11-3-2019

The significance of marine autonomous surface ships: prospects to the Philippine maritime industry

Dennis A. Pandeagua

Follow this and additional works at: https://commons.wmu.se/all_dissertations

Part of the Environmental Policy Commons, and the Oil, Gas, and Energy Commons

Recommended Citation
https://commons.wmu.se/all_dissertations/1228

This Dissertation is brought to you courtesy of Maritime Commons. Open Access items may be downloaded for non-commercial, fair use academic purposes. No items may be hosted on another server or web site without express written permission from the World Maritime University. For more information, please contact library@wmu.se.
THE SIGNIFICANCE OF MARINE AUTONOMOUS SURFACE SHIPS: PROSPECTS TO THE PHILIPPINE MARITIME INDUSTRY

By

DENNIS A PANDEAGUA
Philippines

A dissertation submitted to the World Maritime University in partial fulfilment of the requirement for the award of the degree of

MASTER OF SCIENCE
In
MARITIME AFFAIRS
(MARITIME SAFETY AND ENVIRONMENTAL ADMINISTRATION)

2019
Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

(Signature): [Signature]
(Date): 20 September 2019

Supervised by: Dr Dimitrios Dalaklis
Associate Professor (Safety and Security) World Maritime University
Acknowledgements

This research work is dedicated to my loving wife, Gia and to our children Dennis Anthony, Theodore and Francis.

I also dedicate this work to all the members of my family, who were very supportive not only to me but to my wife and children while I am here at WMU.

A special recognition to Rear Admiral Elson Hermogino, the Commandant of the Philippine Coast Guard as my sponsor for this Master’s study.

Thanks to my supervisor, Dr. Dimitros Dalaklis for patiently supervising the development of this research work.

To all the Titos’ and Titas’ of Malmo, “thank you so much”.

Thanks to my mentors and all my friends: Capt Jerry Simon, Sir Rolly, et al., Engr Macatol and Capt Cornejo, Cdr Ronnie Ong, Capt Longboan and Ms Custodio, Cdr Eugene Federico.

To the faculties and employees of World Maritime University.

To WMU, MSEA Class 2019 family.
Abstract

Title of Dissertation: THE SIGNIFICANCE OF MARINE AUTONOMOUS SURFACE SHIPS: PROSPECTS TO THE PHILIPPINE MARITIME INDUSTRY

Degree: Master of Science

This research paper is intended to give the Philippine Maritime Industry a deeper understanding and knowledge regarding Marine Autonomous Surface Ships (MASS) and its impact when it is implemented. Marine Autonomous Surface Ships are ships that can navigate without Human Manipulation On-Board. It is the latest Science and Technology product development that it involves satellite and communication technology, Artificial Intelligence, remote control systems, big data analytics, information geographical systems, debugging diagnosis technology, environmental information perception and internet of things.

Today, Autonomous Ships are often discussed in International Shipping. Different Autonomous Level is being implemented until its full transition. In the event that MASS is fully implemented, it will eliminate human errors and reduce crewing cost which is favorable in Shipping Magnates. This technology will also promote safety of the seafarer and favor the environment given its efficient use of fuel and the elimination of harmful emissions. Moreover, it will minimize the high maintenance parts of the vessel such as rotational components.

Philippines is one of the biggest suppliers of maritime labor across the world fleet and 4th place when it comes to Ship Building. The skills of seafarers were honed regularly through its strict application of the IMO training and education policies like the STCW. It is also known that the Philippines covers 30% of the seafarers of the world making the country as an important component of the global trade. Philippines relies heavily on its manpower exports particularly in ship manning services. Most of the Norwegian, German, Danish ships and other ship-owners are manned by the Filipino officers and crew due to salary rate considerations which is lower than its European counterparts and other country-suppliers of maritime labor-force without comprise to its quality and dedication to work which are admired by ship-owners worldwide. With this topic, the Philippine Maritime Industry will be given an idea about Marine Autonomous Surface Ship and how it will address the impact on the seafaring industry of the Philippines.

KEYWORDS: MASS, Philippines, Seafaring, Prospects, Significance
# Table of Contents

Declaration
Acknowledgements
Abstract
Table of Contents
Table of Figures
List of Tables
List of Abbreviations

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Problem and its Settings</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Problem and its Settings</td>
<td>1</td>
</tr>
<tr>
<td>1.1</td>
<td>Introduction, Background, Rationale</td>
<td>1</td>
</tr>
<tr>
<td>1.2</td>
<td>Statement of the Problem</td>
<td>5</td>
</tr>
<tr>
<td>1.3</td>
<td>Objective of the Study</td>
<td>5</td>
</tr>
<tr>
<td>1.4</td>
<td>Significance of the Study</td>
<td>6</td>
</tr>
<tr>
<td>1.5</td>
<td>Scope and Limitations</td>
<td>7</td>
</tr>
<tr>
<td>1.6</td>
<td>Assumptions</td>
<td>7</td>
</tr>
<tr>
<td>1.7</td>
<td>Structure of the Research</td>
<td>7</td>
</tr>
<tr>
<td>1.8</td>
<td>Definitions of Terms</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Review of Related Literature</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Review of Related Literature</td>
<td>10</td>
</tr>
<tr>
<td>2.1</td>
<td>Beginning of MASS</td>
<td>10</td>
</tr>
<tr>
<td>2.2</td>
<td>Nature of MASS</td>
<td>13</td>
</tr>
<tr>
<td>2.2.1</td>
<td>MASS as a Disruptive Technology</td>
<td>13</td>
</tr>
<tr>
<td>2.2.2</td>
<td>MASS as an Ecosystem</td>
<td>14</td>
</tr>
<tr>
<td>2.2.3</td>
<td>Factors Driving the Development of Autonomous System</td>
<td>15</td>
</tr>
<tr>
<td>2.2.4</td>
<td>Levels of Autonomy</td>
<td>15</td>
</tr>
<tr>
<td>2.3</td>
<td>Advantages and Disadvantages of MASS</td>
<td>17</td>
</tr>
<tr>
<td>2.4</td>
<td>Opportunities and Threats of MASS</td>
<td>18</td>
</tr>
<tr>
<td>2.5</td>
<td>Successful Study and Research about MASS</td>
<td>19</td>
</tr>
<tr>
<td>2.6</td>
<td>Summary and Current State of MASS</td>
<td>23</td>
</tr>
<tr>
<td>2.7</td>
<td>Impact of MASS/Digitalization on the other Maritime Sectors</td>
<td>25</td>
</tr>
<tr>
<td>2.8</td>
<td>Opportunities of the Philippine Maritime Industry</td>
<td>26</td>
</tr>
<tr>
<td>2.8.1</td>
<td>Current Philippine Maritime Ship Manning Status</td>
<td>27</td>
</tr>
<tr>
<td>2.8.2</td>
<td>Philippine SBSR and Ship Recycling Status in the Philippines</td>
<td>27</td>
</tr>
<tr>
<td>2.9</td>
<td>Conceptual Framework</td>
<td>28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Methodology</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Methodology</td>
<td>30</td>
</tr>
<tr>
<td>3.1</td>
<td>Method of Research</td>
<td>30</td>
</tr>
<tr>
<td>3.1.1</td>
<td>Locale of the Study</td>
<td>30</td>
</tr>
<tr>
<td>3.1.2</td>
<td>Respondents of the Study</td>
<td>30</td>
</tr>
<tr>
<td>3.1.3</td>
<td>Research Instruments</td>
<td>30</td>
</tr>
<tr>
<td>3.1.4</td>
<td>Data Gathering Procedure</td>
<td>32</td>
</tr>
<tr>
<td>3.1.5</td>
<td>Data Analysis</td>
<td>32</td>
</tr>
<tr>
<td>3.2</td>
<td>Research Design</td>
<td>35</td>
</tr>
<tr>
<td>3.3</td>
<td>Research Philosophy</td>
<td>35</td>
</tr>
<tr>
<td>Chapter</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>3.4</td>
<td>Research Approach</td>
<td>36</td>
</tr>
<tr>
<td>3.5</td>
<td>Sampling Design</td>
<td>36</td>
</tr>
<tr>
<td>4</td>
<td>Presentation, Analysis and Interpretation of Data and Findings</td>
<td>38</td>
</tr>
<tr>
<td>5</td>
<td>Summary, Conclusions and Recommendations</td>
<td>47</td>
</tr>
</tbody>
</table>

References 53
# Table of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Conceptual Framework</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Participation for the Interview and Focus Group Discussion</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Perception on the Status of MASS</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Perception about the Nature of MASS</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Impact on the Maritime Industry of the Philippines</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Challenges on Development of MASS</td>
</tr>
<tr>
<td>Figure 7</td>
<td>Deception or Outlook of the Philippine Maritime Industry on the Advert of MASS</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Plan How to Address the Advent of MASS</td>
</tr>
<tr>
<td>Figure 9</td>
<td>Mitigating Measures on Adverse Impact by MASS</td>
</tr>
</tbody>
</table>
List of Tables

Table 1  IMO’s Four Degrees of Autonomy
Table 2  Timeline Leading to the Development of Autonomous Ships from 1970 to 2019
Table 3  Factors Driving the Development of Autonomous System
Table 4  Comparative Table of Levels of Autonomy Developed by the Researcher
Table 5  Advantages and Disadvantages of MASS
Table 6  Successful Studies and Research and Developments about MASS
Table 7  Schedule of Respondents and Participants (Interview and FGD)
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AIS</td>
<td>Automatic Identification System</td>
</tr>
<tr>
<td>COLREGS</td>
<td>Collision Regulations</td>
</tr>
<tr>
<td>ECDIS</td>
<td>Electronic Chart Display and Information System</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
</tr>
<tr>
<td>MSC</td>
<td>Maritime Safety Committee</td>
</tr>
<tr>
<td>MASS</td>
<td>Marine Autonomous Surface Ship</td>
</tr>
<tr>
<td>MIDP</td>
<td>Maritime Industry Development Plan</td>
</tr>
<tr>
<td>PSA</td>
<td>Philippine Statistics Authority</td>
</tr>
<tr>
<td>RADAR</td>
<td>Radio Detecting and Ranging</td>
</tr>
<tr>
<td>RCE</td>
<td>Remote Controlled Equipment</td>
</tr>
<tr>
<td>ROC</td>
<td>Remote Operating Center</td>
</tr>
<tr>
<td>STCW</td>
<td>Standards of Training, Certification and Watchkeeping</td>
</tr>
</tbody>
</table>
Chapter 1: Problem and its Settings

1.1 Introduction, Background and Rationale

The present development in the maritime industry heralds a modern phase of evolutionary transformation on a global scale – the new paradigm in the future of machine intelligent unmanned ship. Several players and nation states with their corresponding roles at stake with this shift, are participants in the hugely complex maritime transport life cycle consisting of core (building, ownership, registration, operations and scrapping) and ancillary (financing and insurance, global terminal operations, and seafaring) activities (Dalaklis, 2019). The possible ramifications of the shift to autonomous ship operations are global and systemic in scope. With this backdrop, this research effort investigates how and in what ways relevant is the impending shift to autonomous shipping affects the Philippines and the country’s maritime industry particularly its Ship Manning Sector.

