.

The RBDM approach is focused mainly on the analysis of consequences and the vulnerabilities of the port facility in order to determine what measures are necessary to implement. This and the use of basic foreseeable scenarios to start the security assessment. This is understandable since there is always the possibility of a lack of specific and credible intelligence to assess the level of threat. Therefore, for the purpose of the assessment, it is better to fix the threat at a certain level consistent with the security levels to be set by the government, and then changes in security levels will be the reference for future modifications of the assessed threat levels. The advantage of this approach is that it does not necessitate frequent updates of the security assessment.

This characteristic, however, has the disadvantage that it could generate too many mitigation measures because the security assessment team will have the tendency to cover all the possibilities in the subjective limits of the security levels. This situation weakens the essence of the RBDM model, which seeks to avoid mitigation measures based on worst case scenarios and is, therefore, out of balance with the threat. For the identification of vulnerability, actual physical inspection and observations are better than purely table top assessment, as it provides better picture as to actual environment at the time of assessment and, at the same time, any defect or malfunction can be immediately identified and recommendation of rectification be made. In this context, vulnerability assessment used in RAMT does not refer to specific assessment parameters, but rather mentions them broadly and in a manner, which is not clear; this constitutes obvious disadvantage when compared to the assessment parameters that were referred with clear characteristics and explicitly in RBDM or even implicitly in TRAM.

Referring to assessing the consequences, RBDM is considered the best of the three approaches, as there are five assessment parameters that contain specific criteria, thus reducing the inaccuracy in consequences score and constituting the most important advantage. On the other hand, the Evaluation of the consequences is less accurate, whether in TRAM or RAMT, due to the lack of parameters and inaccuracy in determining the distinctive criteria.

approach does not include any judgment about the likelihood of threats

Under the TRAM requirement, the main challenge faced during the security assessment is the determination of the level of acceptable risk score. In RBDM, the mitigation determination worksheet linking to the matrix provides clear action of what to be done from the assessment outcome, whereas in the TRAM, acceptable risk score is not mentioned to guide further mitigation initiatives. Therefore, the number obtained to calculate the risk for threat scenarios represents only a numerical value that is used in arranging the scenarios from the highest value to the lowest, but does not indicate whether the level of risk is high, medium, or low.

Referring to mitigation strategies, it is observed that the RBDM approach touches on the important role of cost-benefit evaluation only marginally. Mitigation measures have to be effective and feasible, and feasibility implies that the costs of implementation of the mitigation measures should be affordable. In this context, the question of what level of security risk is acceptable becomes important, because different designated authorities in different countries could have different criteria in this respect. On the other hand, neither TRAM nor RAMT explained how to deal with this matter, which constitutes a weakness for the three approaches.

As a main finding of this study, it is clear that, the differences in parameters included in the selected approaches affect their potential capabilities and suggest that an exhaustive investigation be made to study how effective each parameter is. More importantly, it addresses the urged need for a more comprehensive maritime security risk-based methodology that integrates the advantages and overcomes the shortcomings of the currently used approaches.

5. Conclusion

The ISPS Code singles out five main objectives, one of which is "to provide a methodology for security assessment so as to have in place plans and procedures to react to changing security levels" (IMO, 2012).

The challenge to this objective is the absence of the single acceptable methodology to carry out By a specific port/port facility, which makes it a more difficult task to accomplish. The majority of maritime administrations do specify the methodology of their choice but some may leave it to the port facility to decide.

This study reviewed three assessment methodologies that are commonly used for port and port facilities. Each methodology provides good guidelines to carry out the security assessment for port / port facility but, at the same time, there exist areas where certain elements are left to the judgement of the port facility, which may result in inconsistencies in the assessment outcomes. The structure of each of the three methodologies was analyzed along with its approach for assessing risk and the type of results it provides, whether qualitative or quantitative. Additionally, the types of threat and vulnerability considered parameters by each methodology were examined in a comparative pattern. This effort has shown the points of strength and weakness in each of the three approaches, and should assist in identifying new aspects that have to be considered in risk assessment.

References

Alcaide, Juan. Ignacio., and Llave, Ruth. Garcia, (2020). Critical infrastructures cybersecurity and the maritime sector. transportation research procedia, 45, 547–554.

American Bureau of Shipping, (2003). Guide for Port Security, ABS consulting, Houston, USA.

Aven, T., (2016). Risk assessment and risk management: Review of recent advances on their foundation. European journal of operational research, 253 (1), 1–13.

Bruno, Patricia. J., (2016). First-Responder Risk Assessment Methodology: The Bruno Method. Master Theses, American public university system.

Cameron, I., Mannan, S., Németh, E., Park, S., Pasman, H., Rogers, W., and Seligmann, B., (2017). Process hazard analysis, hazard identification and scenario definition: Are the

fuzzy set theory and evidential reasoning approach. Expert systems with applications, 39 (5), 5087–5103.

the security assessment, and to determine the level of threats that are likely to be experienced

conventional tools sufficient, or should and can we do much better?. Process safety and environmental protection, 110 (1), 53–70.

Dong, Q., and Cooper, O., (2016). An orders-of-magnitude AHP supply chain risk assessment framework. International journal of production economics, 182 (1), 144–156.

Faz, D. Romero., and Orive, A. Camarero, (2017). Risk assessment of critical infrastructures –New parameters for commercial ports. International Journal of Critical Infrastructure Protection, 18, 50–57.

Fransas, Anne., Enni, Nieminen., Mirva, Salokorpi., and Jorma, Rytkönen, (2012). Maritime safety and security Literature review. Publications of Kymenlaakso University of Applied Sciences. Series B Research and Reports, No 77.

International Labour Organization., (2003). Code of practice on security in ports. IMO-ILO Tripartite meeting of experts on security, safety and health in ports., Geneva.

International Maritime Organization, (2012). Maritime security manual: guidance for port facilities, ports and ships. IMO, London.

Kwesi-Buor, J., Menachof, D. A., and Talas, R., (2016). Scenario analysis and disaster preparedness for port and maritime logistics risk management. Accident analysis & prevention, http://dx.doi.org/10.1016/j.aap.2016.07.013 [accessed Mar 3 2020].

Lim, J. Gino., Jaeyoung, Cho., Selim, Bora., Taofeek, Biobakua., and Hamid Parsaeic, (2018). Models and computational algorithms for maritime risk analysis: a review. Annals of operations research, 271 (2), 765–786.

Mokhtari, K., Ren, J., Roberts, C., and Wang, J., (2012). Decision support framework for risk management on sea ports and terminals using

Melendez, Fidel, (2004). A selection and comparison of risk assessment methods and models to be used for the International Ship and Port Facility Security Code. MSc. Dissertation, World maritime university, Malmo, Sweden.

Ng, A.K.Y., and Vaggelas, G.K., (2012). Port security: the ISPS Code. In: Talley, W.K. (Ed.), The Blackwell companion to maritime economics. Blackwell, Hoboken, NJ, 674–700.

Nyman, T., Tuominen, R., Rytkönen, J., Kujala, P. and Ylitalo, T., (2010) Preliminary study of developing a new method to control maritime safety and security risks together. The Finnish Transport Agency, Ministry of Defence, The Finnish Border Guard, Aalto University, Kymenlaakso University of Applied Sciences and Technical Reseach Centre of Finland.

Parra, Nelly. M., Ayman, Nagi., Wolfgang, Kersten, (2018). Risk assessment in seaports, A literature review. HAZARD project Turku school of economics university of Turku, Finland.

Singh, R., 2013. Hazards and threats to a pipeline system. Pipeline integrity handbook. Risk management and evaluation, Gulf professional, Oxford, 45–120.

Sullivan-Wiley, K. A., Short Gianotti, A. G., (2017). Risk perception in a multi-hazard environment. World Development, 97 (1), 152–138.

United States Government Accountability Office, (2011). Risk model, grant management, and effectiveness measures could be strengthened. Report to Congressional Requesters.

Yang, Z.L., K.Y.Ng, A., & Wang, J., (2014). A new risk quantification approach in port facility security assessment. Transportation research part A, 59, 72-90.

Impact of Autonomous Ships and Blockchain Technology

On the Maritime Industry: Port State Control Paradigm

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Abstract:

Ships are the most efficient mode of transportation between the continents, which can carry all types of commodities in a huge amount, compared to other transport modes. In this paper, blockchain technology has been discussed and the proposed ways of its usage in the maritime industry. The technology has a wide set of advantages, which allows the marine parties to connect to the supply chain more efficiently, decreasing the industry operational costs and increasing operational security, especially in the Port State Control (PSC) inspections paradigm.

The form of the convention's strategy poses a challenge in using this new form of technology. This is apparent, in the absence of regulations, mentioning the autonomous ships equipment, as well as, a strategy for using the new technology, through the PSC, to manage and inspect the safe shipping operation to avoid marine accidents and protect the environment .

This paper aims to investigate the technological innovation, and the importance of using the digitalized database, exemplified in Blockchain Technology (BT), in facilitating the PSC tasks and digitalizing the current conventions, after being amended to cope with the autonomous innovation. The research is based on a descriptive approach, as this methodology is the most capable of providing a comprehensive picture of the efficiency of the new technology .

Finally, the findings of this paper are that, booming of this new Autonomous technology and the integration with the Blockchain technology, with the benefits of transparency and cost-efficiency, facing major problems in working at sea will be minimized, also, there will be a scheme to follow in the updated conventions & the port state control inspections, that will update the new effective standards, in the maritime industry, that will diminish marine accidents .

Keywords: Port state control, Autonomous, Blockchain

1- Introduction

Big data, is the name given, to the large cluster of data, both, structured and unstructured, that is generated in the personal, professional, and operational lives. It can be defined by its variety, the velocity, and the volume, with which it is, generated (Crosby, 2016). Big data as identified by Crosby (2016) has the potential to transform the marine industry. The features of the big data can lead the seaborne trade and supply chain to create application program, to be more efficient to organize the data transfer. Despite, information alone is not enough, it is the analysis of this data and the actionable insights it provides, that will move the industry forward to the technological future.

Blockchain technology is defined as "a distributed database of records or public ledger of all transactions or digital events that have been executed and shared among participating parties" (Crosby, 2016).

The system is secure, the records are verified by public ledgers and can never be erased in the future. The main benefits of blockchain technology are transparency and cost-efficiency. Blockchain technology allows firms to make transactions directly between each other and is made in a very secure manner. Another advantage of the blockchain technology is the possibility to execute "smart contracts". Smart contracts are computer programs that can automatically execute the contracts conditions.

There are many types of blockchain increased greatly in the last few years.

A-Public Blockchain: Available to the public and any single person can involve in the decision-making process, but end users may or may not be benefited from their participation in the decision-making actions.

B-Private Blockchain: Not available to the popular and are unsecured to only a group of people or firm and the records are shared to engage members only.

C- Permissioned Ledger: The engaged members are familiar and already trusted. In license records, an agreement protocol is used to maintain a shared version of the truth rather than a consent tool.

D- Distributed Ledger: In a dispatch records blockchain, the records are distributed between the entire competitor in the blockchain and it can expand across many companies, sorted block and they can be used for both private and public. (Sarmah,2019)

1.1Blockchain History in the Maritime industry.

1.1.1Companies introducing Trade Lens Blockchain Shipping Solution

A company announced the creation of Trade lens, a blockchain-enabled shipping solution designed to promote more efficient and secure global trade, bringing together various parties to support information sharing and transparency, and spur industry-wide innovation (Rosic, 2020).

1.1.2. Ports Launches Blockchain Technology for Trade Community

Abu-Dhabi's Ports subsidiaries were advanced and launched its own blockchain technology system named Silsal in 2018. Silsal will merge blockchain technology and unique digital user specifications, to provide a smooth and secure link between the supply chain circles among the seaborne trading (Rosic, 2020).

1.1.3. Companies that Concluded a Successful Testing of Blockchain Technology

A Protocol signed between the fleet operation of Pacific International Line and Singapore office database center to tracking cargoes transport between Chongqing to Singapore via the Southern Transport Corridor using BT technology and database analysis for this testing (Rosic, 2020).

This research presents one of the biggest advantages of Blockchain which is distribution. It allows a database to be shared without a central body or entity. Due to the digitalized nature of the blockchain, it is almost impossible, to hack the data as compared to other conventional databases. It is possible that Blockchain technology applications in the maritime industry will serve the Port State Control and cope with the future technology of "Autonomous ships."

2- Autonomous Ship technology

Autonomous shipping will be the future phase, Robotics, Drones and E-certificates already used in marine sectors and approved from port authorities under regulatory framework. The legal perspective concern is only natural bearing in mind that the autonomous shipping market, estimated in 2018, to be worth USD 6.1 billion is now projected by some to reach a staggering $136 billion by 2030 (koscielecki, etal.2019).

Autonomous features and benefits for maritime shipping are plenty, not just the reduction or elimination of human errors and crew claims, but also for the accuracy of used BT for analyzing the data to achieve and determine the corrective action.

The exciting development of a "smart ship" will revolutionize the landscape of ship design and operations, but this revolution will come with many challenges. This briefing presents the definitions of autonomous ships, and focusing on the International Conventions and Regulations which will need to be adapted to cope with this new technology revolution.

2.1- Definition of Autonomous Ships

Currently, there isn't a specific international definition of what an autonomous or unmanned ship is what the various levels of autonomy are, and whether an autonomous ship is a ship under international law. When definitions are used in many conventions, they have tendency to be very comprehensive and customs-made to cover the subject matter to be regulated. Making an attempt to build a cohesive legal and regulatory framework is extremely difficult, if there are no preliminary agreements on the basic definitions. A proposal on a list of recommended terms was submitted to the IMO's Maritime Safety Committee, MSC 101. The "autonomous ship" is defined as, "the operating system of the ship able to make decisions and determine actions by itself. It performs functions related to operation and navigation independently and self-sufficiently.", and a "smart ship" defined as "A ship equipped with automation systems capable, to varying degrees, of making decisions and performing actions with or without human interaction." (MSC, 2019)

2.2- Non-Attendance the Crew Cause

The main scope of maritime conventions should be amended to cope with the new technology; UN Convention on the Law of the Sea (UNCLOS) provides that, all ships must be "under the charge of a master and officers, who possess appropriate qualifications". Furthermore, the International Convention for the Safety of Life at Sea (SOLAS), International Convention for the Prevention of Pollution from Ships (MARPOL), Standards of Training, Certification, and Watch keeping Convention (STCW) and the Paris MoU, as well as the EU directive 16/2009 on Port State Control all presume that the master will be present on board. There are also requirements for the master, as the ship owner's representative to issue documentation, and for documents to be physically kept onboard. These challenges may be overcome if flag states amend their regulations to make digitally issued documents acceptable, and if Port State Controls remove their requirements for certain documents to be kept on board.

3- Autonomous Ships Via Blockchain

Marine Autonomous Surface Ships (MASS) are becoming fact, as the First autonomous ferry is under testing since 2018 in Finland, and small autonomous Unmanned Surface Vessels (USV's) are used in ocean research, coast guard, and military applications. (www ship-technology.com)

Japan's Nippon Yusen Kabushiki Kaisha (NYK) has launched the first autonomous ship, Dead Weight (DWT) 70,826-tonne Pure Car Truck Carriers (PCTC) Iris Leader, sailing from China to Japan. Using the navigation type system Sherpa System for Real ship (SSR), the voyage planned from port of Xinsha-Chinas toward Port of Yokohama-Japan from 14th -20th 2019. (www.NYKline-autonomous-ship-test, 2019)

Investigations are carried out, on how to improve the security of communication systems and data security of MASS using new technologies. Being an essential part of MASS, communication has to be back and forth, secured and supported by many systems. The conclusion of the trail shows the automatic navigation used SSR has a high performance for monitoring sea conditions, collected weather information, plotting safe routes, speeds, and data analysis, that can calculate collision risk by using the digitalization effort, this features to support the IMO, to announce the outlines for the autonomous ship trial guidelines, in June 2019 that accepted from Panama flag state.

Having secure communication is out of the question, in order to prevent negative factors from obstructing ships communication or taking control of the ship (Mraković, et.al, 2019). Introducing security based on blockchain technology will provide secure communication as well as safe data storage. Thus, amending the marine conventions is expected to highlight the importance of BT for the upcoming future.

4- Port State Control Strategy

The Memorandum of Understanding (MoUs) PSC relies on three cases: case (1) a risk-based targeting system; case (2) the U.S. Coast Guard (USCG) responsible for inward ships and the flag state for U.S. vessels; and case (3) the New Inspection Regime (NIR) initially implemented by the Paris MoU in 2011 and adopted by the Tokyo MoU in 2014, the Black Sea MoU in 2016.

Port state control mainly concerned the type of ship, the performance of the flag register, and the history of detention and deficiencies laid by the keel, and the performance of the ships fleet in the MoU based on a risk-based targeting scheme. As for the MoU carrying out the NIR, inspection systems depend on daily Ship Risk Profile (SRP) inspections as well as further inspections due to significant or unforeseen factors. During times depending on the SRP, routine inspections are carried out.

If a vessel is listed as a High-Risk Ship (HRS), it may be inspected within 2-4 months of the preceding inspection and should also be re-inspected after that interval. They can be inspected within 5-8 months and 9-18 months for ships assessed as Standard Risk Ship (SRS) and Low Risk Ship (LRS) (Tokyo MoU, 2018).

4.1- Inspection Criteria

Phase 1: As shown in table (2) make sure that the risk type based on the NIR .

1.1In case the sum of weighting points is ≥ 4, the ship is considered as HRS .

1.2In case the sum of weighting points = 0, the ship is considered as LRS .

1.3In case the sum of weighting points is between 0 and 4, the ship is considered as SRS .

Phase 2: Check the time window according to the ship's risk type.

2.1 HRS: 2–4 months.

2.2 SRS: 5–8 months.

2.3 LRS: 9–18 months

Phase 3: Check priority.

3.1 Priority I: Time window closed or dominating factor.

3.2 Priority II: Time window open or unforeseen factor.

3.3 Non-Priority: Time window yet to open and no dominating or unforeseen factors

Phase 4: Check whether to examine a vessel or not. Start step 5 if yes; if not, finish the steps.

Phase 5: Implement an inspection based on the IMO (Res.1119, 2.2.5).

5.1 Initial inspection.

5.2 A more detailed inspection.

5.3 Detention

Phase 6: State the result that will be considered in step 1.