Autonomous Technology started with the development of knowledge ranging from Remote Controlled recreational systems for toys and automation in various industries with complex digitalization to the latest Artificial Technology. More than three decades ago, underwater drones or unmanned underwater vessels were used for research, while in the aviation sector, fly by wires or unmanned aircrafts were flown by remote controlled system specially in the military application. Today, these are known to be long range drones for various applications like domain awareness, information gathering and weapons carrier for war fighting (CBINSIGHTS, 2019). Subsequently, cars were developed in autonomous version by different manufacturers like BMW, Mercedes Bens, Toyota and other car producers.

From land and air applications, the sea transportation which is the cheapest mode of transportation due to its large carrying capacity is no exemption from the development of higher and more complex artificial technology. In Norway, the technology company Kongsberg and Yara International - an agricultural firm has announced in 2017 to build the world’s first autonomous and electric container vessel with the goal to replace the 40,000 trucks journey a year aimed towards cleaner air environment. Presently the ship is being built and expected to be launched in the first quarter of 2020 (Yara, 2018). According to Oskar Levander, VP of Rolls Royce, the
Autonomous Ships are already here and it’s already a matter of time to have full applications (Rolls-Royce, 2016).

On this note, various countries are already engaged with its respective studies on MASS. Countries like Japan, South Korea, Australia, United States and others are also joining the development of MASS (ITF, 2017). This is similar to the study of autonomous cars wherein RADAR, LIDARS, GPS, cameras, sensors are employed. In the case of surface ships, inherent sensors are already available like RADARS, AIS, GPS, ECDIS, fathometers, Satellite and other related tools that shall be integrated to new Artificial Intelligence system of the MASS (Zhiaxiang, Youmin, Xiang, & Chi, 2016). However, other countries and even companies like Maersk Line do not concur that removing humans or operator onboard the vessel will be beneficial to the ship operations itself and to the Industry as a whole. This is according to Soren Skou, CEO of Maersk (The KRIST Law Firm, P. C., 2019).

While there is a lack of common understanding about autonomy, an attempt to delineate between unmanned ship and autonomous ship was done. Autonomous ships and unmanned vessels are two terms used interchangeably in the literature and current technological developments and research (Kitada et al., 2019). The former is a ship that has no human operator or crew onboard. Yet, unmanned ship is the one that may be controlled and remotely operated from a shore-based control station or another mobile station, such as another ship. The shore-based control stations may opt to operate the ship during its routine operations with the assistance of the personnel onboard. An unmanned vessel is ‘guided by automated on-board decision systems but controlled by a remote operator in a shoreside control station (MUNIN, 2012). By contrast, autonomous ship through the use of Artificial Intelligence - a decision support system, in any change in control settings can navigate the ship on its own and without human intervention.

Moreover, IMO defines MASS as a ship which, to a varying degree, can operate independently of human interaction (Shanghai Maritime University, et al., 2018). In December 2018, MSC 100th has developed four levels of autonomy as to the operation of MASS:
The technology of MASS is known to be dependent on the Artificial Intelligence based on digitalization of basic technology to be integrated to the system as a whole addressing various challenges like efficient operations of the vessel, environmental issues of operating the autonomous vessel, security of the vessel against cyber security threats up to the physical threats posed by the pirates, vandals and regular thieves. Another issue on the MASS is its legal concerns such as on the issue of liabilities in the event of collision, fire and others (IMO, 2018). One of the largest insurance companies based in France like Allianz is quite skeptical and do not see the advantages of no human intervention on board the ships (Allianz, 2018).
While in the Philippines, the skills of the regular seafarers are honed regularly through its strict application of the IMO training and education policies like the STCW. It is also known that the Philippines covers 30% of the seafarers of the world (Galvez, 2019). Therefore, the Philippine seafaring industry is a significant component of the global trade which makes it a more important fiber of its local economy. The 30% of the world’s seafarers account for about 380,000 of the 1.5 million seafarers according to the PSA, and considered to be the largest provider of seafarers serving across the world’s fleet (Kritz & TMT, 2017). In the Philippines, it is considered as the giant industry contributing a huge portion to the country’s GDP, thus a major driver of the national economy (Richter, 2016). A 2018 report on Filipino seafarers onboard foreign-owned ships stated a total amount of 6.14 billion USD remittances sent home (Bertiz, 2019).

Moreover, revenues from the different maritime sub-industries that comprise of (1) the seafaring industry, (2) seafarers’ education and training sector, (3) the port and (4) liner operations, break-bulk and related services, (5) the shipbuilding, ship repair and engineering sector and (6) the maritime tourism when combined, form an important pillar for the national economy by creating jobs, attracting foreign investments, generating further support industries, strengthening the local purchasing power as well as offering plenty of business opportunities.

Additionally, the Philippines’ role as the fourth largest ship producer in the global market since 2010 (based on GT) takes the form of exporting large commercial ships which brings significant share in the country’s economy (DTI, 2017). Such impact contributed to the national economy are shown by the jobs provided to 48,000 workers. Revenues from shipbuilding represented for 2.6% of total exports valued at US$ 1.5 billion while approximately $1.6 billion on shipbuilding and repair as total estimated revenue (BusinessWorld, 2018).

Therefore, the Philippines is relying heavily on its man-power exports particularly in the ship manning industry wherein most of the Norwegian, German, Danish ships and other shipowners are manned by the Filipino officers and crew. Its salary rate is always lower than its European counterparts and other country-suppliers of maritime labor-force but its quality and dedication to work is always admired by shipowners worldwide.

This study will conduct research on the implementation of the Maritime Autonomous Surface Ships in international seaborne trade and how the Philippines should address the impact in the seafaring industry of the Philippines. The use literature analysis and expert’s opinion through interview and focused group discussion will be employed in this research work.
1.2 Statement of the problem

This study aims to answer the following questions:

1. What is the present status of the Maritime Autonomous Surface Ship today?

2. What are the Challenges in the implementation of MASS in international shipping?

3. What is the reception or outlook of the Philippine Maritime Industry on the advent of the Technology of MASS?

4. How should the Philippine Government plan to address this up and coming application of MASS impacting the Seafaring industry of the country?

1.3 Objectives of the Study

The Autonomous Ships or MASS is a technology that already exists and no longer a fiction. Its development started from the availability of knowledge to culmination of technology like digitalization, artificial intelligence and domain awareness and more efficient propulsion.

With these developments, the Philippines is a country with large reliance on its human force for its dollar reserves (due to its OFWs), agriculture and minimal technology and exports. The country is still developing its research culture and techno scientific evolution which relies on individual efforts. However, the DOST or Department of Science and Technology is already existing and pushing hard its techno scientific development support to the country’s local scientists and inventors.

The goal of this research is to identify the nature of operation of Marine Autonomous Surface Ships in the international seaborne trade. It seeks to examine the views and perceptions of several stakeholders in the Philippines on how they view the impact of digitalization in shipping, and what could be the strategic plans to embrace the forthcoming disruptive changes in international shipping.

Specifically, the study aims to address the Primary Objective:

1. The primary objective of this study is to find out the stage and development of the MASS from the level of its manufacturers and identify the advantages of this technology from the ship owner’s perspective.
2. The second objective of this study is to see the advantages and disadvantages of this technology to the seafaring industry and the economic effects to the Philippine economy, especially to its dollar reserves and recommend mitigation strategies to the decision makers including the Philippine government and its stakeholders.

1.4 Significance of the study:

**Maritime Industry**: This research will serve as an eye opener and aimed to provide an awareness about digitalization in international shipping. This research will be useful in allowing the Philippine Maritime Industry for a responsive action in aid of decision making in the future of the Maritime Industry of the country, the seafaring industry in particular.

**Seafarers**. This research will serve as an eye opener and raising awareness of seafarers about the subject matter. It will help them realize to consider broadening their skills that encompass a degree of digital nativism and foreseeing in the future of work in the digital era.

**Business and Trade**. This research will aid the business and trade sector to understand more about the effect Digitalization in international shipping. This study will promote the value and use of new digital tools. This study will motivate them that Digitalization needs to be nurtured to bring in new capabilities and avenues in trade. This will inspire business sector to develop new opportunities how and what ways applicable data science and data analytics and solution systems be a part of impending development in MASS.

**Economy**. This research will help the economy on how to optimize the existing talents and skills of individuals in the Philippines. It would help them to better understand what is Digitalization and how it will be impacting one of the lucrative occupational opportunities of the country as a substantial source of dollar remittances contributing to the Philippine economy. At the same time, this research would emphasize the advantage of Digitalization in Maritime Industry as it will provide many new opportunities that might enhance productivity, efficiency, and sustainability of logistics.

**Academia (Philippine Maritime Schools/Philippine University)**. This research will help the academe in formulating new studies or courses that will address the need of Digital Maritime Industry in the future. This research will relay a knowledge on how they will make Seafarer who are technology facets and to make ready for the digital transformation in shipping.
1.5 Scope and Limitations:

The settings and all applications of the study of MASS in this research shall be based on the Philippine settings only.

In spite of the fact that this subject matter is all about technology, the study and its methodology is centered on the effects of the application of the development of the technology in the maritime sector. Therefore, the technical study of the digitalization, artificial intelligence and alike shall not be covered in this research but it will be just part of the RRL for the understanding of the evolution and its relationship as one factor of MASS.

The legal aspect of the MASS applications in the local setting shall also not be part of the study since it is assumed that policies, regulations and laws of its applications in the Philippine setting is not yet present.

1.6 Assumptions:

The assumption of the study shall be based in the Philippine settings particularly on the effects of the MASS technology on its economic impact in general and the possible effects on the Techno-scientific development of the country.

1.7 Structure of Research:

Chapter 1 of the research study is divided into eight subsections which include the introduction, background, and rationale of the study; statement of the problem, objectives, significance, scope and delimitation, assumptions, structure of research, and definition of terms. The introduction describes the domain of the problem and its significance.