6.1 Reporting authority by ships particular details, ship name, flag register, ship type, call sign, IMO number, Tonnage (Gross tonnage, Deadweight), date of inspection, place of inspection, the latest status for the ship behavior, on last survey, deficiencies, and detentions.

Table (1) The Ship's Risk Profile of the Tokyo MoU

Parameters		Profile			
		High-risk ship (Sum of weighting points ≥4)		Standard-risk ship (Sum of weighting points =0–4)	Low-risk Ship (Sum of weighting points = 0)
		Criteria	Weighting points	Criteria	Criteria
Type of ship		Chemical tanker, gas carrier, oil tanker, bulk carrier, passenger ship, container ship	2	Neither LRS nor HRS	
Age of ship		All types>12y	1		-
Flag	BGW-list IMO Audit	Black -	1 -		White Yes
Recognized organization (RO)	RO of Tokyo MoU Performance	- low very low	- 1		Yes High
Company performance		Low Very low No inspection Within the previous 36 months	2		High
Deficiencies	No. of deficiencies recorded in each inspection within the previous 36 months	How many inspections were there which recorded over 5 deficiencies?	No. of inspections which recorded over 5 deficiencies		All inspections have five or fewer deficiencies (at least one inspection within the previous 36 months)
Detentions	No. of detention within the previous 36 months	3 or more detentions	1		No detention

Source: http://www.tokyo-mou.org

According to, Y. Xiao, 2020 Table (1) shows the Tokyo MoU, SRP that is clarify and explain the factors that can evaluate the ships condition. Every ship obtains points if the sum of this points between Zero and 4 or equal to or greater than 4 and equal Zero the ships classified as HRS, LRS, and SRS and the inspection time window will be carried as a follow:

A. The HRS inspection time window during 2-4 months .

B. The LRS inspection time window during 9-18 months.

C. The SRS inspection time window during 5-8 months

According to the previously explained PSC strategy, the following can be deducted:

- Using the BT contributes to managing and securing the PSC targeting evaluation through various cons. Users in a blockchain can easily trace the history of any ship's data as all the tracking data on a blockchain is digitally stamped.
- Blockchain is resistant to cyber-attacks due to its peer-to-peer nature and that would be helpful in preventing any access to PSC database especially by hackers.
- Blockchain provides PSC multiple copies of the data which can be stored.

Conclusion

Blockchain is not a sole technology or one that has never existed before; however, it is a group of many present technologies combined into one. It is a reliable and unique database, decentralized, and trustful. Various peer-to-peer computing database is included in BT and is connected to the self-organizing distributed network.

The technological achievement brought to life, the vision of fully autonomous shipping, while supporters of autonomous shipping are working hard, to implement the technology faster and put it into force as fast as possible. This paper has shown the importance of the Blockchain in the maritime field, especially in the mechanism of PSC and Autonomous ships operation, to operate and transfer data; this will result in changing the maritime conventions and codes. There are many marine entities, which have used this technology in different ways, which proved its success in marine ports and marine companies. The use of Blockchain technology in the transferring and securing of data in the operation of Autonomous ships and managing the PSC strategy for targeting its ships has several advantages like for example:

- Creating a large database, this can transfer large amounts of data in an orderly and secure manner and the possibility of entering more than one individual to follow up on these intentions, Reducing paperwork, cost, and preserving the marine environment.
- High-security level, that data able to change without any manipulation that can be useful in operation for Autonomous ships and PSC.

Reference

Ball, B. (2016). Reducing Global Logistics Cost with Benchmarking and Shipping Container Pricing Transparency. Aberdeen Group.

Caribbean MoU, (2018). Caribbean Memorandum of Understanding on Port State Control (accessed 7 January 2019), http://www.caribbeanmou.org/sites/default/files/ App. roved_MOU_Rev_7_Jan_2018.pdf.

Crosby, M., Pattanayak, P., Verma, S. and Kalyanaraman, V. (2016). : Blockchain technology: beyond bitcoin. Appl. Innov. 2(6), 6–10.

Gary Wollenhaupt, (2018). Supplychain dive, “UK grant will study autonomous shipping regulations” [Online]. [20 June 2019]. Available from: www.supplychaindive.com/news/uk-grant -autonomous-shipping-regulations/539180/

Hahn, G.J., and Packowski, J. (2015). A perspective on applications of in-memory analytics in supply chain management. Decis. Support Syst. 76(1), 45–52.

IMO, (2018). Resolution A. 787(19)-Procedures for Port State Control (accessed 29 November 2018), http://www.imo.org/en/KnowledgeCentre/ IndexofIMOResolutions/Assembly/Documents /A.787 (19).pdf, 1995.

IMO (Res.1119, 2.2.5). MSC101/5/4https://www.imo.org/en/MediaCentre/ /IMOMediaAccreditation/Pages/MSC-101-preview.aspx 2019

Kondratenko, Y.P., Kozlov, O.V., Korobko, O.V. and Topalov, A.M. (2017). Internet of things approach for automation of the complex industrial systems. In: ICTERI-2017, CEUR Workshop Proceedings Open Access, vol. 1844, pp. 3–18 (2017).
https://pdfs.semanticscholar.org/3ff6/ 4e4a07 4e4a07be1e8c2f0b16f4736397be1405218a.pdf

Kondratenko, Y.P., Kozlov, O., Gerasin, O., Topalov, A. and Korobko, O. (2017). Automation of control processes in specialized pyrolysis complexes based on web SCADA systems. Proceedings 2017 IEEE 9th International Conference on IDAACS, Bucharest, Romania, vol. 1, pp. 107–112, 21–23 Sept 2017.
https://doi.org/10.1109/idaacs.2017.8095059

koscielecki,et al.2019 "Legal Briefing Sharing'' the Club's legal expertise and experience. UKP&I www.ukp&i.com

Lacey, M., Lisachuk, H., Giannopoulos, A. and Ogura, A. (2015). Shipping smarter: IoT opportunities in transport and logistics. The Internet of Things in Shipping. Dupress-Deloitte.

Markets and Markets, (2018). "Autonomous Ships Market by Autonomy" (Extracts). [Online]. [20 June 2019]. Available from: www.marketsandmarkets.com/Market Reports/autonomous-ships-market267183224.html?gclid=EAIaIQobCh

McPhee, C., Ljutic, A. (2017). Blockchain. Technol. Innov. Manag. Rev. 7(10), 3–5.

Mraković, I., Vojinović, R. (2019). Maritime Cyber Security Analysis – How to Reduce Threats? Transactions on Maritime Science 8(1), p. 132-139.

Rodrigue, J.-P. (2018). "Routledge, New York, 456 pages", ISBN 978-0-367-36463-2. Safety4sea (2018), "Port of Antwerp works on blockchain pilot project – SAFETY4SEA", available at:https://safety4sea.com/port-of-antwerp-works-on-blockchain-pilot-project/
(accessed 23September 2019).

Rolls-Royce (2019). Finferries and Rolls-Royce test fully autonomous ferry in Finland, from: https://www. ship-technology.com/news/finferries-rolls-royce-ferry/,
accessed on 2019-07-07

Rosic, Ameer (2020). What is Blockchain Technology? A Step-by-Step Guide for Beginners. Accessed on August 2020 from: https://blockgeeks.com/guides/what-is-blockchain-technology

Simanta, S. Sarmah (2020). "Understanding Blockchain Technology" Research Gate: http://www.researchgate.net/publication/3361309 Accessed I May 2020

Tachizawa, E.M., Alvarez-Gil, M.J. and Montes-Sancho, M.J. (2015). How "smart cities" will change supply chain management. Supply Chain Manag. Int. J. 20(3), 237–248

Tokyo MoU, (2018). Memorandum of Understanding on Port State Control in the Asia Pacific Region (accessed 30 December 2018), http://www.tokyo-mou.org/doc/ Memorandum%20rev18.pdf, 2018.

Van Baalen, P., Zuidwijk, R. and van Nunen, J. (2008), "Port inter-organizational information systems:capabilities to service global supply chains", Foundations and Trends in Technology ,Information and Operations Management, Vol. 2 Nos 2/3, pp. 81-241

Yi Xiao,et al. (2019). "The effectiveness of the New Inspection Regime for Port State Control: Application of the Tokyo MoU" ELSIVER, http://www.elsevier.com/locate/marpol.

A study to improve port policy and management for the green port concept in Egypt

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Abstract:

At the global level, many ports and terminals pursuit of enhancing energy efficiency as a result of energy cost raises over the years, and to mitigate the climate change phenomenon effects. Climate change is associated with global warming, a rise in sea level, flooding of low coastal areas, ocean acidification, and melting of ice covers the Earth northern and southern poles, necessitate the global action to take place towards Green House Gas (GHG) emission reduction. CO_2 is the main contributor to the adverse effects of climate change. This study aims to set up a framework for Egyptian seaports authorities from policy and management perspective, which will help Egyptian seaports authorities to implement/activate energy efficiency measures/tools in port operations to step ahead towards the green port concept. A comparative analysis conducted between Egyptian seaports and the leading seaports in Europe and Asia, namely Rotterdam, Antwerp, Singapore and Shanghai regarding port energy efficiency policy/management. The outcomes showed that despite the great potential for adoption/developing sustainable seaports in Egypt, still there is lack of the active control measures for emissions reduction. Besides, many port authorities are ignoring the importance of sustainable development.

Key words:

Egypt seaports, Green port, ESPO, Framework, Port policy/Management, Port energy efficiency, Climate Change.

1. Introduction

With the pressure of environmental acts accompanied by increasing community awareness of environmental issues like climate change and resource depletion drive the port authorities to invest in sustainable development (Woo et al., 2018). The tremendous volume of sea-born trade, which reached 80% result in an expansion of seaports infrastructure to cope and service this amount has caused significant adverse effects not only on the environment but also create health /safety-related impacts on the surrounding communities (Corbett and Winebrake, 2007). According to the third International Maritime Organization (IMO) GHG study (2014), the annual CO2 emission from shipping is estimated by 3.1% for the period (2007-2014) and forecasted to increase by 50-250% by 2050 if the maritime industry maintains the contemporary escalating rate. Ports are a crucial player in the logistics network, due to their role in global production and distribution systems, by trading over 10.3 billion metric tons annually (UNCTAD, 2017). A green port defined as effective strategies and policies contains sustainable development and energy-efficient approach (Lam and Van de Voorde, 2012; Acciaro et al., 2014; Acciaro, 2015). Government, communities, and the public are more likely to support ports operating in a high standard of sustainability, which consequently increases potential investors and enhances their market value (UNCTAD, 2015). In 2017 European Seaport Organization (ESPO) surveyed the top 10 environmental priorities for European seaports, the results were highlighted by air quality, energy consumption, noise, water quality and relationship with the local community, compared with 2004 list energy consumption was not exist at all (ESPO, 2017).

Ports are implementing policies towards becoming green or ecological ports, for instance, ESPO certifies ports under the Port Environmental Review System (PERS) upon satisfactory levels of environmental impact mitigation. The concept of a green port was officially proposed in the United Nations Climate Change Conference in 2009, referring to a sustainable development port that focuses on balancing environmental impacts and economic interests. However, the idea is not fully implemented in many developing countries' ports due to institutional, legal, training, technological, and logistics barriers. Woo et al. (2018) stated some measures for establishing green port concept like electrification of equipment, the use of alternative fuels, and renewable energy sources should have a significant share in the next port generation.

This study investigates the strategy for Egypt seaports to transition into green ports by analyzing port practices/operations from the case study of main Egyptian seaports, in comparison with the best practices from selected ports of Rotterdam, Antwerp, Singapore and Shanghai.

2. Best practices of implementing green port concept at a global level

Best practices seaports in sustainable development domain are defined as ports where the port authorities adopted or undertaken feasible measures/strategies to achieve zero-emission and or energy-efficient port operation while monitoring social and economic dimensions. (Lam and Van de Voorde, 2012; Acciaro et al., 2014; Acciaro, 2015)

Green port concept has been implemented at a global level in different ports such as Rotterdam, Antwerp, Singapore and Shanghai which have been selected as they are highly relevant to the search topic due to the substantial ship traffic and amount of cargo handled generating more significant environmental impact. This section reviewed the various management practices implemented to mitigate and control the environmental impact of port operations.

2.1 Rotterdam best practices

Rotterdam has ambitious goals by 2030 to be the world's most sustainable port. The port operates an innovation center where various industries are integrated with the city to promote a circular economy and support port growth (Port of Rotterdam, 2018). In addition, the Rotterdam Climate Initiative program aims to reduce CO_2 emissions by 50 percent by 2025 through all stakeholders including Rotterdam Region, Government, Organization, Enterprises and Citizen. For example, the port of Rotterdam uses rewards and penalty schemes, a 10 per cent extra

Charge on berthing fees for barge operators using fuel oil close to the maximum allowable content of Sulphur. On the other hand, seagoing vessels calling at port with 31 points on the Environmental Ship Index (ESI) enjoy a 10% discount on berthing dues (Lam & Notteboom, 2014; European Commission, 2017). Port of Rotterdam imposes penalties on ship-caused marine oil spills and non-compliance with the modal change agreement (Port of Rotterdam, 2011; Lam & Notteboom, 2014). The port also uses the Automatic Identification System (AIS) to track ship emissions by monitoring fuel oil usage (MARIN, 2008). Rotterdam has adopted the International Standards Organization (ISO) 14001 in its Environmental Management System (EMS) (ESPO, 2010). The port authorities in Rotterdam have adopted IMO regulations under the International Convention for the Prevention of Pollution from Ships MARPOL Annex VI relating to port operations (IMO, 2012).

2.2 Antwerp best practices

The Port of Antwerp released its first study on port energy efficiency in 2012. Antwerp imposes penalties on maritime oil spills caused by ships and, on the other hand, offers a 10% discount on berthing fees for ships reaching the ESI (Lam & Notteboom, 2014; European Commission, 2017). Also, the port of Antwerp controls the emission of GHG from ships, the whole port area and the logistic chain, and incentivizes shipping companies that carry out energy audits (Port of Antwerp, 2010).

In the area of port development/expansion, the port monitors and tests the design and construction of ecological ports. In addition to the IMO MARPOL Annex VI and the IMO INTERVENTION Convention Protocol, more rules are required for port extensions controlling marine pollution damage by coastal construction projects adopted by the Antwerp Flemish Port Decree. Furthermore, the port authority of Antwerp imposes new regulations for the handling of cargo and vehicles on sulfur fuel limits (Port of Antwerp, 2012).

2.3 Singapore best practices

Singapore port is the second-largest container port in the world (UNCTAD, 2019). The port started introducing the Maritime Singapore Green Initiative in 2011, which seeks to reduce the environmental effect and enforce the Green Port strategy. The green initiative comprises three programmes, such as the Green Ship Programme, the Green Port Programme, and the Green Technology Programme. The Green Port Program offers an opportunity to reduce berthing fees (MPA, 2013). The Green Technology Program encourages local shipping companies to develop new green technologies through a given fund. Several other management techniques have been used by the Singapore Maritime and Port Authority (MPA), such as the introduction of the EMS, the monitoring of port expansion activities, and the introduction of the Sulfur Cap Environmental Regulations (Goh, 2010; ESPO, 2012). Moreover, rules on the prevention of pollution damage to the marine environment by vessels and marine pollution caused by the disposal of industrial waste have been introduced in Singapore's national legislation. The Singapore Government has also introduced legislation to regulate the expansion of ports for environmental damage caused by coastal construction projects.

2.4Shanghai best practices

The port of Shanghai is the largest container port in the world. It includes three major port container zones, such as Wusongkou, Waigaoqiao and Yangshan. In particular, the port of Yangshan is the largest automated container terminal in the world. Shanghai city government released a green port strategy for the sustainable development of the port of Shanghai in 2015. By 2017, six shore power facilitations were installed to supply 12 berths. Besides, under this program, energy usage in container terminals will be replaced by 75% by renewable energy, and LNG-powered ones will also replace container trucks. The port of Shanghai also imposes some fines for marine oil spills caused by waste disposal, port expansion and coastal development projects (Lam & Notteboom, 2014).

Based on the above review, Rotterdam has been recognized as a leader in the introduction of the green port, sustainable transport and intermodal link concept, which plays a critical role in the supply chain. The port of Antwerp follows the port of Rotterdam in the green port area. However, the ports of Singapore and Shanghai are not as involved as the previous two ports. Otherwise, lessons can still be learnt from the two Asian ports in formulating strategies for developing countries to adopt the Green Port concept.

3. Studies for improving implementation of the green port concept

The majority of the studies concentrate on guidance to port authorities, port policy and management, and green port factors, tools and performance indicators for approaching a green port (ESPO, 2012; Lam & Notteboom, 2014; Chiu, Lin & Tin, 2014). ESPO Green Guide was approved by the ESPO Executive Committee in June 2012, towards excellence in port environmental management and sustainability, which guides the systematic environmental management and standard approach for responding to environmental challenges (ESPO, 2012). The Guide aims at encouraging port authorities to be involved and dedicate themselves to sustainable and consistent environmental performance growth. The Guide recommends that all port authorities establish and maintain a systematic approach to the green port framework, such as the implementation of the Port Environmental Review System (PERS), ISO 14001 and the EU Eco-Management and Audit Scheme (EMAS) and the achievement of related certifications. Nebot et al. (2017) provided some strategies for the development of ports through research on previous work. The first strategy is the maritime strategy and the integration of coastal management. This integrated approach is based on the context of today's growth in demand and its impact on coastal regions, including the port, marine biodiversity, fishing, energy, environment, transport and infrastructure. In terms of the relationship between the public and coastal policies, the role of port management is highlighted. Chiu et al. (2014) researched a Fuzzy Analytic Hierarchy Process (AHP) model which includes 13 Green Port factors. This model helps approach the Green Port and in assessing ports operational efficiency. The assessment findings allow decision-makers to select the most relevant factors for use within a particular period within the limited port resource. Roh et al. (2016) said that developed countries had several difficulties in creating greener harbours. For example, in most ports in developing countries, the "Green Port" concept is still at its infancy, with a large number of ports struggling to survive on a competitive market, capital investments for long-term port planning and improved environmental standards as economies in developing countries have not yet grown .

In conclusion, the majority of studies currently focus on the growth of local or national ports without the global vision for establishing sustainable port growth strategies. Besides, the port authority's dedication in terms of port policy and administration is the foundation for achieving the green port. Only a few research, however, has listed a fragmented discussion about port policy and management. Also, national policies and policies of the local government are essential components of the port policy.

4. Methods

This research aims to gather/examine lessons from the leading ports namely Rotterdam, Antwerp, Singapore and Shanghai focusing on the port policy and management, then analyze the factors affecting the development of a green port in Egypt by literature review/on-site observations and case study. The ports of Rotterdam and Antwerp are the leading ports in the world in the area of green ports, especially in the aspect of developing policies for sustainable development of ports. The ports of Shanghai and Singapore are the busiest port in the world; they have made some great efforts to approach the green port, which have a high reference value for other countries' ports.

An extensive literature review was done through desk research to understand what best practicing ports around the world are implementing their green port initiatives. A focus was put on the ports of Rotterdam, Antwerp, Singapore, and Shanghai. A SWOT analysis was conducted to understand the Strengths, Weaknesses, Opportunities, and Threats for Egypt seaports regarding the selected best practicing port around the world.

The on-site observations conducted by the authors for six months' period from July 2019 until January 2020 to identify the level of adoption and or implementation of any measures related to green port approach for two of the main ports of Egypt namely Alexandria port and port said port.

5. Findings from reviewing main Egypt seaports

Competitiveness of the Egyptian economy and increasing exports at an annual rate of more than 10 % were among the priorities of Egypt's five-year plan between 2016-2020 (MTI, 2016). However, the latest statistics in 2020 show that annual exported rate was 6.5% (CEIC, 2020). Also, under the plan, the Egyptian government encouraged the private sector to increase investment, especially in the services sector (Sislian & Jaegler, 2016). As the service sector plays a pivotal role in promoting the economic sector, Egyptian ports will be studied to determine their contribution to increasing economic activity.

Egypt is considered to be the most crucial route of foreign trade between East and West, with its geographical location. Moreover, developing new seaports, enhancing the productivity of existing ports, expanding the Suez Canal axis, restoring, and investing the Northwest Gulf of Suez, the Northwest Coast, and North Sinai will turn Egypt into an international logistics center moreover creating high-value investment opportunities (MTS, 2018). In term of renewable energy resources availability, Egypt is among the most promising clean energy generating countries, has adopted a strategy to turn Egypt into a regional center for energy exchange and trade that gives it a national disposition (MTS, 2018).

Currently there are 48 ports in Egypt 15 commercial and 33 specialized besides, two more commercial ports under construction, the nine major ones being Alexandria, El- Dekheila, Port Said, Safaga, East Port Said, Damietta, Adabiya, Suez, and El-Sokhna (MTS, 2018). The estimated total number of vessels calling annually at Egyptian seaports are about 14,000, the estimated total Twenty-foot Equivalent Units (TEUs) handled annually are about 7,000,000 TEUs, the annual total gross cargo volume is about 160,000,000 tons, (MTS, 2019) which, indicates the high volume of power consumed and ships traffic at Egyptian seaports and consequently, reflects the adverse environmental impact.

Port Said port authority reported that container volumes fell by almost 450,000 TEUs in 2017. However, the port maintains a fifth place in the Top 5 region ports (MTS, 2018), with a total throughput of over 3 million TEUs (HELLENIC SHIPPING, 2018). The Suez Canal Authority has given Egyptian vessels a 30% discount in transit charges by the end of 2018 in order to increase the transport of containers from port Said to the hub port East Port Said. (HELLENIC SHIPPING, 2018).

Port Said, Egypt and Tangier Med, Morocco are the leading ports in the Mediterranean region of Africa, in term of liner shipping connectivity, Port Said and Tangier Med both provide comprehensive transshipment facilities, benefiting from their geographical location and private sector investments by major global port operators (UNCTAD, 2019).

Egyptian ports are considered as non-efficient ports due to lack of equipment maintenance, use of old technologies and equipment, improper management structure due to the hierarchical and bureaucratic system and weak communication between the port authority and port users (Sislian & Jaegler, 2016). Therefore, the Egyptian government began to study the main factors needed to develop a sustainable green port .

In the past two decades, there has been a significant increase in container handling in all Egyptian ports. The Egyptian Maritime Data Bank of the Ministry of Transport (EMDB) announced that the increase in the number of containers reached 50 percent from 1995 to 2014, and the number of vessels increased by 35% compared to 1995. Although Alexandria port is the most crucial port in Egypt in terms of vessels traffic, which accounts for 26% of total vessel traffic, the study and green power project have been applied for Damietta port as the first initiative and then will be circulated to the rest of the Egyptian ports (Sislian & Jaegler, 2016). MTS in the achievement report for the year 2019 stated that the total ships call on Damietta port, Alexandria port is 3257, 2994 respectively illustrating that Damietta port has overtaken Alexandria port in light of ships traffic.

The green power project is to change power generation from the use of fossil fuel to using 100% of clean power by application of biomass unit and Photovoltaics (PV). The project is divided into two stages. In the first stage, the aim is to provide 50 % of the total required electricity from biomass and PV within the port. Another 50% of electricity is from the national grid. In the second stage, the entire port will be provided by 100 % green power by 2026, and any extra electricity will be sold to the national grid (Alsnosy & Noha, 2017). The primary drivers for the transition from conventional power to renewable energy power are the scarcity of conventional fuel and the rise of environmental awareness.

The amount of obtained PV power in Egypt is estimated at 6KW/h/day (Alsnosy & Noha, 2017). Many factors are affecting this capacity, for instance, temperature, solar intensity, cell material and incident angle. The project assumes that 20% of the land area will be used for the installation of solar panels before 2026. The daily production capacity is expected to be 430 kWh, which is equivalent to approximately 18 MW and therefore, there will be an excess of energy estimated at 6 MW per day (Alsnosy & Noha, 2017). Since it is not easy to store solar energy, the intention is to sell the surplus to the local grid or those in need from neighboring areas. Last but not least in 2017, Damietta Port authority agreed to provide all berthing vessels with electricity at a rate of 50 cents per kilowatt-hour (EMICS, 2018).

6. Discussions

From reviewing and comparing the results of the research carried out in the area of green ports, especially on ports covered by on hand research paper. Some ports like Rotterdam, Antwerp, Shanghai and Singapore have made tangible progress in their efforts and taken as leading port in light of green port concept .

A SWOT analysis was used to better understand the strengths, weaknesses, opportunities, and threats for the collected data by literature and or on-site observations for six months' period to evaluate then improve port performance/operation while developing green ports for Egypt seaports, the results are shown in figure 1:

Figure 1: SWOT analysis for developing a green port in Egypt

According to the literature review, the case study of Egypt seaports and on-site observations, some Egypt ports have already begun to approach the green port concept, and some ports have made some progress like Damietta port. In the Strength aspect, some port policies and related green concept projects have been implemented, such as green power project in Damietta port; and the implementation of ISO 14001 has provided a solid foundation for the green port approach. On the other hand, the weaknesses are still prominent in the ports of Egypt for instance, absence of integration among Egyptian seaports, a lake of human resources development and qualification, poor communication between port authorities and port users, limited data resources, absence of comprehensive vision and adoption of green port policy, improper management structure and poor equipment maintenance. Furthermore, when designing strategies for sustainable development of ports in Egypt, the threats and opportunities should be carefully considered. Like IMO regulations related to the environment which needs time to adapt in the Egyptian national law. Furthermore, the Egyptian ports are regulated by the local government and mostly managed by the Port Authority. Hence, that may represent a threat while implementing green port policy. Moreover, due to the currently escalating number of ships transiting Suez Canal and/ or calling East Port Said resulting in adverse environmental impacts like air pollution through emissions, water pollution from oil leakages and garbage waste, and biological risk from ballast water.

Differing from threats opportunities will present, by economic development through new projects and investments, the increase of transshipment should be managed by a prudent approach to fulfil the green port concept at handling and storing stage. Like automation and equipment electrification, EMS which is being implemented in Damietta port in the form of ISO 14001 promoting the green port concept. New protocols and agreements at a regional level were held like the first green port contract between (SCZone) and (SISCO), renewable energy sources like the available solar power and wind power which is being exploited in Damietta port and Elzafrana area respectively. Egypt 2030 sustainable development vision which develops safe ports that can adapt to regional and international variables and compete regionally and globally, the establishment of new green ports will support the investment in renewable energy and alternative fuel (LNG) bunkering.

Based on the above-mentioned discussion the authors suggested guidelines and corrective measures for improving port policy and management while applying the green port concept in Egypt, moreover, these suggestions may be the concrete foundation of the green port model for Egyptian seaports.

a) Central government policy

Due to the lack of advanced technology and equipment, and a lack of investment in resources in Egypt, central government financial support for The development of infrastructure is necessary. Mandatory requirements enforced by government for emission reductions are compelling drivers for the development of the green Port concept, such as Emissions Control Areas (ECAs). In addition, some incentive policies for private ports, such as tax reduction, should be considered in order to reduce costs for the implementation of green ports.

b) Local government policy

Structural barriers can prevent successful policies being enforced between central and local governments. For example, the EU's objective is to build a level playing field that does not coincide with the national objective of economic interests; some local governments may only focus on their political performance through economic development rather than sustainable development. No two ports are the same thing. Local government should, therefore, consider sustainable development in the context of long-term planning, establish more agreements with stakeholders to develop funds or projects, and develop policies based on the entire coastal area at a global level.

c) Port policy

Port policies should align with government policy objectives. Since sustainable development policies may impose some additional cost on the port, economic feasibility should be considered at the beginning of the policy-making process. In Egypt, most ports do not have appropriate necessary conditions and experience in implementing international standards, such as ISO 14001 and energy management standard ISO 50001. The capital cost of infrastructure and management is a significant challenge for some ports to implement related international standards .

The lessons of ESPO, like the Eco-Port project, should be examined at ports in Egypt. The Eco-port management system is active. The project is open to any port that may apply to a member on-line. The project will then provide technical and specific advice to each port to help it address the requirements of the Eco-Port. Some similar organizations and projects should, therefore, be considered in developing countries, and cooperation with these mature organizations should be strengthened. Besides, port authorities may also establish pricing policies and regulations on access to boost their competitive position and promote productive operation by customers. The pricing policies may include incentives for good practices or penalties for no compliance.

d) Port management tools

Currently, several management tools can be considered by port authorities at the global level, such as ISO 14001 and ISO 50001. These tools are based on a systematic approach and a continuous improvement framework for the Plan-Do-Check-Act (PDCA) cycle. Compared to other methods, ISO 50001 is a new port management tool. ISO 50001 is an international standard approved by the European Committee for Standardization (CEN) on 25 October 2011, which aims to enable organizations to develop energy performance improvement systems and processes. A small number of ports at the global level have already implemented ISO 50001 standard and certified, such as the port of Antwerp, the port of Hamburg. ISO 50001 implementation can reduce operating costs, improve energy efficiency and promote management system through documentation, records and related audits.

e) Investing in renewable energy sources

Renewable energy, such as solar power, biomass, and wind turbines, is getting more and more attention to addressing environmental issues. Port area is a perfect place to install a massive amount of wind turbines and solar panels. The biomass power plant can also be installed in port areas to minimize pollution, such as in the port of Antwerp, where a biomass station can reduce greenhouse gas emissions by 20%.

7. Conclusion

With the growth of the global economy, ports in developing countries like Egypt is facing more stringent regulation, the competition of economic interests, and environmental impact. As the green port concept has a significant potential to address these issues, this study has reviewed the best practices of the ports of Rotterdam, Antwerp, Singapore and Shanghai, and analyzed internal and external factors affecting the development of green port in Egypt by literature review and on-site observations, the result shows that although some Egypt ports have already begun to approach the green port concept, and some ports have made some progress like Damietta port ,and the 2030 Egyptian Maritime Sector vision adopted in 2015, still there is lack of the active control measures for emissions reduction. Besides, many port authorities are ignoring the importance of sustainable development while they are mainly considering economic interest.

8. Recommendations

From strengths and opportunities, and taking into account weaknesses and threats, some recommendations for developing a green port in Egypt are shown as follows:

- Adopting comprehensive policy for green port not only focusing on ports but extended to cover multimodal transport like, seaports, railways, river transport, and road network.
- Promoting the role of the private sector in developing of green port as they need a huge investment.
- Environmental goals should be given high priorities while setting the long term strategies in order to achieve sustainable development goals.
- Establishing human development program, like training, motivation and awareness program especially with regard to environment and green projects.
- Integration among Egyptian seaports should be promoted under the ministry of transport.

References list

Acciaro, M., Vanelslander, T., Sys, C., Ferrari, C., Roumboutsos, A., Giuliano, G., Kapros, S. (2014). Environmental sustainability in seaports: a framework for successful innovation. Maritime Policy and Management, 41(5), 480–500.
https://doi.org/10.1080/03088839.2014.932926

http://www.greenport.com/features101/
vessel-build-and-maintenance/assessment-tools/benchmarks-of-sustainability-progress-in

Acciaro, M. (2015). Corporate responsibility and value creation in the port sector. International

Journal of Logistics: Research and Applications, 18(3), 291–311.
https://doi.org/10.1080/13675567.2015.1027150

Alsnosy, B., & Noha, H. e. (2017). Green energy seaport suggestion for sustainable development in Damietta port, Egypt. Paper presented at the Ecosud 2017, 67-76. 10.2495/ECO170071 Retrieved from
www.researchgate.net/search.Search.html
?type=publication&query=Green%20energy%
rt%20suggestion%20for%20sustainable%20
%20in%20Damietta%20Port,%20Egypt.

CEIC. (2020). Egypt Total Exports Growth [1995 - 2020] [Data & Charts]. Retrieved from
https://www.ceicdata.com/en/indicator/egypt/total-exports-growth

Chiu, R. H., Lin, L. H. & Tin, S. C. (2014). Evaluation of Green Port Factors and Performance: A Fuzzy AHP Analysis. Mathematical Problems in Engineering, (2014), ID 80297

Corbett, J. J., & Winebrake, J. J. (2007). Sustainable goods movement: Environmental implications of trucks, trains, ships, and planes. EM Magazine.
https://scholarworks.rit.edu/cgi/viewcontent
.cgi?article=2229&context=article

European Commission. (2017). Study on differentiated port infrastructure charges to promote environmentally friendly maritime transport activities and sustainable transportation FINAL REPORT. Retrieved from
https://ec.europa.eu/transport/sites/transport
/files/2017-06-
differentiated-port-infrastructure-charges-
report.pdf

EMICS. (2018). Power supply to vessels during berthing at Damietta port - Egypt. Retrieved from
file:///C:/Users/Fawzy/Desktop/Green%20
port%20paper/Emics-Circular_March_2018.pdf
ESPO. (2010). Benchmarks of sustainability:
-environmental-management-systems

ESPO. (2012). Green Guide: Towards Excellence in Port Environmental Management and Sustainability. Retrieved from:
https://www.espo.be/media/espopublications
espo_green%20guide_october%202012_final.
Pdf.

ESPO. (2017). Sustainability report 2017. Retrieved from
https://www.espo.be/media/2017.11.08%
20Sustainability%20report%202017
%20Review%20final.pdf

Goh, M. (2010). Green ports and green shipping: Singapore's contribution, Presentation at World Ocean Forum, Busan, 15-17 Nov 2010
HELLENIC SHIPPING. (2018). Feature: Top 5 Ports in the Middle East | Hellenic Shipping News Worldwide. Retrieved from
https://www.hellenicshippingnews.com
/feature-top-5-ports-in-the-middle-east/

IMO. (2012). STATUS OF CONVENTIONS as at 29 February 2012
http://www.imo.org/About/Conventions/Status
OfConventions/Pages/Default.aspx

Lam, J. S. L., & Notteboom, T. (2014). The Greening of Ports: A Comparison of Port Management Tools Used by Leading Ports in Asia and Europe. Transport Reviews, 34(2), 169–189.
https://doi.org/10.1080/01441647.2014.891162

Lam, J. S. L., & Van de Voorde, E. (2012). Green port strategy for sustainable growth and development. Paper presented at the Transport Logistics for Sustainable Growth at a New Level, International Forum on Shipping, Ports and Airports (IFSPA), 27-30.
MARIN. (2008). Ship emissions in the port of Rotterdam revealed by AIS data. Retrieved from
http://www.marin.nl/web/Publications/
Port of Rotterdam. (2018). Circular economy. Retrieved from
https://www.portofrotterdam.com/en/the-port/energy-transition/circular-economy

progress in Environmental Management System. 03 Mar 2010

Publication-items/Ship-emissions-in-the-port-of-Rotterdam-revealed-by-AIS-data.htm

MTI. (2016). Industry and Trade Development Strategy 2016-2020. Retrieved from http://www.mti.gov.eg/English/MediaCenter/News/PublishingImages/Pages/2017-Strategy/2017 Strategy.pdf

MTS. (2018). The Egyptian Maritime Transport Strategy, Development & Increasing the Competitiveness of port. Retrieved from http://www.emdb.gov.eg/images/front/en/MTS-Strategy2018.pdf

MTS. (2019). 2019 Maritime Transport Sector Contents. Retrieved from http://www.emdb.gov.eg/multimedia//docs/Achievements2019_E.pdf

MPA Singapore 2013. Maritime Singapore Green Initiative. http://www.mpa.gov.sg/sites/maritime_singapore/msgi/maritime-singapore-green-initiative

Nebot, N., Rosa-Jiménez, C., Ninot, R.P. & Perea-Medina, B. (2017). Challenges for the future of ports. What can be learnt from the Spanish Mediterranean ports? Ocean Coast. Manage. 137,165–174

Port of Rotterdam 2011. Maasvlakte 2 Sustainable transporthttp://www.maasvlakte2.com/en/index/show/id/600/Sustainable+transport Harbour Dues http://www.portofrotterdam.com/en/Shipping/harbour-dues/Pages/Apply-ESI-discount.aspx

Port of Antwerp 2010. Annual Report 2010. Energy and climate policy http://annualreport2010.portofantwerp.com/en/page/194/energy-and-climate-policy

Port of Antwerp. (2012). Ship fuel monitoring and oil spills | Port of Antwerp. Retrieved March 26, 2020, from https://www.portofantwerp.com/en/ship-fuel-monitoring-and-oil-spills

Roh, S., Thai, V.V. & Wong, Y.D. (2016). Towards sustainable ASEAN Port development: challenges and opportunities for Vietnamese Ports. The Asian J. Shipping Logistics, 32 (2): 107–118

Sislian, L., & Jaegler, A. (2016). A green ocean carrier network design problem: Empirical study on Egyptian port of Alexandria. ILS 2016 - 6th International Conference on Information Systems, Logistics and Supply Chain, 2–9.