Chapter 2, presents the review of related literature and studies, covering both local and foreign literature. It critically discusses and summarizes literature which are relevant to the topics in the research problem. Past studies and literature are summarized, evaluated, applied to the topics covered in the study, analyzed, and synthesized.

Chapter 3 provides sufficient understanding of the methods used in the research study. It presents the research methodology, the research philosophy, the research approach, the research design, the respondents of the study, the sampling design and sample selection, the research instruments used, the data gathering procedure, and the analysis of data.
Chapter 4 presents the findings and analysis of the data gathered.

Chapter 5 presents the summary, conclusions and recommendation of the study.

1.8 Definitions of Terms

**Automation.** It refers to the technology by which performance of the procedure or process has minimal assistance (Covill, Klein-Ureña, & Shepherd, 2019).

**Autonomous System.** It refers to an operating or computer system with the ability for performance of tasks requiring no human intervention (Covill et al., 2019).

**Fully Autonomous Ship.** It is the unmanned ship that functions as fully autonomous functions for control (Rødseth, Nordahl, & Hoem, 2018).

**Maritime Autonomous Surface Ship (MASS).** It is a ship with the capability to operate to varying degrees, independently of human interaction (Covill et al., 2019).

**Maritime Education and Training.** It refers to programs completed for a period, meeting the competence standard specified by the Standards of Training, Certification, and Watchkeeping for seafarers (STWC) Code (ITF, 2017).

**Maritime Manning Industry.** It refers to the maritime manning firms offering crewing, documentation, informational, and support services to individual sailors and shipping companies (Theotokas, 2018).

**Maritime Training.** It refers to courses for seafarers systematically designed according to the requirements of Standards of Training, Certification, and Watchkeeping for Seafarers (STWC) Code, monitored continuously by its administrators and developed by approved training institutes for the issuance of seafarers’ certificates (Mukherjee & Brownrigg, 2013).
Chapter 2: Review of Related Literature

The aim of this literature review is to examine relevant facts and information from articles, journals, policies, publications, and other related studies necessary in this research. This review collated the latest information about MASS (Marine Autonomous Surface Ships).

2.1 Beginning of Maritime Autonomous Surface Ships

The idea of Autonomous ships has started during World War II. Since then, technology evolution started not only for military purposes but for scientific use. Back in WWII, the concept of remote-controlled vessel was used for gunnery exercises and as missile target (Roberts, G. N. & Sutton, 2006). Later the concept of autonomous technology was used for underwater mine clearing operations, sea-mining and research activities. It was seen possible that ASVs were a better way to save human lives and could bring many advantages to military applications. Application of autonomous concepts was recently intended for trade and commercial purposes. Table 2 provides timeline how this concept was developed up until shipping has been a target of said technology.

In China, the Wuhan University of Technology and the Maritime Safety Administration is developing the concept of non-crewed multifunctional ships as the country’s effort for a more advanced transport solution. Also, the British Engineering giant which is Rolls-Royce is set built a remotely operated local vessel by 2020 and planned to launch an unmanned ocean-going ship by 2035 (Muzaffar, 2019).

Overall, Marine Autonomous Surface Ship (MASS) is the product of the latest science and technological development. The development in terms of satellite and communication technology, Artificial Intelligence, remote control systems, big data analytics, information geographical systems, debugging diagnosis technology, environmental information perception, internet of things and others has made a great progress in recent years (Muzaffar, 2019).
Table 2: Timeline Leading to the Development of Autonomous Ships from 1970 to 2019

Source: (Roberts, 2018)

<table>
<thead>
<tr>
<th>Date</th>
<th>Project</th>
<th>Details</th>
</tr>
</thead>
</table>
| Between 1970 to 1980 |                                              | - The concept of autonomous ships was first mentioned in an article written in 1970 by Rolf Schonknecht, a German writer;  
|                    |                                              | - It was mentioned that the Captains of the ships in the future will perform their duties from an onshore office building. Vessels will be navigating with the use of computers. |
| 1983-1988          | Japanese Intelligent Project Ship            | - It is aimed to as to develop systems of highly automatic operation integrating marine system;  
|                    |                                              | - It involved elements such as shipping in high seas, port entrance, berthing, anchoring, cargo handling;  
|                    |                                              | - Operation of ships without any interaction by crew on board and design to receive support from a shore based system;  
|                    |                                              | - Linked through satellites.                                                                                                           |
| July 2011 to July 2018 | Korea Autonomous Unmanned Surface Vessels (USV) | - Led by the Korean Research Institute of Ship & Ocean Engineering (KRISO);  
|                    |                                              | - Sponsored by Ministry of Oceans and Fisheries;  
|                    |                                              | - Focused on the development of Autonomous Unmanned Surface Vessels (USV) for maritime survey and surveillance |
| Sept 2012 to Aug 2015 | Maritime Unmanned Navigation through Intelligence in Networks (MUNIN) | - Launched in 2012;  
|                    |                                              | - Funded by the European Commission under its Seventh Framework Programme (FP7);  
|                    |                                              | - Its purpose is to investigate the technical, economic and legal feasibility of unmanned ships;  
|                    |                                              | - It aims to develop and verify a concept for an autonomous ship which is defined as a vessel primarily guided by automated on-board decision systems but controlled by a remote operator in a shore side control station. |
| 2013-2018          | Revolt (DNV-GL)                              | - Launched in 2013;  
|                    |                                              | - Concept for zero emission unmanned ships for short voyages with battery power;  
<p>|                    |                                              | - DNV GL’s own concept for autonomous ships.                                                                                           |
| 2013               | AMOS (Centre for Autonomous Marine Operations and Systems) | - Aim to create a world-leading center for autonomous marine operations and control systems.                      |</p>
<table>
<thead>
<tr>
<th>Date</th>
<th>Project/Initiative</th>
<th>Description</th>
</tr>
</thead>
</table>
| February 2015 to June 2017 | Advanced Autonomous Waterborne Applications Initiative (AAWA)                     | - Launched by Rolls-Royce in 2015  
- Sought to analyze challenges in different scientific fields related to autonomous shipping operations;  
- Developed both autonomous and remote operation for ship navigation, machinery and all onboard operating systems. |
| February 2016      | Lloyd Registers: Cyber-enabled Ships; Shipright Procedure Guidance-Autonomous Ships | - Published a guidance concerning Cyber-enabled ships;  
- December 2017 when Revised update of LR's Cyber-enabled ships ShipRight procedure was launched. |
| May 2017           | MOL: R&D on Autonomous Ocean Transport System                                      | - Supported by Japanese government;  
- Research consortium of the project is comprised of MOL and other partners;  
- Develop the technological concept for autonomous vessels, drawing upon the strengths of each participating company and organization. |
| June 2017          | First Remote-Controlled Tug                                                        | - Revolutionising marine operations;  
- Demonstrates some impressive new developments, taking us one step closer to autonomous shipping. |
| Nov 2017 to Oct 2019 | H2H Project                                                                       | - Kongsberg Seatex launched The Hull to Hull (H2H) project;  
- Received funding from the European GNSS Agency under the European Union's Horizon 2020 research and innovation programme;  
- Will address the need to navigate safely in close proximity and other stationary or moving vessels and objects, therefore helping mariners in taking correct navigation decisions, and creating the fundamental condition for autonomous vessels |
| November 2017      | Aragon II                                                                          | - Developed purely by Korean technology;  
- Successfully tested on real sea experiment;  
- Ministry of Oceans and Fisheries unveiled that it was successfully tested on Nov 2107 the unmanned ship at Jangmok Port, Korea. |
| January 2018       | MV COSCO Shipping Arie                                                             | - 20,000 TEU container ship delivered to COSCOS in January 2018, is the first ever container ship to receive Lloyd's Register's Cyber-enabled ship (CES) descriptive note, "Cyber AL3 Secure Perform", for its energy management system. |
| April 2018         | First Autonomous Shipping Company: Massterly                                       | - Wilhelmsen and KONGSBERG are joining forces to take the next step in autonomous shipping by offering a complete value chain for autonomous ships, from design and development, to control systems, logistics services and vessel operations - by creating company Massterly. |
2.2 Nature of MASS

2.2.1 MASS as a Disruptive Technology

The autonomous technology will surely bring various and great changes. Hence, this transport innovation will truly disrupt the maritime transport industry. Various issues are anticipated to arise with the changes driven by MASS in the near future such as the economic and social dynamics which includes seafarer welfare, training and education, maritime safety, and environmental protection, changes in labor market and operating models (GMT, 2013). There are different reactions from the various sectors. Private sectors, driven by the cost efficiency of MASS operation and projected shortage of labor are enthusiastically pushing for possible shift to autonomous ship. Others, when asked if the MASS is considered a threat, the labor and seafarers particularly answered that they are ambivalent when confronted with the changes MASS may bring in labor and skills demand (Nautilus Telegraph, 2018 cited in Johns, 2018; Quinisio, 2018). The maritime industry takes many factors in operation. Two of the most salient are the extent of its safety and its regulatory policies- both within national and international level - that need to be amended, created, coordinated and implemented (MI News Network, 2019).
2.2.2 MASS as an Ecosystem

The advent of MASS is not only viewed as a disruptive technology. It is also a complex network which involve players and stakeholders on a global scale level and all are in the loop with its share of interconnected work and accountabilities, as well as benefits and impact – both beneficial and costly, the imminent operation of the MASS entails an ecologically sound, systemic strategy (Håkansson & Snehota, 1995; Håkansson, et al, 2009, cited in Quinisio, 2018). The changes will involve multiple sectors – shipping and port industry, information and communication technology, training and education, labor and economy, business, legal and regulatory bodies, cyber security, the public consumers – the list is long. Multiple ripple effect and impact will take place among several players. Within the shipping industry itself, how future ships are designed and how equipment are installed onboard. How ships will interact from the other ship, and how is the manner of operation requiring new skills, managed and regulated, and other changes are forthcoming. These anticipated changes will concern the academe, ship architects and engineers, classification societies and equipment manufacturers to explore the technological factors, regulatory, economic, legal and social factors, in order to make autonomous ships a reality need first to be addressed (Komianos, 2018). The Advanced Autonomous Waterborne Applications Initiative or AAWA launched in 2015 is one such large-scale project that demonstrated approaching innovation with a multi-sectoral collaboration and partnership such as experts from leading universities of Finland and leading members of maritime clusters including Rolls-Royce, INMARSAT, DNV-GL, Deltamarin, ESL shipping, Brighthouse Intelligence, NAPA and Finferries (AAWA, 2016). The technological work of this research encompassed the implications of deck machinery, automation and control, remote control and autonomous ships for propulsion, using when possible, and established technology for commercialization. More ambitious than the above project with multi-state collaboration by 2025 with a primary aim to lead the way towards an operating autonomous maritime ecosystem is One Sea, which is a high-profile ecosystem. This Finnish collaboration gathers altogether leading marine experts and is a strategic combination of business, top research and state-of-the-art information technology (www.oneseaecosystem.net, 2017). The extensive reach of its ecosystem framework of autonomous maritime covers technical, operational, ethical, regulatory, traffic control and security issues (MI News Network, 2019).
2.2.3 Factors Driving the Development of Autonomous System

Several factors have been identified as the main factors driving the development and near-future deployment of MASS. These factors are vital to provide an assessment of the extent of the present development of MASS and to guide and give directions to the future works (see Table 3).