Third IMO GHG Study. (2014) Executive Summary and Final Report. (2015). Retrieved from www.imo.org

http://www.imo.org/en/OurWork/Environment/Pollution Prevention/AirPollution/Documents/Third%20Greenhouse%20Gas%20Study/GHG3%20Executive%20Summary%20and%20Report.pdf

UNCTAD. (2015). Review of Maritime Transport 2015. United Nations Publication, New York and Geneva. https://unctad.org/en/PublicationsLibrary/rmt2015_en.pdf

UNCTAD. (2017). REVIEW OF MARITIME TRANSPORT. Retrieved from https://unctad.org/en/Publications Library/rmt2017_en.pdf

UNCTAD. (2019). United Nation Conference on Trade and Development Review of Maritime Transport 2019. Retrieved from https://unctad.org/en/Publications Library/rmt2019_en.pdf

Woo, J. K., Moon, D. S. H., & Lam, J. S. L. (2018). The impact of environmental policy on ports and the associated economic opportunities. Transportation Research Part A: policy and Practice, 110,234-242. https://doi.org/10.1016/j.tra.2017.09.001

Enhancing The Competency-Based Offshore Helicopter Underwater Escape Training: The Simulation Fidelity Perspective

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Abstract:

The offshore oil and gas industry is now relying greatly on helicopters as the primary mean of transportation. However, similar to other transportation means, helicopters are vulnerable to technical failures and human errors. If a failure occurs while flying over water, the consequences could be extremely hazardous as the helicopter will lose altitude until it finally ditches on water, forcing passengers to initiate an abandoned process which is considered a challenging task that has to be carried out adequately in a potentially stressful environment. Despite the improvement in offshore helicopter safety, ditching accidents remain to be present and need to be addressed to reduce the level of risk associated with underwater escape. A range of Helicopter Under Water Escape training "HUET" standards are established by Governmental and Non-governmental bodies worldwide. One of which is OPITO, formerly known as the Offshore Petroleum Industry Training Organisation, which is concerned with initiating emergency response training standards for the offshore industry including HUET. The hypothesis held by the author argues that the current OPITO HUET standard may not fully ensure an adequate level of fidelity causing false confidence within the quality of training and its objective to effectively prepare helicopter passengers for a real emergency ditching. Based on the literature, and reviewing success rates of several HUET training programs delivered to 1096 trainees during 12 months at AASTMT. In addition to exploring the learning outcome targeted within the OPITO HUET standard, this research paper intends to provide an understanding of the fidelity level achieved and whether the standard in its current form provides a competency-based training that is effective in preparing the offshore workforce to respond adequately should a ditching situation arise. Moreover, it proved that the OPITO HUET standard, in its present form, might not fully ensure the adequate similarity to real emergency ditching situations, creating false expectations in the mind of the trainees, and probably leading them to react inappropriately when experiencing a real emergency ditching accident. The study recommends considering fidelity increase to improve the efficiency and reality of the helicopter safety training by including simulated environmental conditions and additional practical exercises such as cross cabin and manual lifejacket inflation.

Keywords: Offshore, Helicopter, Accidents, OPITO, HUET, Training, Fidelity.

1- Introduction

Offshore helicopter transportation has become a vital component contributing to the sustainability of the offshore oil and gas industry. Being more efficient and reliable than other alternative methods of transportation available in the offshore industry made it widely used for transferring personnel to and from offshore installations. Even though, it is performed in a challenging and hazardous open sea environment (CAA, 2014). Similar to other transportation means, Helicopters are vulnerable to human element errors and several typical emergencies that would affect the normal operation of the helicopter including mechanical failure, engine fire, hydraulic or electrical or lubrication systems failure. If a serious failure occurs while traveling over water, the consequences would be hazardous, as the helicopter will lose its altitude and eventually ditch on water (EHEST, 2011). According to the European Aviation Safety Agency, the term “ditching” refered to “An emergency landing on water, deliberately executed as per the rotorcraft flight manual (RFM) procedures, with the intent of abandoning the rotorcraft as soon as practicable” (EASA, 2016). After ditching, the helicopter most probably would invert and rabidly submerge with water rushing in. This will cause inherent buoyancy and disorientation to passengers who, in order to survive, must carry on several emergency response procedures including impact-protection and locate positions, and deal with several types of survival equipment such as safety harness, life jackets, aviation suits, emergency breathing systems and jesting mechanism. In addition to finding their way to the surface outside the flooded structure, they have to carry on water survival techniques until being rescued. According to Brooks CJ et al., (2008), this is a challenging task that has to be carried out adequately in a potentially stressful environment. Based on the findings of Taber (2014), the conditions faced by survivors need to be overcome through knowledge, training, preparation, and attitude, where further work needs to be directed toward how to best prepare the global offshore workforce for ditching accidents. Currently, there are various training standards established by several recognized bodies such as the Norwegian Oil Industry Association (OLF), the Canadian Association of Petroleum Producers (CAPP), and OPITO. All of them have the same goal, even though their training approaches may differ considerably (Taber, 2016). OPITO as a global, not-for-profit, industry-owned organization, works with governments, national oil companies, operators, and contractors, offering a range of services and products to meet the international skills needs and support workforce development. Through operation centers in four regions; UK and Europe, Middle East and Africa, Asia Pacific, and the Americas; OPITO is driving safety and competency improvements to benefit the industry by training more than 375,000 persons per year, across more than 200 approved training providers in more than 50 countries (OPITO, 2020a). The OPITO HUET standard, being the most recognized and widely implemented within the Middle East region, shall be the main focus of this study.

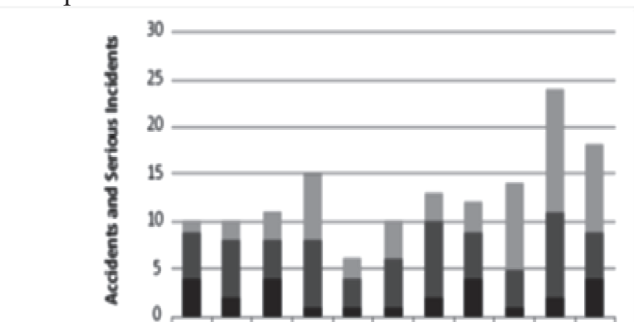
The hypothesis held by the author argued that the current standard may not fully ensure an adequate level of fidelity leading to false confidence within the quality of training and its objective to prepare helicopter passengers for a real emergency ditching. Based on literature and reviewing the pass rates regarding a set of HUET Courses, delivered to 1096 trainees, in one year, in addition to assessing the fidelity level used in delivering learning outcomes within the OPITO standard, this research study intended to gain an understanding as to whether the current HUET standard established by OPITO provides a realistic and effective competency-based training for preparing the offshore workforce to respond adequately should a real emergency ditching situation arise to the helicopter, and identify areas where training enhancement can be made.

2. The Need for Helicopter Ditching Emergency Response Training

As multiple ditching accidents have taken place involving helicopters flying to and from offshore rigs and platforms, the safety of offshore helicopter transportation has become a great concern to operators, regulators, and the workforce, leading to many safety reviews (CAA, 2020). Despite the recent improvement in increasing floatation time that allowed additional time for occupants to escape the helicopter structure, can’t fully guarantee the survival of passengers and crew if not followed by timely and correctly performed response procedures, thus the more knowledge acquired by trainees during training, and the more preparation of attitude, on different levels of potential circumstances, will ultimately greater the chances of surviving a helicopter ditching (Taber, 2014).

2.1. Helicopter Ditching: An Overview

The first reported helicopter ditching accident occurred in November 1944 (Lillard JM, 1999), but attention was given to the numbers of fatalities resulting from helicopter ditching accidents when Glancy (1971) reviewed the US Navy helicopter accidents and pointed at “drowning” or “lost at sea” as main causes of death contributing to 55% of ditching fatalities. According to Okstad et al., (2012), helicopters have become the biggest contributor to the overall risk of fatal accidents within the offshore Industries. A significant study on offshore fatalities occurred between 2003 and 2010, presented by the US Center for Disease Control and Prevention (CDC) concluded that the risk of fatality in the offshore oil and gas industry is seven times higher than for all workers in the United States, and referred to the Helicopter transportation as the most dangerous part of an offshore worker’s job (CDC, 2013). As per the recent annual safety review published by the European Union Aviation Safety Agency in 2020, Figure (1) illustrates the fatal, non-fatal, and serious incidents per year involving commercial air transport helicopters.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Serious Incidents	1	2	3	7	2	4	3	3	9	13	9
Non-Fatal Accidents	5	6	4	7	3	5	8	5	4	9	5
Fatal Accidents	4	2	4	1	1	1	2	4	1	2	4

Figure (1): Fatal / Non-fatal /Serious incidents per year of commercial Helicopters
Source: The European Union Aviation Safety Agency (EASA), 2020

In Figure (1), it can be seen that accidents and incidents are inevitable in the offshore Oil and Gas industry, where recent improvements in helicopter technology couldn’t effectively contribute to the reduction of accidents number over the years. Therefore, traveling offshore by helicopters will keep representing some of the most unique challenges to survival in the event of ditching. By this virtue, the offshore workforce needs to be effectively trained in the necessary knowledge and skill competencies to respond adequately should a ditching situation arise.

2.2 The Helicopter Underwater Escape Training Criteria

The aim of the HUET with Emergency Breathing System (EBS) is to prepare delegates that intend to travel by helicopter to and from offshore oil and gas installations and vessels by providing specific training in pre-flight and in-flight requirements and to equip delegates with the basic emergency response knowledge and skills required in the event of a helicopter emergency, with a specific focus on escaping from a helicopter following ditching (OPITO, 2020b). To make a successful helicopter underwater escape, particularly in the water below 15°C, it became vitally clear that a supplemental air supply must be available for each of the trainees whether it should be a compressed air system or a re-breather system (Stefanie et al., 2020). The present HUET training criteria involves a simulated ditching in a swimming pool while rotating the training module upside down as shown in Figure (2). The training focuses on students practicing bracing for impact, identifying primary and secondary exit points, using EBS and escaping through exit windows underwater, then surfacing for air. The traditional HUET simulates an immersed cabin rotating around a single axis, usually lengthwise. While the commonly used simulators can only be turned left or right in the horizontal plane, the new generation simulators can turn up to 360° in both the horizontal and vertical planes.

Figure (2): Helicopter Under Water Escape Training Simulator
Source: MSI-AAST&MT. 2020a

In general, the HUET training intends to increase the time-saving awareness of situational characteristics that can prevent successful escape, such as the role of the seat belt to control excess buoyancy caused by the safety suits inside the helicopter, how to operate the breathing system, and to locate and jesting emergency exits .

3. The Fidelity in HUET Simulation.

On 12 March 2009, with 18 persons onboard, a Cougar Helicopter Sikorsky S-92A ditched at the east coast of Canada striking the water at a high rate descent. Based on the investigation report published by the Transportation Safety Board of Canada, the water impact compromised the helicopter structure while the emergency flotation system did not deploy leading to the rapid sinking of the helicopter causing the death of seventeen persons including two crew members. Only one passenger survived the accident with severe injuries (TSBC, 2009a). According to the Offshore Helicopter Safety Inquiry (OHSI) that was established after the crash, the only survivor, in his testimony, compared his HUET experience with what he actually faced during the ditching accident and identified significant difference regarding the impact effect and surrounding environments such as water temperature, saltwater, and waves action (TSBC, 2009b).

This survivor's testimony is questioning the adequacy of the fidelity level utilized in the current HUET standard and raises concerns regarding how delegates are prepared for real accidents. Research has shown that a simulated environment that ensures a level of fidelity consistent with the real-world allows for the controlled development of specific skill sets (Baldwin and Ford, 1988) while using helicopter underwater escape simulation that is not representative of the operating environment has the potential to negatively affect the training outcomes (Hytten, K., 1989). Thus, realism in training is important and HUET simulating should offer the adequate level of fidelity that effectively achieve the intended training outcomes.

3.1. The Importance of Physical and Cognitive Fidelity in Skill Acquisition

Physical Fidelity is described as the degree to which a simulated environment replicates the look, sound, and feel of the real environment (Hochmitz & Y. Gavish, 2011). Using physical fidelity in training is not a new concept to ensure the transfer of skill knowledge from a simulated environment to a real-world setting. It has been suggested that the closer a simulation training is to real conditions, the better transfer of skills is achieved (Baldwin and Ford, 1988). However, another alternative perspective argues that physical fidelity during underwater escape training could be un-necessary and that only reproducing a representative environment is sufficient during skill acquisition (Coleshaw, 2006). Although this might be true for simple tasks that do not affect the overall performance related to specific skill sequences, it's confirmed by research that higher realism in training produces better performance outcomes in reality (Hochmitz & Y.Gavish, 2011). On the other hand, Cognitive Fidelity is described as the degree to which a simulation replicates the psychological and cognitive factors such as stress, anxiety, situation awareness, and decision-making requirements found in a real environment. Cognitive fidelity in training is considered useful as it helps in preparing individuals to make decisions in stressful situations (Kaiser & Schroeder, 2003).

3.2. The Adequacy of Fidelity levels in HUET simulator.

According to Taber (2016), fidelity levels in HUET simulators could be ranged from low to extreme levels based on how it replicates the real devices, conditions, and environments present in an actual event. To explore the possibility of shortcomings within the current HUET standard regarding the level of fidelity utilized, the impact of each level could be explained as follows:

3.2.1. Low-Level Fidelity.

Low-level fidelity devices or low-fidelity simulations don't present an equivalent functionality as that of the real-world. The reduction of fidelity as compared to a training set that replicates a real-world environment will rarely induce the same levels of stress and anxiety.

3.2.2. Medium-Level Fidelity.

Medium-level fidelity in simulation is featured as being limited where there are just some limited similarities in the context of the real-world (Taber, 2016). Delegates, therefore, aren't provided the opportunity to practice their range of skills and abilities in a simulated environment that is similar to what they may experience in real conditions. Such simulators are likely to be less difficult than real equipment, subsequently, medium-level fidelity leads to a high rate of success during training exercises.

3.2.3. High-Level Fidelity.

Allowing trainees to perform and practice full tasks in a simulation environment that is highly similar to what they will experience in reality would indeed be considered an advantage to the delegates (Taber, 2016). The inclusion of the environmental conditions such as wind, rain, and waves during HUET exercises, would enhance the trainee's experience and ensures that all phases of the survival and rescue process are adequately explored during and after the helicopter egress training.

3.2.4. Extreme-Level Fidelity

In a simulated environment, using extreme fidelity training would achieve the closest simulation to a real-world environment, thereby providing the best method for transferring knowledge and skills (Taber, 2016). However, it also can expose delegates to unnecessary risks and is deemed as dangerous, wherein this matter delegates would unlikely complete all the assigned training exercises.

3.3. The Optimum Level of Fidelity in HUET training.

According to Taber (2016), there is some extent where any additional realism would not benefit the training which is indicated as an extreme level of fidelity, thereby simulating a situation during which risks are outweighed by the benefits, the training environment would no longer be safe. To estimate the optimal level of fidelity in training, the performance outcomes could be demonstrated as an Inverted-U perspective representing the theoretical curve of HUET performance transfer of skills based on the continuum range of fidelity levels from low to high, which can be safely replicated in the training environments. Figure (3) shows varying levels of fidelity represented along the horizontal axis, while the vertical axis represents the transfer of HUET performance skills. The areas below the curve indicate low to medium fidelity that might allow only for minimal skill transfer, whereas the extreme zone, could during initial stages, produce higher levels of skill transfer. However, at such extreme levels of fidelity, injury risks would be increased while the performance outcomes are rapidly reduced.

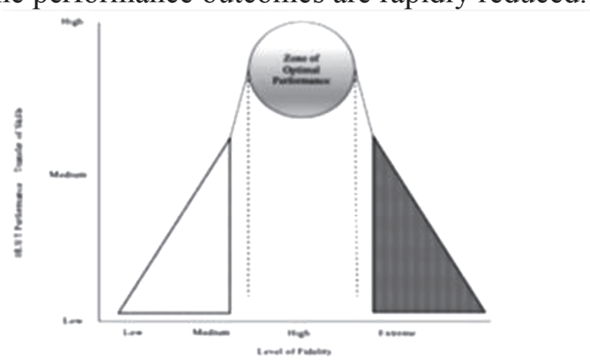


Figure (3): Levels of Fidelity in HUET .Simulation Training
Source: Taber, 2016.

Therefore, using a combination of high physical and cognitive fidelity during the acquisition of critical skills ensures that trainees can imagine how to complete the tasks in a stressful environment while having the experience of being able to perform the necessary tasks. Based on ditching event information, and previous research, it can be argued that to properly prepare an individual or team to perform a complex task in a real-world event, demonstration of critical skills should be practiced in a realistic, high fidelity simulated environment while ensuring that safety is maintained.

4. The Current OPITO-HUET Training Standard

The objective of the current OPITO HUET is that delegates will be able to demonstrate, in a simulated environment, that they can use the safety equipment, and follow procedures in preparing for, and during helicopter emergencies, with particular focus on escaping from a helicopter following ditching (OPITO, 2020b). The training is designed to meet the offshore safety and emergency response training requirement for personnel new or returning to the offshore oil and gas industry who will be supplied with (EBS) during offshore helicopter travel. (OPITO, 2020b).

4.1Review of Success Rates (competency) of HUET courses.

Table (1) demonstrates success rates for delegates who participated in an OPITO approved HUET program, where it was delivered as a module of the Basic Offshore Safety Induction Emergency Training (BOSIET) or the Further Offshore Emergency Training (FOET) or a full HUET courses. The training took place within a well-recognized OPITO approved training provider in Africa that maintains a high level of commitment to the OPITO standard (MSI- AAST&MT, 2020b).

Table (1) illustrates the success rates of the total number of 1096 delegates of different age and gender with an indication of swimming capability limitation, during the period from January to December 2019.

s	2019 Month	HUET (BOSIET)	HUET (FOET)	HUET	Total	Non-swimmers	Competent	Not – Competent	Success Rate
1	January	28	5	4	37	23	37	0	100%
2	February	27	13	0	40	19	40	0	100%
3	March	57	18	4	79	56	78	1	>98%
4	April	87	27	1	115	92	114	1	>99%
5	May	42	30	2	74	49	73	1	>98%
6	June	35	5	2	42	27	41	1	>97%
7	July	154	21	8	183	138	181	2	>98%
8	August	72	7	1	80	45	78	2	>97%
9	September	68	26	2	96	51	95	1	>98%
10	October	70	28	3	101	59	100	1	>99%
11	November	100	8	1	109	67	107	2	>98%
12	December	132	8	0	140	116	137	3	>97%
	TOTAL	872	196	28	1096	742	1081	15	>98%

Table (1): Success Rates of HUET programs within an OPITO approved training provider.
Source: Author, 2020.

On reviewing the assessment outcome (Competent or Not-competent) of HUET programs shown in Table (1), a high rate of success each month can be observed, even though there is a significant number of non-swimmers delegates. The overall success rate for delegates who achieved the learning outcomes and skill competencies is higher than 98% for all who attended HUET programs. On the other hand, in real ditching accidents, the number of fatalities represents a survival rate that is well beneath the rate accomplished in training. Data reported by Taber and McCabe (2005), who reviewed the global helicopter ditching accident between 1971 and 2005, showed that in 511 accidents involving 2478 occupant persons, only 66% survived while 30% of the survived persons had some form of injury. More recent survival rate related to ditched helicopters was identified by a comprehensive study, based on reports from the National Transportation Safety Board (NTSB), Civil Aviation Authority (CAA), and several other sources, concluded that within

delegates should deploy and operate the EBS the period from 2000 to 2010, the international offshore industry has encountered 60 helicopter ditching cases that caused the death of 152 of the 294 (52%) individuals, revealing that the overall world survival rates of helicopters ditching accidents are on average of 48% (Taber, 2010).

Such a significant gap between training success rate and actual survival rates may raise doubts regarding the fidelity level utilized in simulating ditching conditions that offer easier and safer training but not realistic. Driven by such doubts, the OPITO standard's learning outcomes and how they are achieved need to be explored to gain an understanding of the fidelity level presented.

5. Assessing Fidelity levels in current OPITO HUET standard

The OPITO Helicopter Under Water Escape Training Standard Revision 5, Amendment 9, January 2020, describes target groups, delegate's prior achievement requirements, learning outcomes, training program, duration of the training, and assessment (OPITO, 2020b).

5.1. The Ditching and Evolution speed simulation

As per section (E3) of the standard, where training equipment's requirement is described, there is no indication for a specific operating speed of the ditching sequence, therefore it's commonly conducted as slow as possible, including the inverted training evolutions. This could be considered low fidelity in simulation training and may raise concerns regarding the appropriate disorientation required to effectively prepare delegates to face a real emergency ditching impact and evolution speed.

5.2. The Learning Outcomes Targeted by the Standard.

As per section (C.5) of the standard, fourteen learning outcomes are described that must be achieved to succeed in the training and consider a delegate being competent for traveling offshore by helicopters .

5.2.1. Learning outcome (1): Emergency Breathing System (EBS)

The first learning outcome includes the donning of EBS and conducting its integrity checks, where and breathe from it during the capsize exercises. Furthermore, the EBS is also involved as an essential part of the learning outcomes (4,5,8,9,11,12) (OPITO, 2020b). Without the use of EBS, occupants may not be able to breath-hold for sufficient time to complete all of the actions required to escape and then reach the water surface. For the last 15 to 20 years, passengers flying offshore in Europe had carried either a rebreather EBS or a hybrid rebreather system, then the compressed air EBS occurred following the G-WNSB accident in 2013 (CAA, 2014). To date, the Air Pocket re-breather type is still approved by OPITO training standard and is globally utilized in HUET. However, this type of rebreathing equipment is useful only if passengers had sufficient time to deploy it before the helicopter submerges in water. Keeping in mind that accident reports have indicated that the helicopter would invert or sink immediately or after a short delay of time in almost 60% of all water impacts accidents (CAA, 2005/06), That means delegates are intensively trained to use a piece of equipment that is not operational in the majority of helicopter ditching accidents when there is no instruction from the pilot, or in cases where immediate inversion with limited time is experienced.

5.2.2. Learning outcome (2): Brace and Locate Positions

The Second learning outcome describes the required actions to prepare for a helicopter ditching, where mainly two body positions (Brace & Locate) are exercised. Firstly, on instructions from pilots, delegates should perform "Brace Position" to protect themselves to limit any injuries due to the high ditching accelerations impact. Secondly, to overcome the disorientation resulting from the inverted position, the delegates are trained to practice "Locate Position" to locate their harness release mechanism and establish a reference point related to the emergency exit before jettisoning the exit. However, the learning outcome doesn't extend to provide any training exercise in case there is no pilot instruction, although the European Union Aviation Safety Agency reveals

practice escape through an exit window in both that the more likely situation is a helicopter ditching case where the majority of occupants may be unaware and will not have braced for impact (EASA, 2017). Furthermore, the “Locate position” is practiced only for seats that are located next to emergency exit windows, while no practice regarding mid seats, even though most offshore helicopter configurations include middle seats for passengers.

5.2.3. Learning outcome (5, 9, 12): Emergency Exits Mechanism

These learning outcomes include the practice of push-out windows for simulating jettisoning the emergency exits. That means the training simulation is limited to only one jesting mechanism, even though probably half of the emergency exits in helicopters worldwide depend on various other kinds of mechanical exit mechanisms (King et al, 2018). This issue was early highlighted by Brooks et al (1997) who raised concerns regarding the number of different exit jettison mechanisms and the fact that there are 23 different doors, hatches, and window release mechanisms identified in 35 types of helicopters that fly over water. Moreover, there is no reference regulating the force required to push out window exits, thus the training window is not of the same tension required for a real helicopter window exit. King et al (2018), demonstrated that high forces are required to remove a real type of exit, raising serious concerns regarding the ability of helicopter occupants to jettison exits when required. According to the UK Air Accident Investigation Branch report AAR 1/2016, relating to the accident of helicopter G-WNSB, the majority of passengers who succeeded to push out exit windows reported that "it was not easy and was significantly harder than they experienced during training" (UK AAIB, 2016). That means a delegate who holds an OPITO HUET certificate, could be involved in a ditching situation and could be sitting beside a mechanical exit that he hasn’t been trained to operate, or at least wasn’t prepared to operate hard pushing out windows as to how it is in real helicopters.

5.2.4. Learning outcome (7, 8, 9, 10, 11, 12): Seating Positions and Exits

These learning outcomes require that delegates upright and capsized conditions. In 1999, Bohemier et al revealed that seats beside an exit provide the greatest probability of survival, while the chance of survival decreases with the increase in distance between seat and exit. In the G-WNSB accident (UK AAIB, 2016), several underwater escape routes were reported by the survivors with only four passengers were sitting next to an exit and managed to escape successfully, while another four passengers had to carry on a 'cross-cabin’ task to find their way to the exit. Whilst this fact was early recognized, yet the issue is still not addressed within the current training, as per the standard delegates practice only escaping from seating positions located next to exit windows with no single practice for a cross-cabin or cross-seat exercise. Meaning that the trainees are not trained to locate an exit from a middle seat nor removing the exit with the harness unfastened.

5.2.5. Learning outcome (7, 8, 9): Partially-Submerged Helicopter

These learning outcomes involve a “partially submerged helicopter” where the simulator is lowered upright to the water until the cabin is flooded, then delegates practice escaping through a window underwater while the simulator is in a submerged upright position. Due to the weight to buoyancy location in all helicopters airframes, it is not physically possible for a helicopter airframe or cabin to fill up with water up to passengers’ heads and still be upright (EASA, 2016). Therefore, delegates are trained to overcome an emergency case that is not likely to happen in any real ditching situation.

5.2.6. Learning outcome (1,13)- Aviation Life Jacket

Both learning outcomes include the deployment of an aviation lifejacket by releasing a compressed gas cylinder. In the case of cylinder malfunction, the passenger can manually inflate the lifejacket by breathing into a tube installed on the upper section. According to TSBC (2015), there are several survivable ditching accidents where occupants appear to have escaped from the helicopter but have failed to

swell, wind speed, water spray, light, visibility, survive as their lifejackets had not been inflated or were only partially inflated leading to drowning However, within the learning outcomes, there is no exercise regarding lifejacket's manual inflation but only the mechanism is explained theoretically. Moreover, this process may require a minimum swimming capability to allow time to manually inflate the lifejacket by breath, yet swimming skill of any level is not required by the standard as a pre-requisite to attend the course. That means non-swimmer delegates might experience drowning in a real ditching accident in case of inflation failure as they won't be able to maintain flotation for a sufficient time to inflate the life jacket manually.

5.2.7 Learning outcome C.5 (6) Aviation Life Rafts

Whilst this learning outcome includes training on assisting others where possible in carrying out initial actions on boarding the aviation life raft, including mooring lines, deploying the sea anchor, raising the canopy, and raft maintenance; it doesn't specify any requirement for delegates to practice the deployment and inflation of the life raft itself. Based on the investigation report published by the Dutch Safety Board regarding the G-JSAR accident in 2006, neither the flight crew nor the rear crew deployed the life rafts before ordering the evacuation of the cabin, resulting in all passengers and crew evacuating into water directly, then an unsuccessful attempt by the winchman to manually deploy the life raft. It was noted that his training had covered the location of this handle but not operating it. As a result, all of the passengers and two of the crew remained in the water without the protection offered by a life raft against a 12o C water temperature (DSB, 2010). It seems that the most essential initial action that should have been addressed by the standard is missing in this learning outcome.

5.3.The Surrounding Environment Conditions

The Survival time in water varies depending upon the location, time of year, the water temperature, and factors that individuals can take to increase their survival time and hence being rescued. However, in general, the standard doesn't specify any requirement regarding any simulation to weather and sea state conditions such as waves, fog, rain, and water temperature.

For example, repeated hits by waves can interfere with normal breathing, and as the survivor fatigues, it can become increasingly difficult to synchronize breathing with gaps in the wave splash. In such rough weather conditions, the use of the sprayhood attached to lifejackets can significantly improve the airways protection thus reducing the risk of drowning (Armstrong et al, 1994). However, if helicopter occupants have not been exposed to waves during training they may not realize the importance of this equipment .

Based on the above-mentioned observations regarding the fidelity level associated with the learning outcomes and how they are delivered within the OPITO HUET standard, the researcher believes that ditching simulation training in that manner is not of high fidelity or realistic, but worse, the false expectations created by such low fidelity in training will not prepare the delegates to face a similar occurring real emergency ditching situation but can create confusion and, if not surprise, during a subsequent real crash; and potentially cause fatalities.

CONCLUSION

Realism is important as it helps to make evacuation behaviors faster, and helps in decreasing the time required to escape. Using helicopter underwater escape simulation that is not representing the real operating environment has the potential to negatively affect training outcomes. Given the current OPITO standard to which HUET is conducted today worldwide, the researcher believes that most offshore workers are not adequately prepared to face a real ditching emergency, as an actual escape from a real crashed helicopter could be much more difficult than what being presented by the simulated training. The trainees have not experienced severe disorientation, rapid inversion, and fast lowering into the water similar to what a real helicopter ditching may be, nor trained with high fidelity exits and jettisoning mechanisms according to different helicopter specific interior seating

Brooks et al, (1997). Brooks, C. J.; Bohemier,

configurations. If training is insufficient, then survival is that much more unlikely and or difficult. This study discussed possible shortcomings within the learning outcomes and how they were achieved as per the OPITO current HUET standard. The study concluded the importance of increasing the realism and fidelity to the training standard with the enclosure of weather and sea state conditions, in addition to the need to conduct at least one training sequence cross cabin or across another seat, even if empty to prepare delegates for different seating configurations.

Recommendation

This research paper highly recommended a further investigation to critically explore the present standard in its entirety for improving the fidelity of training simulation that ensure delegates, on completion of training, are better prepared to respond in the event of a real emergency helicopter ditching accident.

References

Armstrong et al, (1994). Armstrong I J, Bennett-Smith S C & Coleshaw S R K, (1994). Offshore Technology Report: Performance of Immersion Suit and Life Jacket Combinations at Sea. HSE Books. Health & Safety Executive. Retrieved on 16 August 2020 from: https://www.hse.gov.uk/research/othpdf/400-499/oth428.pdf

Baldwin & Ford, (1988). Baldwin, T. T., & Ford, J. K. (1988). Transfer of training: A review and directions for future research. Personnel Psychology, 41(1), 63–105. Retrieved on 9th July 2020 from: https://onlinelibrary.wiley.com/doi/abs/10.1111/j..1744-6570.1988.tb00632.x

Bohemier et al, (1999). Bohemier A, Brooks CJ, Morton JS, Swain JH, High fidelity survival training for ditched aircrew and passengers. Paper presented at RTO HFM Symposium on "Current Aeromedical Issues in Rotary Wing Operations", San Diego, USA, 19-21 October 1998. Published in: RTO MP-19. Neuilly-sur-Seine, France: NATO. 1999.

A. P. (September 1997). "Helicopter door and window jettison mechanisms for underwater escape: ergonomic confusion!". Aviation, Space, and Environmental Medicine. 68 (9): 844–857. ISSN 0095-6562. PMID 9293355. https://pubmed.ncbi.nlm.nih.gov/9293355/

Brooks CJ et al., (2008) Brooks, C.J., MacDonald, C.V., Donati, L. and Taber, M. Civilian helicopter accidents into water: Analysis of 46 cases, 1979-2006. Aviation, Space, and Environmental Medicine, 2008 79(10), 1-6.

CAA, (1984). Review of Helicopter Air Worthiness Panel (HARP). CAP 491. A report prepared for the chairman of the Civilian Aviation Authority, London, UK. 1984. Accessed from: http://aerossurance.com/wp-content/uploads/2015/02/CAP491.pdf

CAA, (2005/06). CAA PAPER 2005/06: Summary Report on Helicopter Ditching and Crashworthiness Research. Published by TSO (The Stationery Office) on behalf of the UK Civil Aviation Authority. December 2005. Page 36. Retrieved from: https://publicapps.caa.co.uk/docs/33/2005_06.PDF

CAA, (2014). Safety review of offshore public transport helicopter operations in support of the exploitation of oil and gas. CAP 1145. Feb. 2014. London: Civil Aviation Authority. https://publicapps.caa.co.uk/docs/33/CAP%

CAA, (2020). Safety Review of Offshore Public Transport Helicopter Operations in Support of the Exploitation of Oil and Gas. CAP 1877. Jan. 2020. London: Civil Aviation Authority. http://publicapps.caa.co.uk/docs/33/CAP1877.pdf

Glancy (1971). Glancy, J.J., and Desjardins, S.P.

CDC, (2013). Centers for Disease Control and Prevention. Fatal Injuries in Offshore Oil and Gas Operations — United States, 2003–2010. April 26, 2013 / 62(16);301-304. Accessed from: https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6216a2.htm?s_cid=mm6216a2_e

Coleshaw, (2006). Coleshaw, S.R.K., 2006a. Investigation of removable exits and windows for helicopter simulators. OPITO Report SC 153. Retrieved from: https://downloads.opito.com/downloads/investi

DSB, (2010). Emergency landing Bristow AS332L2 search and rescue helicopter. North Sea, Den Helder, 21 November 2006. Project number M2006LV1121-07. The Hague, Netherlands: Dutch Safety Board.

EASA, (2016). European Aviation Safety Agency, Notice of Proposed Amendment 2016-01. Helicopter ditching and water impact occupant survivability, RMT.0120 (27&29.008) — 23.3.2016. Accessed from: https://www.easa.europa.eu/sites/default/files/dfu/NPA%202016-01.pdf

EASA (2017). Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Annex III Organisation requirements for air operations [Part-ORO] of Commission Regulation (EU) 965/2012 on air operations. Consolidated version including Issue 2, Amendment 12. December 2017.

EASA, (2020). European Union Aviation Safety Agency, 2020 -ANNUAL SAFETY REVIEW 2020. Catalog number TO-AA-20-001-EN-N, Page 82. Accessed from: https://www.easa.europa.eu/sites/default/files/dfu/easa_asr_2020.pdf

EHEST, (2011). European Helicopter Safety Team, Component of ESSI, Training, and Testing of Emergency and Abnormal Procedures in Helicopters. Accessed from: https://www.easa.europa.eu/sites/default/files//dfu/EASA_EHEST_HE_11.pdf

(1971). A survey of Naval Aircraft Crash Environments with Emphasis on Structural Response. Report No. 1500-71-43. Dynamic Science. Phoenix, Arizona: Office of Naval Research, Arlington Virginia.

Hochmitz and Y. Gavish, (2011). Hochmitz, I., Yuviler-Gavish, N., 2011. Physical fidelity versus cognitive fidelity training in procedural skills acquisition. Human Factors 53 (5), 489–501. p.490.

Hytten, K., (1989). Karsten Hytten, "Helicopter crash in water: Effects of simulator escape training", Acta Psychiatrica Scandinavica Suppl. 355, 80, 1989, 73-78. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1111//j.1600-0447.1989.tb05256.x

Kaiser, M. K., & Schroeder, J. A. (2003). Flights of fancy: the art and science of flight simulation. In M. A. Vidulich, & P. S. Tsang (Eds.), Principles and practice of aviation psychology. Mahwah, NJ, US: Lawrence Erlbaum Associates, Publishers. pp. 435–471.

King et al, (2018) King TS, MacKinnon SN, Taber MJ How does load and impulse influence the success of jettisoning a simulated S-92 push-out window? International Journal of Industrial Ergonomics 68: 205–210. 2018.

Lillard JM., (1999). First at sea-the early shipborne helicopter. Rotor & Wing 1999; 33 (2): 74.