2.2.4 Levels of Autonomy

In December 2018, during MSC’s 100th session, the committee has approved the methodology and framework for the regulatory scoping exercise on Maritime Autonomous Surface Ships (MASS). MASS was described as a ship that varies its degree on how it will operate independently from human interaction. The UN Maritime body has put pressure on the IMO to investigate and assess how the rise of vessel automation would potentially impact not only the environment but the seafarers as well and in particular, when it comes to security and safety issues. The maritime regulatory body needs to speed up in its process of determining the regulatory requirements to keep abreast with the technological progress in the industry which is already happening (World Maritime News, 2018). In this connection, Four Degrees of Autonomy (see table 1) was developed by the MSC 100th vis-a-vis the regulatory scoping exercise.

Moreover, other than the IMO’s four degree of autonomy, Llody’s Register, Danish Maritime Authority, and WMU suggested and designed their own levels of autonomy in relation to the development of MASS. Table 4 is a comparison of levels of autonomy designed by the above maritime institutions:
Table 3: Factors Driving the Development of Autonomous System
Sources: (GMTT 2030, 2017)

<table>
<thead>
<tr>
<th>Factors</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emerging Technology</td>
<td>The key emerging technologies driving the development of autonomous systems include (1) Artificial intelligence, (2) Sensors and situational awareness, (3) Connectivity, (4) Cyber security, and (5) Energy management and sustainability (GMTT, 2017). This factor raises the question, “Is the technology ready for its widespread application?” (WMU, 2019).</td>
</tr>
<tr>
<td>Artificial Intelligence</td>
<td>Gartner (cited in GMTT, 2017) characterized AI as a technology approach to enable machines to do what was formerly thought only humans can do. In unmanned vessels, AI makes use of compiled information passed through machine learning algorithm in order to make decisions and act upon it, thereby making autonomous operations. It provides the ability for speed of analysis and decision making that surpasses that of people. With AI, anomalies are detected before they arise, and much faster than with more traditional, rule-based condition monitoring, which uses a list of engineering principles that quickly becomes unmanageable as systems become more complex (MDC, 2019).</td>
</tr>
<tr>
<td>Sensors and SituationalAwareness</td>
<td>Sensors and situational awareness are primarily for navigation, monitoring and collision-avoidance, along with data information about the world around it such that it can maneuver to its intended position and direction without collision or inflicting damage to itself or others. A prototype of this feature is the ship design by Rolls-Royce, using “high-resolution visible light and infrared imagery, lidar (Light Detection and Ranging) and radar (radio detection and ranging) technology to map the area around the vessel so that it can avoid collisions, make sharp maneuvers and respond to crises. Satellite connections can be used to message SOS signals to other nearby manned or unmanned ships. And control systems can be designed to automatically shut down if pirates come onboard” (Muzaffar, 2019).</td>
</tr>
</tbody>
</table>
| Connectivity/LoT              | Due to the development of satellite communications with higher bandwidth, maritime community have become much more connected in the 2010s than ever before. This also includes access to Global Navigation Satellite Systems (GNSS) such as Global Positioning System (GPS). Off-ship connectivity provides services ranging from electronic navigation (including weather reporting) to automated identification and distress and safety notifications, among others. A connectivity engine named Fleet Data was recently launched from Inmarsat, a mobile satellite company. This is considered shipping’s first commercially available, bandwidth-inclusive IoT (Internet of Things) platform to make use of data from both onboard sensors and voyage data recorders (Inmarsat.com/fleet data, 2019). This offers a ship-to-shore data automation solution allow ship operators to access Data which can
Table 4: Comparative Table of Levels of Autonomy Developed by the Researcher Sources: (Mfame Team, 2016) (Shanghai Maritime University, et al., 2018) (World Maritime News, 2018).

| Cyber Security | The shift to digitalization of most operations on board ships from steering, propulsion, and cargo control to ECDIS, GPS, AIS, and communication systems and heavy reliance on information technology systems made the issue of cybersecurity critical (Komianos, 2018). Protection of systems, networks and data in cyberspace became a major concern IMO, 2018). |
| Energy Management and Sustainability | The MASS is being considered in less Fossil Fuels, less emissions that will result to a cleaner future for shipping. In the future there is an opportunity to reduce airborne pollution (including particulate matter) carbon emissions and fossil fuel consumption on a global scale and Eco Marine Power is working to develop renewable energy solutions that will lead to a more sustainable shipping future. MASS can make a real impact in terms of protecting the environment & reducing our dependence on fossil fuels. |

The table above shows the different autonomous level present by Danish Maritime Authority, World Maritime University and Lloyd’s register derived from IMO policy. In three comparison, LR’s level reach up to 6 levels. Among the three, the most similar according to IMO standard is the Danish Maritime Authority.
2.3 Advantages and Disadvantages of MASS

Autonomous Ship is a constant discussed topic in the shipping industry today. For a consistent transition from manned (AL0) ships to immediate stages until fully autonomous (AL6) ships is implemented, the technology has to be tested first and foremost and algorithms must be improved and developed. Initially, autonomous ships will be operated in simple inland liner trades or called short sea shipping of bulk carrier or ROLL-IN-ROLL-OUT (R-O-R-O) ships. Norwegian fjord would be the best example of a R-O-R-O ferry operation. This is so because the water transport connectivity-route is simple, less maritime traffic and waters are relatively calm. It has to be noted that for every development there are always pros and cons, disadvantages and advantages. Table 5 shows the advantages and disadvantages of MASS:

Table 5: Advantages and Disadvantages of MASS

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eliminate human error</td>
<td>Large capital expenditure in initially investing in the technology</td>
</tr>
<tr>
<td>Reduce crewing costs</td>
<td>Setting-up of onshore operations to monitor fleet movements.</td>
</tr>
<tr>
<td>Increase the safety of life</td>
<td>Incompatibilities between the current marine infrastructure and an unmanned vessel.</td>
</tr>
<tr>
<td>Allow for more efficient use of space in ship design</td>
<td>Lack of crew will make maintenance of moving parts inordinately difficult on long voyages and breakdowns could result in significant delays</td>
</tr>
<tr>
<td>Efficient use of fuel</td>
<td>Reduction of seafarer jobs</td>
</tr>
<tr>
<td>Minimization of high maintenance parts such as rotational components</td>
<td>Unknown safety risks</td>
</tr>
<tr>
<td>Elimination of harmful emissions</td>
<td>Vulnerability to computer hackers hijacking control</td>
</tr>
<tr>
<td>Offsetting the expected shortage of seafarers in the future</td>
<td></td>
</tr>
<tr>
<td>Reduction of total operating expenses</td>
<td></td>
</tr>
</tbody>
</table>
2.4 Opportunities and Threats of MASS

Rolls Royce Marine suggested that Autonomous Ships by 2030 will be a common vision on the ocean. In September 2018 Rolls Royce and Mitsui O.S.K. Lines (MOL) teamed up for a demonstration test on how an intelligence awareness system installed in a ferry serving Japan’s Seto Inland Sea route is utilized during the navigation. Conversely, Maersk casted doubts on how the development of MASS will progress as the latter do not see any advantage on the part of the ship owner by removing or replacing the human onboard. Maersk categorically made a categorical stand that it will not be an efficient option that a 400-meter long container ships that weighed 200,000 tons navigate in the ocean without any human onboard. (Walker, John, 2109)

However, the General Manager of the remote and autonomous operations of Rolls Royce, Mr Lindborg said that the intelligence awareness system that has been tested is part of the recent development of MASS which offers benefit to the present shipping environment. It is considered one of the most important advances in technology when it comes to safety of vessel navigation. It provides much better understanding and awareness of ship’s surroundings to the crew at the bridge. (The KRIST Law Firm, P. C., 2019). One of the aims of the project is that isolated and remote islands could be served and accessed with lesser risk to the seafarers. While it is believed that 80% of accidents were caused by operator’s error, autonomous ships could be a safer solution option than ships operated by human onboard. Although the risk still exists, the risk is attached to the operator located at the remote control centers. In addition, the existence of risk of a new form of piracy is being feared. Moreover, the Senior Legal Counsel of Japan Association of Marine Safety, Professor Hasebe said that Autonomous ships may give Scandinavia an edge as a soon-to-be pioneering region in the world to set and promulgate regulations pertaining to operation of autonomous shipping. He also mentioned that countries like Norway, Denmark and Finland, without waiting for the international regulations, can always adopt a domestic autonomous shipping regulation upon availability of the technology. The same approach also applies to China and Singapore when it comes to implementation of MASS in their own territorial waters.

The existing international conventions which include COLREGS, SOLAS, MARPOL, STCW were adopted on the assumption that human operator is present onboard (Brien, 2018).

The real challenge of MASS is how MASS will operate with these existing rules and regulations in international shipping. The future of shipping business could be more viable and more
profitable due to reduced manning expenses with more carrying cargo capacities (Howse, 2019) while being also safer due to removal of human factor which is the primary reason that leads to maritime incidents. This development in shipping will create new threats and errors without a doubt. However, should at the very least, decreased or leveled as that of the present, shipping will be more efficient without any human operator onboard (Aro & Heiskari, 2017). It therefore requires amendment which will fit to the operation of an Autonomous ships.