MSI- AAST&MT, (2020a). Maritime Safety Institute, Arab Academy for Science Technology & Maritime Transport. Official Page: Maritime Education & Training, HUET. Accessed on 12 Feb.2020, from: http://www.aast.edu/en/institutes/msi/contenttemp.php?page_id=6900256
MSI- AAST&MT, (2020b). Maritime Safety Institute, Arab Academy for Science Technology & Maritime Transport. Official Page: Maritime Education & Training, about us. Accessed on 26 Mar.2020, from:

Taber, M. (2014). Current Helicopter

http://www.aast.edu/en/institutes/msi/
contenttemp.php?page_id=6900005
Okstad, E., Jersin, E., and Tinmannsvik, R. K. (2012). Accident investigation in the Norwegian petroleum industry – Common features and future challenges. Safety Science, 50, 1408-1414.
OPITO, (2020a) Offshore Petroleum Industry Training Organization. Official website: About us, what we do. Accessed on 27th March 2020, from:
https://opito.com/about-us/what-we-do
OPITO (2020b) Offshore Petroleum Industry Training Organization. Official website: Standards/ Helicopter Underwater Escape Training (HUET) with Emergency Breathing System (EBS) 5095. Page 37. Retrieved on 27 March 2020, from:
https://downloads.opito.com/downloads/Standards
\ basic-emergency-
response/BOSIET_FOET_HUET with-EBS-
Revision-5-Amendment-9-January-
2020.pdf?mtime=20200513030643&focal=none
Stefanie et al., (2020). Stefanie Dawn Martina, Gal Ziv, Elizabeth Sanli and Heather Carnahan (February 3rd 2020). Simulation Fidelity and Skill Learning during Helicopter Egress Training: The Role of Vision, Accident Analysis and Prevention, Murat Darçın, IntechOpen, DOI: 10.5772/intechopen.90391. Available from:
https://www.intechopen.com/books/
accident-analysis-and-prevention/simulation-
Taber, M.J. and McCabe, J. (2005). An examination of survival rates based on external flotation devices: A helicopter ditching review from1971 to 2005. Paper Presented at the SAFE Symposium, Salt Lake City, Utah. March 2007Safe Journal 35(1):1-6. Retrieved on 8th August 2020, from:
https://www.researchgate.net/publication/2857616
An_examination_of_survival_rates_based_on_

Taber, M. (2010). Offshore Helicopter Safety Report 2010 (Exhibit/P-00239)- Prepared for the Offshore Helicopters Safety Inquiry- Canada, Newfound land and Labrador Offshore Petroleum Group. Retrieved on 16 April, 2020. From:
http://oshsi.nl.ca/userfiles/files/Exhibit%20P-
00216%

Underwater Egress Knowledge: Are We Prepared for The Next Ditching? Society of Petroleum Engineers. DOI:10.2118/170390-MS. Retrievedfrom:
https://www.onepetro.org/conference-paper
/SPE-170390-MS
Taber, (2016) Michael J. Taber, (2016) Use and implications of fidelity in helicopter underwater egress training, Handbook of Offshore Helicopter Transport Safety: Essentials of Underwater Egress and Survival. Published by Elsevier Ltd, 2016, Pages 125-150, ISBN 9781782421870. Retrieved from:
https://www.sciencedirect.com/science/article
/pii/B9781782421870000079#
TSBC, (2009a). The Transportation Safety Board of Canada (TSB): Aviation Investigation Report A09A0016, Main gearbox malfunction / Collision with water cougar Helicopters Inc. Sikorsky S-92a, C-Gzch St. John's, Newfoundland and Labrador, 35 NM E 12 March 2009. Retrieved from:
https://www.tsb.gc.ca/eng/rapports-reports
TSBC, (2009b). The Transportation Safety Board of Canada (TSB): Aviation Investigation Report A09A0016, Main gearbox malfunction / Collision with water cougar Helicopters Inc. Sikorsky s-92a, c-Gzch St. John's, Newfoundland and Labrador, 35 NM E 12 March 2009. Page 38-39 Retrieved from:
https://www.tsb.gc.ca/eng/rapports-reports
TSBC, (2015) The Transportation Safety Board of Canada (TSB): Collision with water. Government of Canada, Department of Transport, MBB BO 105 S CDN-BS-4 (Helicopter) C-GCFU, M'Clure Strait, Northwest Territories, 09 September 2013. Aviation Investigation Report A13H0002. Gatineau, Quebec: Transportation Safety Board.
UK AAIB (2016). The United Kingdom Air Accidents Investigation Branch. Aircraft

Accident Report 1/2016: Report on the accident to AS332 L2 Super Puma Helicopter, G-WNSB on Approach to Sumburgh Airport on 23 August 2013. Retrieved from:
https://assets.publishing.service.gov.uk/media/5

The Effect of New Technology on Permutation of Classification Societies Lay Out

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Abstract:

Classification societies have been playing an increasingly important role in the world maritime industry. Setting up technical standards regarding the seagoing traditional vessels hull and structure. Providing technical verification for the maritime autonomous surface ship (MASS) and other related technical services. Classification societies using the underwater vehicles as the remote operated vehicles from past decades and shortly thereafter, started to introduce drones in maritime ships inspection-survey or supervision. Recently, innovation of maritime industry exemplified in MASS technology needs new modern tools to handle the assignments and registration process for the ship interior or aerospace.

The aim of this research is to clarify the importance of generating technological and innovative instruments for the inspection-survey or the supervision process. The paper sheds light on the technological improvement process in the classification societies' inspection-surveys and supervision mechanism nowadays. Aiming to facilitate and upgrade new strategies which serve the upcoming maritime industry in the future. The concept of the classification's societies is based on reviewing of design and survey during and after ships construction and issuing the class certificate, in order to implement harmonized System of Survey and Certification (HSSC). Hence, the MASS technological features will require a new phase of survey and e-certificates. This research was based on a descriptive approach, as this methodology is the most capable of providing a comprehensive picture of the efficiency of the new technology.

Keywords: Classification Societies, Drones, Underwater Vehicles, Autonomous Ships, MASS, Remote survey.

1- Introduction

While the potentials remain unwritten for the upcoming reliable technological days, classification societies have been paying more attention to use modern technology for inspection-surveys or supervision of traditional vessels and MASS (Bratić et al., 2019). The near future will experience an ever-greater amount of trials or activities for involving the automation inside the maritime industry that will be operated by a divergent style of drones, underwater vehicles and autonomous vessels (Beaudet and Benoist, 2020, MSC, 2017). This research clarified the types of effective drones that can be used with the classification societies' experts and the upgrading of the underwater vehicles to meet the client requirements for the upcoming e-vessel technology (MSC, 2017, Carrara and Grasso, 2020, Newell and Gayathry, 2020). As well as lighting the responsibility to develop some unique criteria to Aerial Drones and Inaccessible Area Drones inspections and surveys for traditional vessels nowadays (Xia et al., 2019). That to be ready for the different MASS levels and to comply with the hull and structures during a remote analysis.

Just to name few, classification societies born to be between Det Norske Veritas-Norway merging with Germanischer Lloyd-Germany, Bureau Veritas (BV) and others on behalf of the International Association of Classification Societies (IACS). A field of development to the drone's applications of performing the ship inspection-surveys or supervision, that is particularly suited by Inaccessible Areas Drones – Survey (IAD) and Aerial Drones-Survey for the outer structure (Butcher et al., 2020, Andersen et al., 2020).

Confidence of flag states and the owner-operator companies of the vessels, to operate with remote surveys procedures are vital for the drone technology innovation and facilitation. To do such work, they can use two diverse approaches. The first is called 'See Remotely' and the second is called 'Decide remotely'. Both allow conducting onboard analysis with remote surveys, without any physical access by the surveyor (Andersen et al., 2020).

Furthermore, the call of a classification of merchant ships, boils down to insurance. Hull insurance companies require that a ship subscribes to one of the members of IACS. However, there are also some reasons for a classification, which are based on the fulfillment of the flag state safety requirements. A company may also want to have her ship holds a Cargo Ship Safety Construction Certificate to comply with SOLAS Rule I/12 for a classified vessel. The main objective for this certificate is classify the vessel from a well-known classification society that is recognized by the flag State (Lagoni, 2007).

Current researches are achieving many experimental studies to clarify the initial reliable aspects for the autonomous and remotely controlled ships on a marine market. For that reason, the level of automation, means of regulation, legislative scope and new technological drones for on scene inspection-surveys need to be appropriately classified. International Maritime Organization (IMO) has clarified the main reasons of this new era of technology, which led the maritime industries to obtain safe shipping and environmentally acceptable circumstances for all maritime parties. According to the IMO in 2018, it began to explore the introduction of autonomous ships (Chaal et al., 2020). Also as announced by IMO, research will be managed through regulatory scoping exercise, topped by the challenges of the MASS (Chae et al., 2020, Pribyl, 2018). These instinctive, challenging predictable environment for the drones' inspection-surveys, indicate many promises to take place on the upcoming days, which reflect the need to categorize new autonomy level inside the maritime industry. Figure (1) shows the autonomous maritime systems and autonomous ship types to be in harmony with the IMO autonomous vessel or MASS, which is defined and divided as: "A ship which to have a varying degree that can operate independently without human interaction (MSC, 2017).

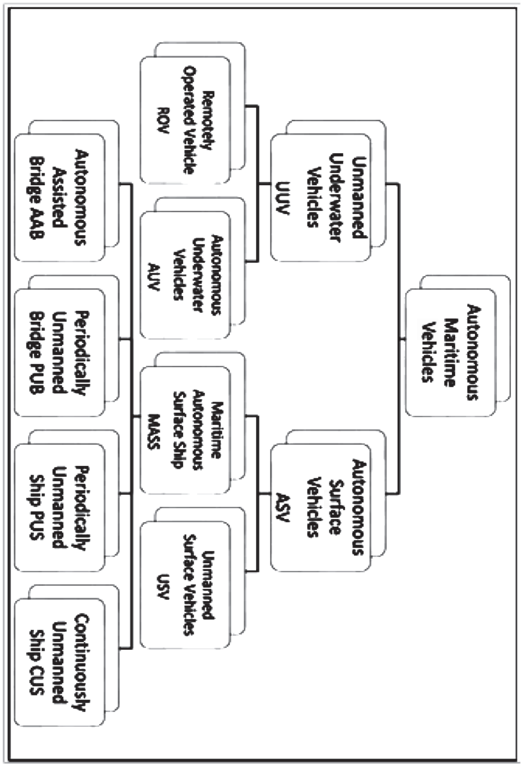

Figure (1): The autonomous maritime systems and autonomous ship types MSC, 2017

"Autonomy Assisted Bridge (AAB) /continuously manned bridge: The ship has a crew on board and they can immediately intervene in ongoing functions. Periodically Unmanned Bridge (PUB): No crew in bridge for limited periods, e.g. in open sea and good weather. Crew can take the command in case of problems. Periodically Unmanned Ship (PUS): No crew on board for extended periods, e.g. sea passage. A crew can board the ship through the port approach phase. Continuously Unmanned Ship (CUS): The ship is designed for unmanned operation of the bridge at all times, except the emergencies".

2. Literature Review

Due to the circumstances facing the maritime industry since the breakout of "Covid-19" pandemic, there are more challenges to depend on the new technologies. These involve, but are not limited to, DNV-Gl as it is one of the main IACS members, which support the maritime industry to conduct the drone and the underwater remote survey. Such inspections or surveys start from the initial mandatory surveys at the manufactory or the shipyards in order to help the maritime industry in this critical phase by providing alternative solutions to guarantee the endurance of operations while helping to shrink the effects of the pandemic (Rowan and Galanakis, 2020, Felski and Zwolak, 2020). The DNV-GL announced that they were already proceeding with the digital transformation surveys with drones in 2016 and since 2017 for the offshore (Poggi et al., 2020). A little step ahead, Lloyd's Register (LR) issued an assessment standard for the use of the remote inspection-survey methods, that indicates the required performance (Poggi et al., 2020).

The new classification societies approach toward renovation, emerged the need of technological inspection-survey or supervision phases (Gonçalves et al., 2016, Wen et al., 2018). Drone - Remotely Piloted Logics (D-RPL) and the underwater vehicles have gained attention in the last couple of years, being able to reduce the required man-power effort and fatigue in the maritime industry, as well as the associated cost (Nier et al., 2020). With a focused spot on drones, being small in size facilitates its maneuver, ability to enter confined spaces (Wen et al., 2018), adaptation to thermal exposure, as well as the possibility to carry compact thermos and laser scanning cameras (Liu and Cho, 2019, Jiménez López and Mulero-Pázmány, 2019).

Bureau Veritas (BV) started its progress of using the remote surveys since 2012 with some constrains. Recently, new technological benefits extend the scope of quality, connectivity, accelerating different activities and wider global developments (Poggi et al., 2020). A reporting from France-headquartered of BV March 2020 stated that it successfully fulfilled its initial equipped drone-assisted survey inside an unspecified Italian interior water for a bulk carrier. Bureau Veritas stated that close-up inspection of the hull structure was a very critical approach to have the clear-ground to comply the safety standards. Hence, implementing an independent programme of investigations and immunity, confirming that the drones relevant survey technologies are currently sufficient to permit remote surveys as the underwater vehicles. Itemizing these drone surveys enhance the livestreaming expansion and numerous linked devices for example Go-Pro cameras, tablets, smart glasses, smart phones and augmented reality (Kaminski and Rigo, 2018).

The flying of thousands of laser pulses every second from the systems onboard the unmanned drone, received by a huge number of collected expertise duly authorized from different maritime supply chain parties for scheduled subsequent analysis. The validity of the detected pulses may referee to a sensor system (Fumian et al., 2020, Parracino et al., 2016). These sensor system data succeed to outline some unique capabilities for vision, that can actually get sharp points in the inspection (Jiménez López and Mulero-Pázmány, 2019).

Increasingly sensor systems became a common remote technology used for analytics and archaeologists surveys (Canuto et al., 2018, Jiménez López and Mulero-Pázmány, 2019). The role of sensors shows a vital key factor for maritime autonomy, where MASS need these essentials while navigating or docking. Sensor systems provide the vessels by accurate coordinates and data awareness during the whole day long and night extended in all fluctuating weather conditions which will be an opportunity for the e-vessel scenarios (Han et al., 2020). Therefore, it has its own lighting equipment, with no need for unique lighting inside the room or the inaccessible spaces to be inspected (Butcher et al., 2020).

The D-RPL advances the safety and free the vulnerability of the hazard operations, a fact attributed to on scene assessment. Efficiently lowering the inspection unnecessariness, observing indispensable natural on scene resolution for experts (Rodríguez et al., 2012), enables creativity for the task being surveyed with new functionality for the process of the decision making. Suitable D-RPL platform provides appropriate diversion for their shapes, heights and sizes. Wings allow the D-RPL to aerial hang up in the air and also support the vision stability and accuracy for the experts at shore side (Liu and Cho, 2019). Lightweight remote optics onboard the D-RPL involves multipart trade-offs with design and hardware simulations for the purpose of the realistic marine scenarios exploration as the dependable underwater vehicles (O'Shea and Laney, 2020).

Worth to be stated is the European Union (EU) sponsored combined research project for example the INCASS (Inspection Capabilities-for Enhanced Ship-Safety) and MINOAS (Marine Inspection -Robotic Assistant System), involving classification societies, several stakeholders, service suppliers, ship-owners along with system developers (Poggi et al., 2020).

As shown in Table (1), the classification of drone - by range and duration, highlights the different categories of drones from light to heavy weight starting with Micro drones to reach altitude of approximately 300 ft. during one hour to reach a distance up to 5 km in range. On the other hand, up till now the heaviest inspection drone named Hale drone of weight less than 3 km reaches altitude of approximately 30.000 ft. and up to 1000 km range in more than 24 hr. (Emad, 2018).

Table (1): Classification of Drone - by range and duration

Category	Weight (kg)	Altitude (ft.)	duration (hr.)	Range (km)
Micro drone	Less: 1	≈: 300	1	up to 5
Mini drone	Less: 25	Less:10.000	1 : 6	up to 25
Close range drone	Less: 200	Less:15.000	4 : 8	up to 75
Small range drone	Less: 750	Less:25.000	8 : 24	up to 200
Male drone	Less: 1.000	Less:30.000	Above 24	up to 1000
Male + drone	Less: 3.000	Less:30.000	Above 24	up to 1000
Hale drone	Less: 3.000	Less:45.000	Above 24	up to 1000

Emad, (2018)

Table (2) focuses on the different types of drones by maximum weightlifting onboard with the optimum working range and duration. Type 1 can load onboard up to 25 kg with a working radius up to 10 NM with an altitude 1000 ft. Type 2 and Type 3 will have some higher characteristics than type 1. But Type 4 is the top of them which holds onboard more than 2000 kg with a working radius reaching above 500 NM with the highest altitude reaching above 3000 ft (Emad, 2018).

Table (2): Types of Drone by maximum weightlifting

Autonomous Drone - Remotely Piloted Logics	Max – load (kg)	Working radius (NM)	Altitude (ft.)
Type 1	Less: 25	Up to 10	1000
Type 2	25 : 500	10 : 100	15000
Type 3	500 : 2000	100 : 500	30000
Type 4	Above 2000	Above 500	Above 30000

Emad, (2018)

The overview of the traditional inspections and surveys in nowadays practices are considered to be in a critical comparison with the new drones' technics and the underwater vehicles inspections or surveys. To the aim of safe inspections and surveys it is important to consider the scope of the classification society contribution for the drones' opportunity. Compared to the depending use for the underwater vehicles, Aerial Drones and Inaccessible Area Drones inspection-surveys or supervision, have not yet concentrated on unique criteria for traditional vessel and MASS for the hull and structures (Poggi et al., 2020).

3. The Role of Classification Societies for Autonomous Ships

The IMO has already started to identify the safety, security, and environmental aspects of MASS operations in line with the existing IMO standards (Bratić et al., 2019). In parallel the IACS new era of drone inspection-surveys along with the use of today's traditional inspection-surveys experiences, will conduct the new performance scenarios for the inspection-survey activities to cope with MASS, and the need of additional level of technical requirements to raise (Bratić et al., 2019). According to IACS aim to participate to this subject by a readiness conscious for designing the requirements and processes that should be included in the strategic action plan, which should focus on :

A. Validation and approval of new technologies would be one of the critical steps, as when new sources of power (fuels) and related technologies are expanded, the responsibilities of the classification societies are to ensure that the new regulations are consistently applied globally.

B. Risk based inspection and new survey with increase in automation connectivity, data can be accessed in real time. All these can be used as condition-based survey and certain remote surveys

C. The survey looks to be remotely in the future due to aimed reduction of costs and accidents.

D. Drones Data Analytics (DDA), reflect the use of data that will be more important. Monitoring and surveys by the DDA are to be used as a recorded evidence for any future discussion or client claims.

E. E-Certification and Cyber security awareness for the DDA, will be based on the level of MASS and the inspection– survey requirements.