2.5 Successful Study and Research about MASS

Up until recently, digitalization continues to reshape the maritime industry with the numerous progress made with ships that are autonomous and remotely operated. All the latest technology development in the field are making the right and much needed foundation for the futuristic ships although it will take time for first commercial autonomous vessels to launch. (Howse, 2019). Table 6 shows the latest successful studies and research development about the autonomous ship.
Table 6: Successful Studies and Research and Developments about MASS
Source: (Howse, 2019) (MI News Network, 2019)

<table>
<thead>
<tr>
<th>Research Institutions / Companies</th>
<th>Accomplishments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolls-Royce and Finnish state-owned ferry operator Finfores</td>
<td>successfully demonstrated the world’s first fully autonomous ferry in the archipelago south of the city of Turku, Finland. The car ferry Falco used a combination of Rolls-Royce Ship Intelligence technologies to successfully navigate autonomously during its voyage between Parainen and Nauvo. The return journey was conducted under remote control. The vessel detected objects utilizing sensor fusion and artificial intelligence and conducted collision avoidance. It also demonstrated automatic berthing with a recently developed autonomous navigation system. All this was achieved without any human intervention from the crew.</td>
</tr>
<tr>
<td>Wilhelmsen and KONGSBERG</td>
<td>World’s First Autonomous Shipping Company; joined forces to take the next step in autonomous shipping by offering a complete value chain for autonomous ships, from design and development, to control systems, logistics services and vessel operations. Through the creation of the new company named Massterly, the companies took the next step on this journey by establishing infrastructure and services to design and operate vessels, as well as advanced logistics solutions associated with maritime autonomous operations.</td>
</tr>
<tr>
<td>“DriX” First Autonomous Unmanned Survey Vessel- UK-based</td>
<td>Successful trials of survey specialist Bibby HydroMap announced the successful completion of testing of ‘DriX’, the 8-metre Autonomous Unmanned Survey Vessel (AUSV) developed by iXblue. Designed to provide a true extension of survey capability from shallow and inshore waters to a full offshore environment, DriX is a new breed of AUSV that is the first autonomous survey platform to truly rival the performance of a traditional survey vessel.</td>
</tr>
<tr>
<td>Rolls-Royce</td>
<td>Opens Autonomous Ship R&amp;D Centre - The new Research &amp; Development Centre for Autonomous Ships includes a Remote and Autonomous Experience Space aimed at showcasing the autonomous ship technologies.</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Aker Arctic</td>
<td>An autonomous ship model was successfully tested in Aker Arctic’s ice model test laboratory in Helsinki, Finland this year. In the demonstration test the ship model was able to detect obstacles in the ice tank utilizing onboard sensors, maneuver around them without operator input and moor itself automatically to a target pier. The test was carried out in ice free waters.</td>
</tr>
<tr>
<td>Autonomous Vessel</td>
<td></td>
</tr>
<tr>
<td>in Model Tests</td>
<td></td>
</tr>
<tr>
<td>DNV GL</td>
<td>DNV GL has released a new class guideline covering autonomous and remotely operated ships. The guideline covers new operational concepts that do not fit within existing regulations, and technologies that control functions that would normally be performed by humans. In terms of new operational concepts, the guideline helps those who would like to implement new concepts with a process towards obtaining approval under the alternative design requirements by the flag state.</td>
</tr>
<tr>
<td>Wilhelmsen Ship</td>
<td>Entered into two agreements that will set the tone for operational and regulatory framework in autonomous shipping. The first agreement focuses on the development of a safety management system (&quot;safety management system agreement&quot;) while the second agreement is for the development of future competence (&quot;competence agreement&quot;). The safety management system agreement was entered into with DNV GL and NMA whereby the parties will collaborate to support WSM’s ambition to develop an efficient safety management system (SMS) for operating autonomous, remotely controlled and remotely supported vessels.</td>
</tr>
<tr>
<td>Management</td>
<td></td>
</tr>
</tbody>
</table>
2.6 Summary and Current State of MASS

There were concerns raised in as to what extent of the development of MASS already touch the globe. The Country State Profile of Readiness for MASS. Indicators have been executed in assessing the readiness as well as the efficiency of the preparedness that can be adopted for the new technologies in the maritime field. These were discussed during the comprehensive study of WMU, 2019 comparing the performance of 17 chosen countries in adopting the emerging MASS technology in the shipping industry. The assessment made use of the following five factors as readiness indicators for the adoption of new emerging technologies, MASS, in particular. These are: 1. Innovation and Technology; 2. Infrastructure Quality; 3. Regulation and Governance; 4. Human Capital and Skills; and 5. Business and Investment. These individual indicators are compiled into a single index, and the resulting score represents or is the level of performance of each country state in terms of the five factors. Seventeen countries from five regions were included in the study. These include:

- Africa: Ghana, Nigeria and South Africa
- Americas: Brazil, Panama, Peru and the United States of America
- East Asia and the Pacific: Australia, China, Japan, Philippines and the Republic of Korea
- Europe: Denmark, France, Norway and Sweden
- Middle East: Turkey

These countries were selected because of their readiness to adapt MASS technology. In the recent scoring, these countries had the highest rates in adapting the MASS implementation.

**The findings revealed that:**

(A) Automation will be most likely developed and implemented and a continuous study will result in different outcome from the different parts of the world. China was the leading country in maritime readiness, scoring 8 (where 10 is the highest, and 0=lowest), followed by Japan, South Korea, Denmark, USA, Norway, Turkey, Australia, South Africa and Sweden scoring between 7 to 5, in the order listed, were located in East Asia and the Pacific, Europe, Australia and the United States. Low Score was given to the Philippines and other countries in Africa and Latin America.
indicating that they are far from technology modernization, investment, regulation, authority and structure in all economic sectors including maritime transport maritime readiness status.

(B) Gap was shown amongst developed and developing countries, particularly in the maritime transport sector. During an assessment, seventeen (17) countries emerged leaded by Australia, China, Denmark, France, Japan, Norway, Republic of Korea, United States and Sweden, and eight (8) countries are under developing countries Brazil, Ghana, Nigeria, Peru, Philippines, Panama, South Africa and Turkey. The result is noteworthy because there is no country that attained a perfect 10 score. Thus, a result-revealing that no country is yet fully prepared to operate autonomous maritime industry.

(C) While many countries have adopted a strategic vision for the introduction of new and emerging technologies in the maritime sector, no country has to date unveiled a comprehensive strategy for maritime transport in 2040, one that combines regulations with innovation, competences and skills, infrastructure and future business models (WMU, 2019).

There are numerous activities that focus on the development and promotion of autonomous ships that is currently ongoing in several countries and states, and in different forms – research and test trials, co-operation and alliances between nation states to jointly undertake projects of e-navigation and the advance technologies development that will be utilized by autonomous vessels. A study called Assessing Ship Risk Model Applicability to Marine Autonomous Surface Ships by Thieme, C. A. et al (2018) focused on the requirements on how the MASS will be fully operational and will promote safety just like the conventional ship. In line with this, the research digs in the maximum level what the current ship can take in case of ship to ship collision, ship-structure collisions and groundings if it can be applied for risk of MASS assessment. Nine (9) criteria were formulated based on a system engineering method that can be used in assessing relevant ship risk models. It consists of technical reliability, software function, human-machine collaboration, operating and various factors in communication aiming to assess correlated considerations for the operation of MASS. (Johns, 2018).

Rolls Royce has done similarly with the partnership of Finnish Funding Agency to develop same technology (Walker, Jon, 2018). Wartsilla of the USA, a Japanese consortium and China’s Defense Agency launched their timelines for them to complete the development the concept of remotely controlled ships.
The study undertaken by Hamburg School of Business Administration (Johns, 2018) cited several developments in different nation states and shipping industries pertaining to maritime autonomy. Some industry organizations and research alliances continue to take place to join methods that is likely to be disruptive changes in the shipping industry, i.e. in China, Australia, Finland, Norway, and the UK. South Korea and Denmark already signed an MoU for partnership and promotion for e-navigation and at the same time developing the advanced technologies that will be maximized by autonomous vessels, the goal of which is to come up with an ample size unmanned vessel last summer 2018. Commercialized unmanned vessels are also one of the plans of Japan to launch commercially, this time it is on a larger scale on 2025 which aims to orbit the possible shortage of seafarers (Nekkei, 2017). There are countries which designated a test sea areas while others are still intending to do so. In Europe, Norway, Finland and the UK test areas are done, and in China 771 square km large, will be dedicated for current test area (INAS, 2019). On October 2021, China’s collision is expected to launch its first commercially viable unmanned ship. (Johns, 2018).

Currently in Norway, a fertilizer company is operating domestically an autonomous ship for its cargo product. The result of the collaboration of the fertilizer company with Wilhelmsen and Kongsberg launched it as the world’s first fully electric, zero GHG emission, ballast free container vessel named Yara Birkeland. It is expected that the ship shall be fully operational by 2020 (Slinn, 2018). This vessel will decrease the number of traffic and carbon emission on land using truck haulers.

The above survey of developments in AS is not exhaustive but few of the representative projects cited are indicative that the technology enabling autonomous ships is now well developed. There are still no countries oppose to a global strategy. While these countries included are leading the innovative shift, there are no country that has a global strategy that will incorporate business plans, innovation, competitive skills and reliable infrastructure (WMU, 2019). In particular, the legal and regulatory issues applicable to MASS are being addressed at present so that the disruptive changes that this autonomous shift will bring, which the present regulatory policies in place do not account for, will be addressed and accommodated with the needed modifications and revisions. Concerns regarding autonomous ships have been handled by IMO’s Maritime Safety Committee (MSC) and made it as one of their main topics. In 2018, IMO-led scoping exercise commenced and will be completed in 2020. This is expected to initiate the handling of various issues that include human factors, concerning safeness, security, liability and

2.7 Impact of MASS / Digitalization on the Seafarers and other Maritime Sectors

In the Philippines, more than Six (6) Billion US-Dollar seafaring industry will be affected upon the start of Marine Autonomous Surface Shipping (MASS) leading the international seaborne trade. Four Hundred Forty Thousand (440,000) Filipinos in seafaring industry would probably be affected dramatically of their benefits and privileges. (Hellenic Shipping News, 2019).

Which means seafaring employment of the Philippines will experience an enormous change as the leading and highest deployer of maritime labor next to china. Moreover, there are also sectors who are affiliated with the seafaring industry that will experience the technological impact. This includes the Three Hundred Ninety-Nine (399) licensed and accredited shipping companies, ship agents and other related business (poea.gov.ph, 2018). The same is true with Maritime schools who operate since modern shipping commenced. In 2002, Fifty (50) Maritime Universities and Colleges in the country provided land-based job opportunities to former seafarers especially in the field of education sector. (Dungo, 2019).

The emerging socio-economic transition affects the economy and this was addressed in one of the research entitled “The Philippine Manufacturing Industry Roadmap Agenda for New Industrial Policy, High Productivity Jobs, and Inclusive Growth” study discussed the need to address this enormous impact by the government to create a roadmap industry. In the roadmap implementation, private sector will lead while the government will facilitate. However, this will result to the fear of manipulation by the private sector who are usually foreign investor. The economic transformation aims to strengthen the industries by the government that can promote domestic firms for local and international markets. (Aldaba, 2014).

At this point, the development is a mere concept no one can actually foretell when this (autonomous ships) is going to be implemented here in the Philippines to give the biggest share in the international seaborne trade. Implementation of autonomous ships require much studies and tests to be operational in the Philippines due to its high demand in terms of modernization in maritime industry. As for international seaborne, it will not take effect immediately. Given to be fully operational, this ship will undergo various kinds of procedure before its approval and implementation. Seafarers should take advantage of this time to create policies, curriculum revisions ad training for seafarers that will help them adopt to the changes MASS technology will
bring before they will be labelled antiquated and be considered immaterial in the maritime industry. This scenario of the marine autonomous surface ship is no different from the scenario that happened in the past. With the motivations and mindset of technology giants in the maritime industry, there is almost zero impossibility that autonomous ship will be crossing the ocean sooner or later (Liu, 2018).

2.8 Opportunities of the Philippine Maritime Industry

The Maritime Industry in the Philippines consists of different sub-industries such as crewing and manning industry, training and education of seafarers, port operations, domestic liner operations, break-bulk and affiliated services, ship building, shipyards and engineering, maritime tourism, etc. These sub-industries formed a significant role in the Philippine economy by producing jobs, encouraging investments, generate additional support industries, solidifying local purchasing power as well as offering numerous business opportunities.

In the past years, the Philippines has been the highest number provider of deployment of maritime labor-force. By 2014, 402,000 seafarers were deployed being at more than 30% of the International Maritime Workforce. Remittances from Filipino Seafarers alone contributed $5.5 Billion USD to the Philippine Economy. In addition to this, the sectors for manning and crewing created various sub-industries which benefited from the Maritime Sector and contributed to the economy like employment.

The major factor of the maritime industry is the education and training of seafarers as it maintains and develops the level of knowledge and skills of the maritime sector and it guaranteed a maritime safety. The government authorities such as CHED, TESDA and MARINA regulated the Maritime Education Training Institution (METIs) in the Philippines. The total contribution of the institutions in 2014 under the three government authorities and the review centers through tuition fees to the Philippine GDP accounted for around 11.9 Billion PHP ($242.89 Million USD).

On top of that, ports have significant part in the competitiveness of Maritime Industry since its operations and services significantly influence the value of supply chain. When it comes to Ports, the Philippines are highly competitive and operations are continuously adapting to the latest global standards.
The tourism and travel sector are also considered as a significant factor of the Philippine Economy as it makes a substantial contribution to its GDP of 4.2% of GDP in 2014 or 533 Billion PHP by value. Due to geographical features of the Philippines, travel and tourism have taken a large part of its income by sea and the maritime tourism has a significant influence on the competitiveness of the whole tourism industry. The entire domestic cargo market paid approximately 1.7 billion PHP VAT-taxes (Richter, 2016).

2.8.1 Current Philippine Maritime Ship Manning Status
The current manpower requirements in Maritime profession and work vis-à-vis shipping are education and training in various maritime institutions and training centers all over the country. Despite the challenges, Maritime Sector was able to address this demand and are strictly complying with international maritime manpower, safety and security, and marine environmental protection standards (i.e., IMO and International Labor Organization (ILO) conventions, among others); and positioning the Philippines in the world maritime map as the leading source of seafarers (2017), 4th largest shipbuilding nation (2017) and 10th top fish producing nation (2015). Based on the available data, the maritime sector is increasingly contributing to the country’s economy in terms of locally manufactured sea vessels, transported passengers, traded goods, created jobs, and generated remittances from the early 2010s to 2017. The number of seafarers deployed overseas has often used as key indicator for Maritime Employment. The Philippines still continues to be a leading source of seafarers in the world over the past five decades. Though China has taken over the Philippines as the leading source of maritime officers for overseas deployment, in 2017 the Philippines deployed 442,820 seafarers to various parts of the world onboard sea vessels owned and managed by shipping companies of different nationalities. According to Marina Report, the workers employed by licensed SBSR companies is at 15,435 in 2017, down by 3 percent from the previous year’s number of employment recorded. If the level of employment in domestic shipping and maritime ancillary business is combined, the number of maritime employments in the country will certainly be larger (MARINA, 2018).

2.8.2 Philippines SBSR and Ship Recycling Status in the Philippines

According to DTI, Philippine has a prevailing disposition in Shipbuilding GVG because for having demands for smaller vessels in the domestic market and vast supplier of merchant ships for international market.
It has both the demand for smaller vessels for the domestic market and the exporter of commercial ships for the International Market. The Philippines has been marked fourth placed as largest ship manufacturer since 2010 according in gross tonnage. Forty-eight Thousand (48,000) workers were deployed in different industry and it focuses in the Manila and Cebu. The advantage of the Philippines is its manpower and overseas employment has higher compensation. In addition to this, the specialized graduates and skilled training programs parallel to the main occupation in ship building do not go to international standards most of the time. The Philippines already placed a position when it comes to export-oriented segment and it always seek for global awareness and continuously targeting new foreign-owned shipbuilder who can invest here in the Philippines as their cost-effective solutions for their business. In 2016, the industry hits the value of $80.2 billion and in 2015 it reaches $117 billion exports. At present, the middle-aged-ship has an overflowing number in global fleet, and it demands for new builds and conversions including repair because of the increasing number of environmental regulations. (DTI, 2017).

Philippines mainly produces a volume of big vessels including tankers. The two exports in the Philippines is currently owned by foreigners, Hanjin and Tsuneish. Additional prominent foreign owned firms are Austal an aluminum passenger and mixed-use Ships Company and keppel, a repair company. Shipyards in the Philippines, predominantly involved in repairs which accounted for 90% of domestic shipyard revenues. Seventeen (17) large and medium domestic shipyard, more than ninety smaller yards including service and float contractors. There are domestic yards which are engaged into shipbuilding for small vessels for domestic and internal demand. Ship upgrading in the Philippines is very high which is another advantage of the country. The manpower qualification suits the current demands specifically in operator level and English language skills. Another advantage of the Philippines is its geographical location including the coastline that provides important access and ample water depth fit for testing sea. The location of the Philippines is also an edge for its proximity to economic activity for shipping business. The Philippines is in fact one of the three countries in East Asia that has a strategic locational routes that make it a repair spot. Lastly, the tax and non-tax exemption for investment and import duty exemptions is also a factor (DTI, 2017).

2.9 Conceptual Framework

The IPOO or input-process-output-outcome is a structural framework with a description of how input, intermediate, and output variables form causal relationships in a system and its difference.
The structural framework consists of four levels of abstraction: paradigm, theory, model, and measurement. The specification degree increases as it continues. The theory is an implementation of a paradigm, a model is a specification of a theory, and a measurement is the quantification or the empirical representation of a model. Implementations of the structural framework may vary in the theory, model, and measurement levels. However, the emphasis on input-process-output is firmly embedded in the paradigm level.

Figure 1. Conceptual Framework

Input something from the external environment that is fed into the system. In this research the Input that the researcher considered are the MASS Introduction, MASS as Revolutionary, MASS SWOT and Development of Autonomous System. These mentioned inputs are existing in our study and its main objective is to relay an information which will be done in Process. Process is the transformation process that are most important element of a system. It accepts the inputs into the system and performs some type of operation on it which transforms it into some other state. In the simplest of terms, the process is the heart of the system. In this research the Process the Strategic step in promoting MASS. Outcome is the result of Input and Process. Without Output, a system has no link back into its external environment. In this research the possible Output the researcher aims are the Acceptance of MASS and Training of existing and upcoming Seafarers for the future adaptability of MASS.
Chapter 3: Methodology

This chapter discusses the procedures employed and the research design used in this study. It includes the research instruments, sampling methods and statistical tools that were used to gather, validate and subsequently analyze the data at hand.

3.1 Methods of Research

This study utilized the descriptive status research design in interpreting and analyzing the data gathered resulting from interviews of key personalities, focused group discussions, documentary analysis, observations, and review of past and recent records that are related to Marine Autonomous Surface Ships. The researcher wanted to find the real facts of the existing conditions.

The descriptive status research method is used to answer the questions to real facts relating to existing conditions. It stresses the current conditions with an assumption that things will change. The researcher aims to conduct a study about MASS. In this method, the researcher will use questionnaire as instrument in gathering the data. Based on the responses of the subjects, the researcher can determine the MASS Status in the Philippines and outside the Philippines; the higher the understanding of MASS is, the higher the performance will be; or the lower the understanding of MASS is the lower the performance will be.

3.1.1 Locale of the Study

This study will be held inside and outside of the Philippines.

3.1.2 Respondents of the Study

The respondent of the study will be Ship Manning Managers, Training Centers Directors and Facilitators, Shipyard and shipbuilding Industry, Academe, and Regulatory Sector.

3.1.3 Research Instruments

Interview and Focus Group Discussion Schedule. A set of questions derived from the problems of the study that will guide the researcher in obtaining information, opinions, and
recommendations in order to attain the output of the study, which is Marine Autonomous Surface Ships (see table 7).

Q’s Refers to:

Q1: What is the present status of the Maritime Autonomous Surface Ship today?

Q2: What are the Challenges of the MASS today from the perspective of the researcher, builder and its users and how it will impact the seafarers?

Q3: What is the reception or outlook of the Maritime Industry Authority on the advent of the Technology of MASS?

Q4: How should the Philippine Government plan to address this up and coming application of MASS impacting the Seafaring industry of the country?

In the body of the Focus Group Discussion guide are inquiries regarding the issues that are discussed in the statement of the problem. Major parts of the guide include:

Part I provides data on the profile of the respondents.
Part II provides data on the perceptions of the respondents on the Maritime Autonomous Surface Ships.
Part III deals with the prospects in the Philippine maritime shipping manning industry.
Part IV provides data on the significant impact of the maritime autonomous surface ships in the era of digitalization on the Philippine Maritime shipping manning industry.
Part V deals with the significant difference in the opinions of the stakeholders and experts in the maritime industry, from other nations and those from the Philippine.
Part VI deals with the potential challenges that will be encountered with the maritime autonomous surface ships on the Philippine Maritime shipping manning industry.
Part VII will provide recommendations can the stakeholders propose on the adoption of maritime autonomous surface ships on the Philippine Maritime shipping manning industry.