According to Bratić et al., (2019) transferring from convention ships having personnel's onboard to the MASS, will have a gradual rising development trend in many different related classification societies' activities. Imagination is hardly to expect that fully autonomous vessels and autonomous drones will lead the seaborne trade operation commence in the upcoming recent years respectively.

4. Drones can Fulfill the Classification Societies Inspection-Survey Requirements

Drones may possibly assist the classification societies requirements for their clients' needs and cut of the budgets for planned or unplanned maintenance by immobilization reduction at yards or ports. Performing the inspection or the survey for the hull or the structure corrosion levels, offers the prospective of improved quality evidence for the surveyor's decision (Liu and Cho, 2019). One of the main pros of the drone-assessed inspections, according to the BV, is that the drone inspection will take shorter intervals to inspect the hull or the structure from a different close-up points. Compared with drones, the duration consumed by the tradition inspection for those entailed to use the ultrasonic thickness for the vessels hull and structure is longer (Kaminski and Rigo, 2018).

With the advancement of the shipbuilding industry and innovation in the safe operation of MASS that leads the classification societies, they seek to use modern means in preventing marine pollution, safe inspection-survey procedures, preventing marine accidents and eliminates the unnecessary costs for their clients.

This technology revolution has observed the marine climate change to all marine institutions to put in place a new mechanism from the classification societies and to deal with its objectives in the near future, especially those e-vessels in seaborne trade (Chang et al., 2020). Classification societies are the cornerstone of the rest of the maritime institutions, their role for survey and inspection is performed before and after the construction of the vessel. IACS updated and upgraded their mechanisms with different trials depending on the types of the drones to deal with such traditional vessels and the e-vessels, with their consideration to issue their own e-certificates or the hardcopy one.

What is more challenging were the unreachable outer places for the vessels and also for the considered e-vessel, as well as, the unsafe enclosed spaces which emit toxic gases and also the narrow space ventilators inspections-survey. This era of drones, may not require the surveyors to expose these risky parts or spaces which will raise the role of the aerial drone - remotely piloted logics survey and the inaccessible drone's surveys. Drones manufacturers are continuously developing and improving the drone technology capacity to enhance its performance for a sustainable support to the classification society's surveyors and expertise discussions and dissensions to generate the appropriate decision (Xia et al., 2019, Wen et al., 2019).

Nowadays the drones are ready eligible to do the survey on an operative basis. Eliminating the time consumption for scaffolding construction up and down on each side/part to be inspected by the traditional ultrasonic inspection-survey procedures, to obtain dependable data to support the surveyor decisions (Al-Jabr, 2020). Subsequently, these reductions will also reflect on saving the required time for the preparation to conduct a single survey for a particular location onboard. Theses piloted drones estimates that the ultrasonic inspection process are effective and is still in the development route (Bonnin-Pascual and Ortiz, 2019). On the other hand, drones advances safety to the surveyor's environment, by saving their efforts and eliminating hazards from climbing up or getting off from the scaffolding, while holding equipment (Carrara and Grasso, 2020). Hence, the surveyors are no longer exposed to risks of working at hard reachable areas or heights. Correspondingly the BV drones calls to conduct the term "the minimization of conditions for working" (Felski and Zwolak, 2020).

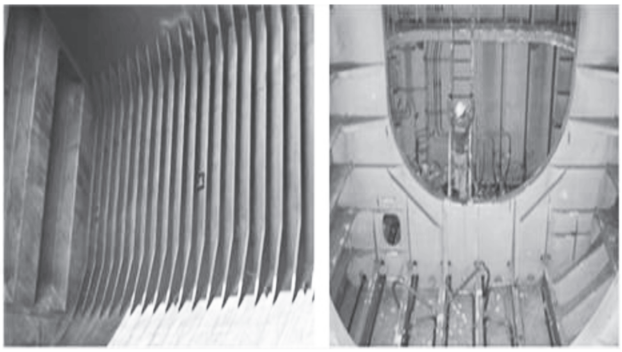

Figure 2 – Working conditions for a traditional Marine vessel inspection-survey Poggi et al., (2020).

Bureau Veritas real progress in advancing its Digital Classification vision, that drones survey components can be customized upon the diversity requirements from several types of traditional vessels and MASS (Kinsey and Olsen, 2020), regardless the owner company or flag state level from digital transformation journey. Furthermore, BV announced for the latest opening for her Primary Remote Survey Center (PRSC) in Rotterdam its new facilities that will empower the applicable surveys for objects, containing classification inspection-surveys and detailed statutory notes as settled by flag administration. This will be provided and endorsed remotely. It will also be implemented as an independent programme of investigation and immunity, confirming that the drone's relevant inspection-surveys technologies are currently sufficient to permit remote surveys. Itemizing these drones' inspection-surveys, enhances the livestreaming expansion and numerous other linked devices for example Go-Pro cameras, tablets, smart glasses, smart phones and augmented reality. In relation to BV linkage to RECOMMS, the development of a capable drones especially for the vessels enclosed steel structures has emerged (Poggi et al., 2020). Their main objectives from the joint, are to improve a steady, constant and reliable drone for following programmable aerospace routes for the inside or outside inspection-surveys for the traditional vessels or the MASS either planned by 3D imagery or piloted.

4.1. Inaccessible Areas Drones – Survey (IAD)

Vessel tanks are usually known as one of the places that are inaccessible compared with different spaces onboard. Each of these tanks must comply with the safety regular survey, accomplished by rope entree team. Moreover, these experts encounter a reduced narrow sight, moisture, flammable gases, heat vulnerability and dust (Subchan, 2019). Therefore, it is a hard challenge to design the inaccessible area drones with the same concept of the aerial drones, but an eligible tool with different characteristics that allow confront of effective operation inward the enclosed spaces is needed (Shahmoradi et al., 2020). New era of alternative procedures using a remote piloted drone for the inspection and survey will save time, effort, fatigue threads and cost. These modern IAD are established on a designed parameters to be flexible, captive all around or uncaged (Gonzalez-Aguilera and Rodriguez-Gonzalvez, 2017). Optimizing the drone operations with a number of multi rotor motors to allow the tiny maneuvers inward the tanks, as well as equipped by sensors, navigation tools, lasers scanners and cameras, is a required approach (Rakha and Gorodetsky, 2018, Segui-Gasco et al., 2014). The IAD facilitates the on-scene survey for mapping different compartments according to the ship general arrangement diagram. Figure (3) below is showing a scheme of imaging from 1 to 3 inside an inaccessible area that was inspected remotely by a group of expertise (Emad, 2018). The IAD sensor system obtained a picture of a crack, resulting after a clear ground inspection-survey, indicated from the kit's onboard the drone (Pereira and Pereira, 2015, Emad, 2018). These kind of findings reveal the need for the investing developing of new technological assistance for the decision makers (Poggi et al., 2020)

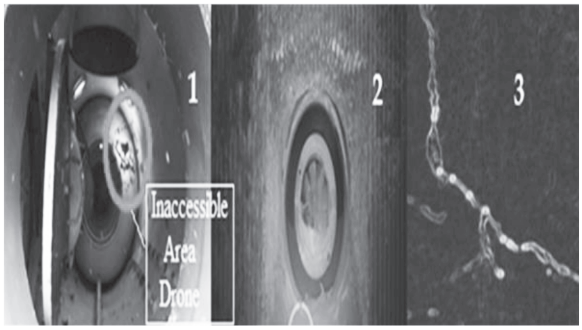

Figure (3): Successful inspection by inaccessible area drone

Emad, 2018, Poggi et al., (2020)

4.2. Aerial Drones – Survey

Aerial Drones or Unmanned Aerial Vehicles (UAVs) have flatter an effective instrument for various civilian tenders as a close-up visual outer inspection-survey, following players at sport stadiums, and mapping (Sirmacek et al., 2019). Aerial drones or UAVs can be used in an active contact-based inspection for the out surrounding and aerial maintenance (Pu et al., 2019). The precision of innovative solution aerial drones-based inspection-survey, were equated to the nowadays traditional merchant vessels-based inspections or surveys of active participation at different locations all around the vessel. Although aerial drones-based inspection-survey had greater initial technique, they will be observed more and more with MASS (Sirmacek et al., 2019). According to a variety of adopted regulations by IMO related to vessel emissions during the active operations, which they are accountable for almost 10–15% of anthropogenic Sulphur oxides (SOx) releases worldwide. Most of these releases are coming from deeply populated coastal zones for currently traditional vessels (Shen et al., 2020). One of the most recent utilizations of areal drones, were planned to inspect, survey or supervise the vessel emissions in a voyage from location to another in a specific area for a separate vessel or the passage of vessels from located drones. Drones can act as one of the enforcement tool of control, complying with the International Convention for the Prevention of Pollution from Ships (MARPOL, Annex VI - Air Pollution) (Xia et al., 2019, Van Roy-

MUMM). Figure (4) is showing these types of technological intervention by aerial drones for the inspection-survey or the supervision of the unlawful acts against the environment. The use of a changeable stations for the aerial drones, allows flexibility to reassign the responsibility to another drone cover specified sectors respectively and with adoption to an overlap process. Also aerial drone can begin and terminate an inspection-survey or a supervisory exploration from the initial station or other different stations. The program of any aerial drone principally entails three operations:

A. Emission inspection-surveys or the supervision for one vessel

B. Emission inspection-surveys or the supervision for two adjacent vessels

C. Battery substitution time

These types of inspection-surveys or supervision, motivated by the classification societies, marine supply chain parties topped by ship-owners to pay attention for the wider use of aerial drones as monitoring vessels (Xia et al., 2019). Furthermore, the data collected by the drones will be sent immediately to the classification society analysis experts to develop the appropriate decision remotely. MASS contribution to the maritime industry will help to develop the emission detection technology inspection-survey upon its automation level and the advanced energy sources.

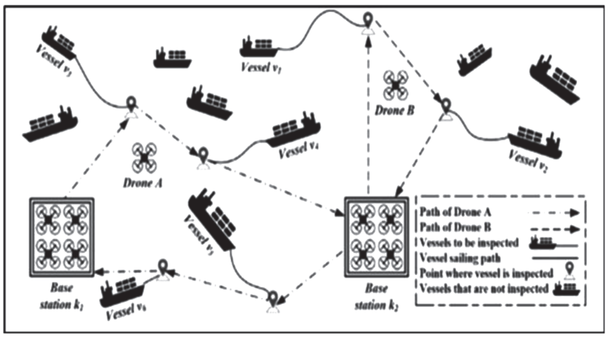

Figure (4): A diagram for a probable inspection-survey locations for the vessel emissions Xia et al., (2019).

5. Remote Operated Vehicles (ROV)

In the previous decades, operations done at sea were demanding and costly (Simetti, 2020). For those reasons, the era for the marine ROVs had observed significant development, which was motivated by the deep need to know, inspect and survey under the waterline by the classification societies, considering human health (Al Makdah et al., 2019). Humans of different age and genders have been adapted to work under the sea level, whatever below these line from vulnerabilities on their lives but unfortunately the assigned job must be accomplished (Tetzlaff and Thomas, 2017).

Reactively the development process for the ROV technology worked in that field. Practice to solve, innovate and decrease the hazards, to reach a downward trend for the health vulnerability for the expert divers or the surveyors has taken place .

That demand on the ROVs, initiated the upgrading to the automation working level, to enrich the data collection by limiting hazards during the inspection-survey or the supervision for the decision making and also for the scientific records beneath the waterline (Sun et al., 2013, Al Makdah et al., 2019). Manned underwater tubes or vehicles were a good step for the initiation of the remotely controlled vehicles (Tegel and Wenzel, 1991). A developed ROVs with a high level of automation are the nowadays trend of solving any problem beneath the waterline of the vessels. These problems can be solved by the classification societies experts by an underwater close-up approaches or remotely from the shore (Rust and Asada, 2011). These types of inspection-surveys will be renovated to work autonomously without the contribution of the human to be physically on scene. An overall raised response by the classification societies to exploit the Autonomous Underwater Vehicles inspection-surveys, is a new era of the MASS .

The ROVs or the renovated Autonomous Underwater Vehicles performance and controllers will be acquired by means of various practices for the design, according to the classification societies requirements. Classification societies autonomously will evaluate the handled operation or the scheduled inspection-survey or supervision under the vessels waterline (Schjølberg and Utne, 2015). Currently the ROVs or Autonomous Underwater Vehicles development, are considered to be a unique controller designed to reject the disturbance and noise including the fluctuating pressure under the waterline. Enhancing the results and reflecting an advanced level for the upcoming MASS planned or unplanned inspection-surveys (Valentinis et al., 2015).

The typical missions performed at offshore marine industry, expect the use of ROVs and a level –up to an Autonomous Underwater Vehicles, arranged and served from surface platform above the waterline (Simetti, 2020). ROVs are a dependent system, relay on the performance and experience of the crew, which consists of at least an operator, a navigator, an intendent and the surveyor, who do a multiple shifting to accomplish the task within a full time. However, the operator primarily handles all the maneuvers and procedures for the inspection-survey (Schjølberg and Utne, 2015, McMurtrie, 2010). The level –up to an Autonomous Underwater Vehicles will use less effort and less exposure to hazards and vulnerabilities and can also support the classification society's experts for a shore-decision making.

Conclusion

To sum up, one of the most important institutions affected by new e-vessels are the classification societies. Traditional vessels have their own inspection-survey technicalities which will not be found in the e-vessel - MASS. Due to the pandemic subsequences on maritime industry, the classification society experts, will choose the alternative technological methods either remotely from any place worldwide as the PRSC or remotely on scene for their decisions upon the drones, renovated ROVs or a new era of Autonomous Underwater Vehicles inspection-surveys or supervision. As the market is hardly pushing to introduce aided inspections-survey for an autonomous procedure, most of the interested maritime parties are actively operating to follow a new technological approach. All of them agreed on the fact that technology is ready and promising, but to be successfully applicable in the shipping field, the information gained by machines should be at least at the same quality level as that normally obtained by a human surveyor. Moreover, the assessment and certification of the achieved results are demanded to the surveyor decision.

As shown in Figure (5) classification surveys scope the possibility of using different types of drones, ROVs and different automation levels for an Autonomous Underwater Vehicles, taking advantage of each type in the implementation of the tasks by the classification societies in the inspection-survey or supervision for the traditional vessels or the e-vessels from the inside or outside hull and enclosed places.

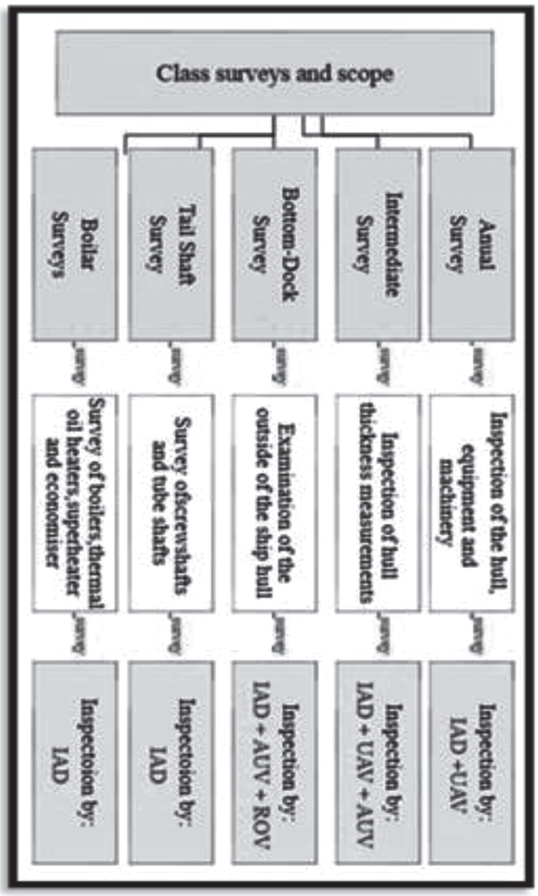

Figure (5): Classification society's scope and instruments

Poggi, et al., (2020)

Hence, the industry is expecting from the classification societies a complete restoration to deal with the safety and environmental concerns. The classification societies have to take proactive role and be facilitator by:

A. Providing guidelines in dealing with new subjects and regulations.

B. Conducting training and seminars to bring awareness.

C. Developing rules and procedures to deal with the changes required.
D. Developing necessary application using available technology software.
E. Providing good internet connectivity to the vessels and the e-vessels is also essential for smooth conduction of inspection-surveys or supervision.
F. Training surveyors to be accustomed to the use of drones, ROVs, Autonomous Underwater Vehicles, remote monitoring tools, webcam and audio equipment.
G. Producing IMO legislation for the upcoming new era of inspection-surveys and supervision instruments.
Finally, the gap between the use of innovative technology in the maritime industry and the regulatory point of view of the classification society's inspection-surveys has to be bridged.

References:

AL-JABR, S. A. 2020. Incorporate wall thickness measurement sensor technology into aerial visual inspection intrinsically safe drones. Google Patents.

AL MAKDAH, A. A. R., DAHER, N., ASMAR, D. & SHAMMAS, E. 2019. Three-dimensional trajectory tracking of a hybrid autonomous underwater vehicle in the presence of underwater current. Ocean Engineering, 185, 115-132.

ANDERSEN, R. H., NALPANTIDIS, L., RAVN, O. & BOUKAS, E. Year. Investigating Deep Learning Architectures towards Autonomous Inspection for Marine Classification. In: IEEE International Symposium on Safety, Security, and Rescue Robotics, 2020. IEEE.

BEAUDET, E. & BENOIST, A. 2020. Ship provided with an installation for launching and recovering vehicles. Google Patents.

BONNIN-PASCUAL, F. & ORTIZ, A. 2019. On the use of robots and vision technologies for the inspection of vessels: A survey on recent advances. Ocean Engineering, 190, 106420.

BRATIĆ, K., PAVIĆ, I., VUKŠA, S. & STAZIĆ, L. 2019. A Review of Autonomous and Remotely Controlled Ships in Maritime Sector. Transactions on maritime science, 8, 253-265.

BUTCHER, P. A., PIDDOCKE, T. P., COLEFAX, A. P., HOADE, B., PEDDEMORS, V. M., BORG, L. & CULLIS, B. R. 2020. Beach safety: can drones provide a platform for sighting sharks? Wildlife Research, 46, 701-712.

CANUTO, M. A., ESTRADA-BELLI, F., GARRISON, T. G., HOUSTON, S. D., ACUÑA, M. J., KOVÁČ, M., MARKEN, D., NONDÉDÉO, P., AULD-THOMAS, L. & CASTANET, C. 2018. Ancient lowland Maya complexity as revealed by airborne laser scanning of northern Guatemala. Science, 361.

CARRARA, E. & GRASSO, A. Year. Robotics Technology for Inspection of Ships. In: 2020 25th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA), 2020. IEEE, 1526-1533.

CHAAL, M., BANDA, O. A. V., GLOMSRUD, J. A., BASNET, S., HIRDARIS, S. & KUJALA, P. 2020. A framework to model the STPA hierarchical control structure of an autonomous ship. Safety Science, 132, 104939.

CHAE, C.-J., KIM, M. & KIM, H.-J. 2020. A Study on Identification of Development Status of MASS Technologies and Directions of Improvement. Applied Sciences, 10, 4564.

CHANG, C.-H., KONTOVAS, C., YU, Q. & YANG, Z. 2020. Risk assessment of the operations of maritime autonomous surface ships. Reliability Engineering & System Safety, 107324.

EMAD, B. 2018. Operational scenarios that implement Industry 4.0 by utilizing UAVs. Hochschule für angewandte Wissenschaften Hamburg.

FELSKI, A. & ZWOLAK, K. 2020. The ocean-going autonomous ship—Challenges and threats. Journal of Marine Science and Engineering, 8, 41.

FUMIAN, F., DI GIOVANNI, D., MARTELLUCCI, L., ROSSI, R. & GAUDIO, P. 2020. Application of Miniaturized Sensors to Unmanned Aerial Systems, A New Pathway for the Survey of Polluted Areas: Preliminary Results. Atmosphere, 11, 471.

GONÇALVES, J., HENRIQUES, R., ALVES, P., SOUSA-SILVA, R., MONTEIRO, A. T., LOMBA, Â., MARCOS, B. & HONRADO, J. 2016. Evaluating an unmanned aerial vehicle-based approach for assessing habitat extent and condition in fine-scale early successional mountain mosaics. Applied Vegetation Science, 19, 132-146.

GONZALEZ-AGUILERA, D. & RODRIGUEZ-GONZALVEZ, P. 2017. Drones—An Open Access Journal. Drones, 1, 1.

HAN, J., CHO, Y., KIM, J., KIM, J., SON, N. S. & KIM, S. Y. 2020. Autonomous collision detection and avoidance for ARAGON USV: Development and field tests. Journal of Field Robotics.

JIMÉNEZ LÓPEZ, J. & MULERO-PÁZMÁNY, M. 2019. Drones for conservation in protected areas: present and future. Drones, 3, 10.

KAMINSKI, M. & RIGO, P. 2018. 20th International Ship and Offshore Structures Congress.

KINSEY, C. & OLSEN, H. 2020. Remote Warfare and the Utility of Military and Security Contractors. International Relations, 10.

LAGONI, N. I. 2007. The liability of classification societies, Springer Science & Business Media.

LEE, Y.-G., BAE, J.-C. & OCK, Y.-S. 2020. Study on technical issues related to the introduction of maritime autonomous surface ship. 한국마린엔지니어링학회지, 44, 250-257.

LIU, F.-W. & CHO, S. K. Year. 3-D Micro Swimming Drone with Maneuverability. In: 2019 IEEE 32nd International Conference on Micro Electro Mechanical Systems (MEMS), 2019. IEEE, 10-13.

MCMURTRIE, A. Year. The efficiencies of low logistics man-portable AUVs for shallow water surveying. In: Oceanology International, 2010. 110-116.

MSC, I. 2017. Maritime Autonomous Surface Ships Proposal for a regulatory scoping exercise. MSC 98/20/2, Feb.

NEWELL, T. & GAYATHRY, H. Year. An Autonomous Underwater Vehicle with Remote Piloting Using 4G Technology. In: Offshore Technology Conference Asia, 2020. Offshore Technology Conference.

NIER, R. D. J., NORIDA WAHAB, S. & DAUD, D. 2020. A Qualitative Case Study on the Use of Drone Technology for Stock Take Activity in a Third-Party Logistics Firm in Malaysia. MS&E, 780, 062014.

O'SHEA, R. E. & LANEY, S. R. 2020. Simulation framework for evaluating lightweight spectral cameras in drone-based aquatic sensing applications. Applied Optics, 59, C52-C62.

PARRACINO, S., RICHETTA, M., GELFUSA, M., MALIZIA, A., BELLECCI, C., DE LEO, L., PERRIMEZZI, C., FIN, A., FORIN, M. & GIAPPICUCCI, F. 2016. Real-time vehicle emissions monitoring using a compact LiDAR system and conventional instruments: first results of an experimental campaign in a suburban area in southern Italy. Optical Engineering, 55, 103107.

PEREIRA, F. C. & PEREIRA, C. E. 2015. Embedded image processing systems for automatic recognition of cracks using UAVs. IFAC-PapersOnLine, 48, 16-21.

POGGI, L., GAGGERO, T., GAIOTTI, M., RAVINA, E. & RIZZO, C. M. 2020. Recent developments in remote inspections of ship structures. International Journal of Naval Architecture and Ocean Engineering, 12, 881-891.

PRIBYL, S. T. 2018. Advanced Automation in Shipping Takes Center Stage at IMO. RAIL, 1, 381.

PU, S., XIE, L., JI, M., ZHAO, Y., LIU, W., WANG, L., YANG, F. & QIU, D. 2019. Real-time powerline corridor inspection by edge computing of UAV Lidar data. Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci, 4213, 547-551.

RAKHA, T. & GORODETSKY, A. 2018. Review of Unmanned Aerial System (UAS) applications in the built environment: Towards automated building inspection procedures using drones. Automation in Construction, 93, 252-264.

RODRÍGUEZ, A., NEGRO, J. J., MULERO, M., RODRÍGUEZ, C., HERNÁNDEZ-PLIEGO, J. & BUSTAMANTE, J. 2012. The eye in the sky: combined use of unmanned aerial systems and GPS data loggers for ecological research and conservation of small birds. PLoS One, 7, e50336.

ROWAN, N. J. & GALANAKIS, C. M. 2020. Unlocking challenges and opportunities presented by COVID-19 pandemic for cross-cutting disruption in agri-food and green deal innovations: Quo Vadis? Science of the Total Environment, 141362.

RUST, I. C. & ASADA, H. H. Year. The eyeball ROV: Design and control of a spherical underwater vehicle steered by an internal eccentric mass. In: 2011 IEEE International Conference on Robotics and Automation, 2011. IEEE, 5855-5862.

SCHJØLBERG, I. & UTNE, I. B. 2015. Towards autonomy in ROV operations. IFAC-PapersOnLine, 48, 183-188.

SEGUI-GASCO, P., AL-RIHANI, Y., SHIN, H.-S. & SAVVARIS, A. 2014. A novel actuation concept for a multi rotor UAV. Journal of Intelligent & Robotic Systems, 74, 173-191.

SHAHMORADI, J., ROGHANCHI, P. & HASSANALIAN, M. 2020. Drones in Underground Mines: Challenges and Applications.

SHEN, L., WANG, Y., LIU, K., YANG, Z., SHI, X., YANG, X. & JING, K. 2020. Synergistic path planning of multi-UAVs for air pollution detection of ships in ports. Transportation Research Part E: Logistics and Transportation Review, 144, 102128.

SIMETTI, E. 2020. Autonomous Underwater Intervention. Current Robotics Reports, 1-6.

SIRMACEK, B., RASHAD, R. & RADL, P. 2019. Autonomous UAV-based 3D-reconstruction of structures for aerial physical interaction. Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci, 601-605.

SUBCHAN, M. 2019. FSO Cargo Tank Inspection with Drone, a Lesson Learned for Future Implementation.

SUN, B., ZHU, D. & YANG, S. X. 2013. A bioinspired filtered backstepping tracking control of 7000-m manned submarine vehicle. IEEE Transactions on Industrial Electronics, 61, 3682-3693.

TEGEL, M. & WENZEL, D. 1991. Unmanned submarine for air rocket. Google Patents.

TETZLAFF, K. & THOMAS, P. S. 2017. Short- and long-term effects of diving on pulmonary function. European Respiratory Review, 26.

VALENTINIS, F., DONAIRE, A. & PEREZ, T. 2015. Energy-based motion control of a slender hull unmanned underwater vehicle. Ocean Engineering, 104, 604-616.

VAN ROY-MUMM, W. Best Practices Airborne MARPOL Annex VI Monitoring.

WEN, F., PRAY, J., MCSWEENEY, K. & GU, H. Year. Emerging Inspection Technologies–Enabling Remote Surveys/Inspections. In: Offshore Technology Conference, 2019. Offshore Technology Conference.

WEN, F., WOLLING, J., MCSWEENEY, K. & GU, H. Year. Unmanned Aerial Vehicles for Survey of Marine and Offshore Structures: A Classification Organization's Viewpoint and Experience. In: Offshore Technology Conference, 2018. Offshore Technology Conference.

XIA, J., WANG, K. & WANG, S. 2019. Drone scheduling to monitor vessels in emission control areas. Transportation Research Part B: Methodological, 119, 174-196.

- يتم إخطار الباحث بخطاب مُعتمد بإجازة نشر البحث وذلك بعد تسديد تكاليف النشر.

الجمعية العربية للملاحة

تأسست عام 1978 وشُهّرت برقم 667/ 69 وانضمت لعضوية الإتحاد الدولى لجمعيات الملاحة فى 1980

أهداف وأنشطة الجمعية

- إقامة مجتمع ملاحى يضم كل من له إهتمامات بعلوم الملاحة ودعم البحوث العلمية فى مجال الملاحة.
- متابعة أحدث التطورات فى مجال الملاحة والعلوم المرتبطة بها.
- عقد المحاضرات وتنظيم الزيارات والرحلات العلمية والندوات والمعارض وعقد المؤتمرات المحلية والدولية داخل مصر وخارجها.
- إصدار النشرة الإخبارية الربع سنوية "الملاح" والمجلة النصف سنوية فى يناير ويوليو من كل عام.

العضوية

العضو العامل

للعضو العامل الحق فى التمتع بالخدمات العلمية والثقافية والاجتماعية التى تقدمها الجمعية وله حق الترشح لعضوية مجلس الإدارة وحضور الجمعية العمومية.

العضو المنتسب

العضو المنتسب له كل حقوق العضو العامل فيما عدا الترشح لعضوية مجلس الإدارة أو حضور إجتماع الجمعية العمومية.

الإشتراكات ورسوم العضوية

- الاشتراك السنوي للمصريين (100 جنيهاً) ، (50 جنيهاً) للأعضاء فوق سن الستون.
- الاشتراك السنوي للعضو خارج جمهورية مصر العربية (100 دولار أمريكى).

رسم العضوية للعضو العامل فقط: (يسدد عند تقديم استمارة طلب العضوية)

(100 جنيهاً) للمصريين و(100 دولار أمريكى) غير المصريين ويسدد مرة واحدة فقط.

قواعد النشر بالمجلة العلمية للجمعية العربية للملاحة

ترحب المجلة بنشر الأبحاث باللغتين العربية والإنجليزية، في حدود 10 إلى 18 صفحة وبحد أقصى 4500 كلمة شاملة المستخلصات والمراجع والأشكال، وتقدم الأبحاث من ثلاث نسخ مع نسخة الكترونية على عنوان الجمعية.

تكتب الأوراق البحثيه ببنط (Times New Roman) بحجم 12 نقطة عادي للأبحاث باللغة الإنجليزية وحجم 14 نقطة عادي للأبحاث باللغة العربية والعناوين الرئيسية بحجم 14 نقطة تقيل (Bold) والعناوين الفرعيه بحجم 12 نقطة تقيل (Bold).

تقبل الأبحاث الأصلية التي لم يسبق نشرها على مسئولية الباحث، وتحتفظ المجلة بحقوق النشر كاملة.

لغة النشر

تُقبل الأبحاث باللغة العربية والإنجليزية مع إعداد مستخلص عربى وإنجليزى فى حدود 150 كلمة تلخص أهم نقاط البحث وتوصياته.

الجداول والأشكال التوضيحية

يجب ترقيم جميع الجداول والأشكال بالترتيب مع كتابة عنوان ومصدر كل منها وبحد أقصى 15 شكل بحالة جيدة بحيث يمكن قراءة محتوياتها عند تصغيرها بعرض 10 سم، كذلك يجب تقديم أصول الصورة الملونة.

المعادلات الرياضية

تكتب المعادلات الرياضية بطريقة واضحة على منسق الكلمات مع تعريف الرموز غير الشائعة عند استخدامها لأول مرة.

المراجع

يشار للمراجع فى المتن باسم العائلة والتاريخ فقط، مع إعداد قائمة للمراجع فى نهاية البحث مرتبة أبجدياً بحيث تشمل إسم المؤلف، ثم الحروف الأولية ثم سنة النشر وعنوان البحث وإسم المجلة العلمية بدون إختصار وإسم الناشر ومكان النشر.

قواعد التحكيم

- تحال الأبحاث للتحكيم دون ذكر إسم المؤلف حيث تعرض على محكم داخلى (أعضاء هيئة التحرير) ومحكم خارجى وفقاً لتخصص كل بحث.
- تعرض الأبحاث على محكم ثالث فى حالة تعارض الرأيين السابقين والذى يعتبر رأيه نهائياً.
- يستند المحكمون فى قراراتهم بشأن البحث على عدة معايير موضوعية ومحددة فى نموذج التحكيم.
- تُعرض جميع الأبحاث مرفقاً بها تقرير المحكمين على هيئة التحرير لتحديد الأبحاث الصالحة للنشر.
- تحال الأبحاث التى اعتمد نشرها من هيئة التحرير للمراجعة اللغوية.

الرؤية المتوقعة للسفن المسيرة ذاتياً

تترابط دول العالم من خلال عوامل عديدة منها التجارة الدولية ومن ثم صناعة النقل البحري والسفن المطلوبة لنقل التجارة الدولية، والتي من المتوقع لها أن تستمر في النمو بحيث ترتفع بحوالي الثلث بالنسبة للتجارة المنقولة بحراً حتى عام 2030.وبالتالي فإن البحار والمحيطات سوف تشهد زيادة كبيرة في حركة مرور السفن وسيزداد الضغط كثيراً خاصة عند المضايق والممرات البحرية والتي سينتج عنها زيادة في مخاطر الحوادث البحرية. وفي الواقع فقد حث هذا الشركات على الاستثمار في التحول إلى الاستثمار في السفن المسيرة ذاتياً وإستخدام التكنولوجيا الحديثة الأتمتة التي تدعمها التقنيات التحوليلية للذكاء الإصطناعي (AI) والتعلم الآلي كحل إيجابي وفعال لتحسين الإنتاجية والكفاءة والسلامة من خلال القضاء على الأخطاء البشرية.

يستخدم مصطلح "الشحن المستقل" بشكل أساسي لوصف سفينة ذاتية الإبحار بدون طاقم ، ولكن هناك بالفعل مستويات مختلفة من التحكم الذاتي. وفقًا لـ Lloyd's Register ، تتراوح مستويات الاستقلالية (AL) من "AL0" التي تعني السفينة المأهولة التقليدية إلى "AL6" التي تشير إلى سفينة مستقلة تمامًا مع نظام تشغيل قادر على حساب جميع العواقب والمخاطر، واتخاذ القرارات بنفسه، دون أي تدخل بشري. يتم تحديد الفوائد للسفن المستقلة وغير المأهولة بشكل متزايد ومناقشتها بين الشركات الملاحية. وفقًا للأبحاث، في حين أن العمالة الرخيصة تقلل التكلفة بنسبة 60٪ ، يمكن أن تقلل الأتمتة تكاليف العمالة بنسبة 90٪. كما صرحت Rolls-Royce، هناك العديد من المرافق والأنظمة الموجودة على متن السفن فقط لضمان إطعام الطاقم وأمانه وراحته كما يمكن أن تؤدي إزالة أماكن الإغاثة إلى تقليل الوقود بنسبة 6٪ وتخفيض آخر بنسبة 5٪ في تكاليف البناء، مع توفير مساحة أكبر للشحن وبالتالي زيادة دخل الشحن والشركات وزيادة سلامة أطقم السفن ومراقبة ظروف الشحن وتوفير عدد الموظفين ومراقبة أداء الآلات وزيادة سعة الشحن وتقليل الأخطاء البشرية ولكن على الرغم من الفوائد المحتملة وخاصة المدخرات التشغيلية سيكون هناك إنفاق رأسمالي كبير في الاستثمار الأولي في التكنولوجيا ، خاصة في المراحل الأولى من تطويرها. ثانيًا، هناك أسئلة قانونية لم تتم الإجابة عليها - لا تعرف الشركات حتى الآن كيف ستطبق القوانين الدولية على السفن التي ليس بها طقم، حيث أن تنفيذ السفن غير المأهولة غير قانوني وفقًا للوائح الحد الأدنى لمتطلبات الطاقم. أيضا من المسؤول في حالة وقوع حادث؟ ماذا سيحدث إذا كانت هناك مشاكل تتطلب اهتمامًا فوريًا - مثل الهجوم الإلكتروني ، أو صيانة الآلات أو تعطلها ، أو تغييرات مفاجئة في المسارات بسبب أحداث غير متوقعة ، ستصبح الأتمتة والذكاء الاصطناعي منتشرين في كل مكان بحيث لن يكون للأطقم الحالية مكان يذهبون إليه بمعرفتهم وكفاءاتهم الحالية. ونتيجة لذلك، ستشكل تهديدا خطيرا على العديد من القضايا الاقتصادية والاجتماعية. لا يسع المجتمع أن يفترض أن هذه الثورة الرقمية ستخلق وظائف بالسرعة التي تقضي عليها. الأتمتة والذكاء الاصطناعي هو المستقبل الذي لا يمكننا تجنبه، لكننا لسنا متأكدين من أن السفن غير المأهولة ستصبح حقيقة واقعية. ومع ذلك، لا تزال الصناعة بحاجة إلى التحرك الآن من أجل إعداد القوى العاملة الحالية والمستقبلية لدينا - مثل إصلاح التعليم، وتعزيز برامج التدريب التي تدعم البحارة للعمل مع الذكاء الاصطناعي والأتمتة.

هيئة التحرير

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المحتويات

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