Respondents of the study will be the stakeholders and experts in the global maritime industry and in the Philippine maritime shipping manning industry, chosen by purposive sampling design.
3.1.4 Data Gathering Procedure

As a procedure, interview schedules, and sets of questions for the focused group discussion were first formulated. The adviser and critique were consulted as to whether or not the prepared questions have the characteristics of generating data to support the outcome of the study. After which, the questionnaires were distributed to the respondents. A week or two was given for the respondents to accomplish the survey questionnaire while the researcher simultaneously conducted interviews and initiated focused group discussions.

In gathering relevant data needed in the study, the researcher adhered to ethical standards and complied with the provisions of the Data Privacy Act. Necessary consent needed from the respondents will be obtained in the conduct of the study. The participants will be briefed about the research and the researcher assured confidentiality of the survey answers, since the study is intended for academic purposes only. A request letter will be submitted to the University, prior to the conduct of Focus Group Discussions, to the respondents chosen to participate in the study. The researcher will personally do the gathering of the needed data.

3.1.5 Data Analysis

After the Data Gathering Procedure, Data analysis is the most important part of any research. Data analysis summarizes collected data. It involves the interpretation of data gathered through the use of analytical and logical reasoning to determine patterns, relationships or trends. In processing the data, the three basic steps must follow:

1. Categorization
2. Coding
3. Tabulation of Data
Table 7: Schedule of Respondents and Participants (Interview and FGD)

<table>
<thead>
<tr>
<th>Name</th>
<th>Industry</th>
<th>Profession</th>
<th>Work Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondent 1</td>
<td>Ship Repair</td>
<td>Operations Manager</td>
<td>20 years</td>
</tr>
<tr>
<td>Respondent 2</td>
<td>Shipbuilding and Ship Repair</td>
<td>General Manager</td>
<td>43 years</td>
</tr>
<tr>
<td>Respondent 3</td>
<td>PCG-Regulatory</td>
<td>Port State Control Inspector/ Maritime Safety Officer</td>
<td>17 years</td>
</tr>
<tr>
<td>Respondent 4</td>
<td>MARINA-Regulatory</td>
<td>Lawyer/ Maritime Safety Officer</td>
<td>2 years</td>
</tr>
<tr>
<td>Respondent 5</td>
<td>MARINA-Regulatory</td>
<td>Mechanical Engineer/ Maritime Safety Officer</td>
<td>32 years</td>
</tr>
<tr>
<td>Respondent 6</td>
<td>MARINA-Regulatory</td>
<td>Marine Engineer/ Maritime Safety Officer</td>
<td>9 years</td>
</tr>
<tr>
<td>Respondent 7</td>
<td>Maritime Training Center</td>
<td>Training Facilitator</td>
<td>10 years</td>
</tr>
<tr>
<td>Respondent 8</td>
<td>Maritime Training Center</td>
<td>Training Facilitator</td>
<td>10 years</td>
</tr>
<tr>
<td>Respondent 9</td>
<td>Professor</td>
<td>Maritime Education/ Academia</td>
<td>15 years</td>
</tr>
<tr>
<td>Respondent 10</td>
<td>Ship Master/ Harbour Master</td>
<td>Harbour Pilot</td>
<td>10 years</td>
</tr>
</tbody>
</table>
After data collection, analysis will be done by establishing categories, the use of coding for the application of raw data categories, tabulation, and the drawing of inferences. This will entail condensing the data into manageable and purposeful categories for the conduct of further analysis.

Coding operation will be used which according to (Kothari, 2004), is transforming the categories of data into symbols which can be tabulated.

Iterative interpretation will be used to analyze the data, utilizing “Thematic Analysis” to identify patterns and themes of meaning across the dataset relative to the research questions. Familiarization of the data will be conducted through reading, transcribing, and initial notes. Coding will organize data that are alike which share meaningful properties for the analysis. The code is used to symbolically assign an essence-capturing attribute for a portion of the visual data.
3.2 Research Design

This chapter presents the scientific approach of the conduct of research study and the method of systematically solving the research problem. It involves the procedure adopted to study the problem and the underlying logic behind the variables being investigated. It includes the study’s research philosophy, research approach, research design, sample selection and sampling design, research instruments, data gathering procedure and methods of data analysis. According to (Kothari, 2004), it is a method of solving systematically the research problem, and how the research was scientifically done, identifying the various steps in understanding the research problem and the logic behind them. It is the design process by which the development of the research study is carried out.

Qualitative Research is used in the descriptive study in order to analyze the non-numerical and qualitative data that will be gathered from Focus Group Discussions, interviews of key informants and subject matter experts or SMEs. It will use Empirical Research which relies on gaining knowledge through direct experience to obtain the desired information that will address the phenomenon under investigation. As evidence is needed to identify prospects in the Philippine shipping manning industry with the adoption of maritime autonomous surface ships. According to (Kothari, 2004), it is appropriate to use empirical research when certain variables have influence on other variables, and when proof is being sought.

3.3 Research Philosophy

The study adopts Epistemology as research philosophy that relates to the development of knowledge on the prospects in the Philippine maritime industry, and the nature of knowledge in the area of study chosen. The study relied with a philosophy of what is known to be true, and guided the research study in gathering, analysis, and use of data on the subject under investigation. The research philosophies form the basis in establishing relationships between the variables investigated. The present investigation considers varied sources of knowledge such as beliefs and perceptions of the respondents, authoritarian knowledge that the researcher used from books reviewed, research literature and studies, and the opinion of experts on the subject investigated. Different sources of knowledge were integrated in the study in the creation of new concepts and insights in analyzing the impact of Maritime Autonomous Surface Ships and its impact on the Philippine Seafaring Industry, utilizing logical and scientific reasoning. Empirical
knowledge used in the study was derived from objective facts and will be used in the formulation of conclusions. The principle of “Positivism” allows the researcher to deal with observable phenomena that led to credible data production, considering factual knowledge gained through measurement conducted in the study, which needs to be proven as trustworthy. Data collection in the study and interpretation of the findings will be done in an objective manner, must be quantifiable and observable, that will lead to qualitative analysis. The positivism paradigm allows the researcher to use deductive approach concentrating on facts making the researcher independent of the study and the investigation being purely objective.

3.4 Research Approach
Deductive approach was utilized in the study. Assumptions were formulated, adopting purposive sampling design, structured guide to the conduct of Focus Group Discussions was developed and will be administered to the identified respondents of the study. Outcomes of the inquiry will be analyzed and a model can be developed based on the findings of the study. The development of assumptions based on existing theories of service quality and customer satisfaction, utilizing deductive approach and allows the researcher to test the hypotheses through the design of the research strategy. According to (Gulati, 2009), deductive approach means formulation of hypotheses derived from theoretical propositions. Establishing relationship between independent and dependent variables can be possible through the deductive design used in the study. At the start of the study, assumptions of the study were constructed, then with appropriate research methods, analysis of the data will prove the assumptions. Using the approach, the study will undergo the stages of deduction from theory, formulation of assumptions through proposal of relationships between the variables of the study, examination of the result of the analysis, making comparisons with reviewed literature and studies, and developing modifications of theory in cases when assumptions are not been confirmed.

3.5 Sampling Design
The study utilized purposive sampling design, a non-probability sampling design in which the researcher will set the criteria for the selection of the sample and sample size of the study. The elements of the sample are selected by the judgement of the researchers who perceive that they can obtain a representative sample through sound judgement that results in time and cost savings.
Purposive sampling is a non-probability sampling which is most effective when the researcher needs a certain cultural domain to be examined with knowledgeable experts within and can be used with both quantitative and qualitative research methods, with the inherent bias of purposive sampling contributing to its efficiency, and the method remains robust even when it is tested against the design of random probability sampling. In this study, competence and reliability of the informant, is ensured, as choosing the purposive sample is fundamental to the quality of the gathered data.

Also known as judgment sampling, purposive sampling design allows the researcher to decide what needs to be known and finds the persons who are willing and can provide the information by virtue of the experience and knowledge of the informant. The sampling technique can be used with methods in data gathering such as survey. Purposive sampling is valid over the realm it represents and contribute more to internal validity.

Using the purposive sampling design, the study obtained a total sample size of 10 respondents, from the subject maritime industries. The data will be generated using Focus Group Discussions with respondents, chosen to participate in the study.
Chapter 4: Presentation, Analysis and Interpretation of Data and Findings

This chapter’s contents present the interpretation of data gathered by the researcher through interviews and focus group discussion as well as a content analysis of documents that would determine the perception of the participants about Marine Autonomous Surface Ship. Moreover, this chapter provided what are the findings of the research base from the data collected from the questionnaires that discourses the research questions as follows:

Q1: What is the present status of the Maritime Autonomous Surface Ship today?
Q2: What are the Challenges in the Implementation of MASS in international shipping?
Q3: What is the reception or outlook of the Maritime Industry Authority on the advent of the Technology of MASS?
Q4: How should the Philippine Government plan to address this up and coming application of MASS impacting the Seafaring industry of the country?

Part 1: Participants
The participant of the interview is composed of Marine Engineer, Ship Captain, Ship Manning Executives, Academia, Training Facilitator, Maritime Safety Officers (Regulatory) (see figure 2). RA No. 10173 of the Philippines or Data Privacy Act of 2012 is being implemented and respondent’s information is being kept as confidential (RA 10173).

Figure 2. Participants for the Interviews and Focus Group Discussion
During the interview, participants were asked if they are familiar about the Marine Autonomous Surface Ship. 50% of the participants are aware about the Marine Autonomous Surface Ship. 30% of the participants are knowledgeable about MASS, meaning they can very well discuss the MASS and conducted further and deeper study. While 20% states that they are not familiar with the technology and that they have just overheard the concept. Figure 3 shows summary of responses on the perception about MASS.

Figure 3. Perception on the Status of MASS

During the interview, one of the participants mentioned that there is already a roadmap for the implementation of MASS in advanced countries such as China, Norway, Japan, etc. One of the respondents also mentioned that by 2047, MASS will be a common sight in the international shipping. One of the participants mentioned that as of now, discussion in the maritime sector about MASS has already started in the Philippines but it was mentioned that it will take some time before it will be adapted here in the Philippines.

Participants were also asked what is their impression about the MASS. 40% of the Participants believed that MASS will be evolutionary during its introduction in dominating the global trade. They believe that this is one of the biggest break-through in the international maritime industry. 30% of the respondents said that the development is so enormous and very promising considering the advantages and benefits brought about by its development. Figure 4 shows interviewees perception about the nature MASS. 20% of the participant’s impression about MASS that it is
disruptive. They perceived that MASS will replace the traditional ships and the existing operational protocols in shipping using human intelligence.

Figure 4. Perception about the Nature of MASS

10% of the respondents perceived that this is something to be considered as a revolutionary to seafarers in particular for Filipino seafarers, however, this respondent believed that MASS is a phenomenon which cannot be avoided in the future. On the other hand, one of the respondents that belongs to the 30% which considered MASS as a promising technology said that MASS is a thing which should not be considered as a threat.

When the respondents were asked about the impact of MASS in the Maritime Industry of the Philippines, 50% responded and said that MASS will largely impact its maritime sector. Since this is a technological breakthrough in international shipping, there will be a number of coping mechanisms that will take place. Like the need to advance and upgrade the cyber connectivity capacity for the Philippines in order for it to cope up. Workforce must be retrained and if possible curriculum must be revised to be ready for MASS application. Regulations and policies need to be developed as early as now, that in the event that this technology will take place, everybody will be ready. Another impact of MASS will be on economic growth, labor opportunities and the maritime industry development. 30% perceived that somehow it is impacting but not as compare to the impact previously stated. Introduction of MASS leaves an impression that it will take such a long time before it (MASS) will be a common sight in the ocean and that it will gradually affect the Philippines seafaring industry. In this case, the Philippine Maritime Industry will be prepared
and ready since the transition to autonomous ship will be evolutionary. While 20% still believe that there is little percentage of negative impact to the Philippines in the long term (see figure 5).

Figure 5. Impact on the Maritime Industry of the Philippines

Part 2: Respondents Perception about the Challenges in MASS

When the participants were asked what are the possible challenges on the implementation of MASS, 40% of the respondents said that MASS is still doubted to be highly acceptable to the public despite technological innovations. It’s still doubted whether it will be safe that will lead to the reduction of number fatalities due to maritime incidents. Accuracy in the operations of autonomous ship was also mentioned to a potential issue in ensuring protection of the marine environment. Since, MASS will be replacing the human intelligence over Artificial Intelligence, the technology on ship application is still in question. 20% of the respondents mentioned that sustainability is also one of the challenges of the MASS. If implementation would be successful but the hardest part is to sustain the ongoing developments as well as the technology, workforce and environmental concerns. Another 20% perceived that “Information Relay” or big data transfer is also one of the challenges of MASS. However, one of the respondents mentioned that there are some technologies of big analytics that are continuously improved so far. The last 20% perceived that issue on cyber security as another challenge to the development of MASS.
Part 3: Respondents Reception or Outlook of the Maritime Industry on the advent of the Technology of MASS

In this particular research question, only respondents from the regulatory were asked as to their perception on the advent of MASS technology in international shipping. 75% of the respondents said that the Philippines through its regulatory body / authorities must prepare with the advent of MASS as early as possible. It is important to consider an early preparation in order to be more competitive than the other maritime labor suppliers in order to maintain its economic benefit from international shipping. While 25% of the respondents said that it is more important for the Philippines to address its present concerns on seafarer’s deployment. Moreover, they said that it is too early to prepare and out the issue of digitalization in the maritime affairs’ priority agenda. However, these 25% respondents also raised that digitalization in shipping is inevitable.
Part 4: Participants Perception on How the Philippines should Plan to Address this Up and Coming Application of MASS Impacting the Seafaring Industry of the Country

40% of the respondents said that as early as now trainings about MASS should be developed so that the present Seafarers for the Philippines to sustain its deployment considering the timeline of implementation of the MASS. 30% perceived that for the upcoming seafarers, curriculum and its educational system must be revised and be designed respectively in order to produce knowledgeable seafarers in relation to operation of MASS and that the Philippine seafaring industry may evolve as a responsive industry vis-a-vis emerging trend in international shipping. Furthermore, 30% of the respondents believe that maritime facets of the Philippines considering its many off-centered maritime opportunities must be developed to support the evolution in maritime trend which will largely impact the deployment of seafarers.
Moreover, when the respondents were asked of the opportunities in international shipping for the Philippines to undertake and focus into, 30% claimed that supply of seafarers and workers onboard cruise liners would still be a lucrative sea-based deployment for Filipino seafarers. This includes deployment to other types of ships that will not outrightly adapt the MASS technology. 25% suggested that MARINA’s 10 Year Development Plan could still be applicable during the transition period from conventional ships to autonomous ships. The respondents said that with the help of private investors, the Philippines is willing to develop its shipbuilding and ship repair capability which is more economically viable for the investors due to cheaper labor and overflowing source of skilled and maritime talents. 25% of the respondents also said that developing the Philippines into a maritime logistics hub is another viable option in making the country as transhipment hub, logistical support provider for the existing types of ships will provide country’s another avenue to benefit from the international shipping industry. 10% of the respondents said that a more innovative approach to strengthen the flag registration sector of the Philippines can also provide

10% of the respondents said that developing the local or domestic shipping and fishing industry will make more stronger backbone for domestic trade considering the Philippines as an archipelagic country, maritime or nautical highway program of the government is the key to this endeavor. Providing more competent and qualified seafarers to our local fleet will enhance the maritime safety stature of the country. Safer domestic shipping is tantamount to stronger domestic maritime trade.
Part 5: Focus Group Discussion

Overall Analysis

During the Focus Group Discussion, the discussion went well and views of the participants were well discussed. All of the participants are well informed and futuristic about the MASS. Participants were aware that in Norway and other countries in Europe are doing enormous effort for the development of Autonomous Ships. They perceived that MASS Technology will advocate sea safety particularly in tanker ship or cargo which are considered hazardous to humane. Though no matter how promising the MASS is, there is still a perception among the participants that it is still a threat in the ship manning industry of the Philippines, unless seafarers would be willing to undergo trainings to cope up with MASS. It was explained that there would be lesser actual human intervention in operating the autonomous ship as compared to the conventional ship we have today. All of the participants are amenable that Philippines should actively participate in the progress of developments of MASS to be well informed in order to keep abreast with the technology. Moreover, it was mentioned that the study from WMU about the present maritime trends should be used as a tool to educate everyone in the maritime sector.

One of the participants added that it is not seen as a threat for manpower because the Philippine is a manning capital of the world. Seafarers would not just say they will be laid off because at the end of the day someone will still operate the technology behind the ship autonomous. When they were asked, in what ways MASS would not be a threat to the Philippine seafaring industry all of
them agreed seafarers need to undergo necessary trainings (or re-skilling of seafarers) relating to the operation of MASS during the transition period (from the first MASS will be introduced considering the levels of autonomy up to the introduction of fully autonomous surface ships. In the event that the MASS will be implemented in international trade, Filipino seafarers should not be left behind with the technology of MASS by which can be done by adopting an educational system which is inline with the trends of emerging maritime technology. At the end of the day, seafarers will be the main character in operating the autonomous ships. Filipino seafarers can always play an important role in this emerging technology in shipping. The only thing that needs to be developed is their knowledge and skills in operating the autonomous ships. There will be a big impact in the academe in updating its curriculum that will correspond to the adaption of MASS technology. Furthermore, according to the participants, it will take a while for the Philippine seafaring industry to respond to the global demand of seafarers who will operate the MASS technology. Therefore, earliest preparation has to happen. The Philippines as a “service economy” can always respond to the global demand on overseas workers. In this case, areas like Science, Technology, Engineering and Mathematics must be strengthened to be part of the basic educational system in order to level up the maritime curriculum in the country addressing the needs of the future work in maritime trends. Moreover, participants also mentioned that preparing the infrastructure of cyber connectivity and autonomous support systems considering the “drivers of digital transformation” must be in-placed in order to support the shore-based support requirement of operating an autonomous ship.

They also discussed that the government must likewise focus on other maritime opportunities of the Philippines such as shipbuilding, ship recycling, ship registration, usual deployment of seafarers to conventional ships during the transition period or from zero (0) to 100% implementation of MASS. The Philippine must also see not only the way of taking advantage of the emerging technology but how to mitigate the impact of MASS in the seafaring of the country.
CHAPTER 5: Summary, Conclusions and Recommendations

This chapter presented the summary of the study and the conclusions derived from the findings in which recommendations were drawn to educate, inform and make everyone aware about Marine Autonomous Ship Surface in the Philippines.

Summary

Autonomous Technology is a fast-coming trend International Shipping Industry. An inspiration from Remote Controlled recreational systems like for toys and automation in various industries with complex digitalization to the latest Artificial Intelligence Technology are the motivating factors for the development of Autonomous Ship. from land, air and sea, and all sectors of shipping is now a target of digitalization. Based on the levels of autonomy designed by Lloyd’s Register, latest modern ship today is already at Autonomous Level 1 (AL1) which will transition into Autonomous Level 2 (AL2) with the advent of remote control ships. In 2017, the world's first autonomous and electric container vessel was announced with an aim to replace the 40,000-truck journey a year aimed towards cleaner air environment. Currently, the ship is being built and set to be launched in the first quarter of 2020. Different countries already have respective studies about Marine Autonomous Surface Ship which includes Japan, South Korea, Australia, United States and other countries have joined the race in the development of MASS. There are also studies that are quite similar with autonomous cars wherein RADAR, Lidars, GPS, cameras, sensors are in place.

For the remote-controlled ships, however, there is still confusion about terminologies with the use of unmanned ship and autonomous ship. It was attempted to delineate the two terms. Unmanned ship has no human operator and it may be controlled via remotely operated shore-based control station. While Autonomous Ship with the participation of an Artificial Intelligence has a support system that when settings were set or changed it navigates on its own without human intervention.

IMO defined MASS as ship that has a different degree and can operate independently without human interaction. IMO developed four levels of Autonomy as a way to operate an autonomous ship and which also describes the timeline of the implementation of MASS. MASS is dependent with Artificial Intelligence according to the concept of technology of digitalization. It integrates the system to connect the different challenges concerning operational efficiency, issues in the environment, security against cyber threats and physical threat post by the pirates. Liabilities such as during collision, fire and others is also another legal issue of MASS, which needs to be in place.
before we can see autonomous ship navigation the ocean and intended for commercial purposes.

The implementation of MASS will dictate the future of the Philippine maritime industry, its seafaring in particular. Seafarers in the Philippines undergo different trainings and strict compliance and application of the IMO training and education requirement like STCW. The Philippines covers the seafarer in the world with the percentage of 30% and this made the Philippine Seafaring as an important element of the global trade. Revenues from the different maritime sub-industries that comprise of (1) the seafaring industry, (2) seafarers’ education and training sector, (3) the port and (4) liner operations, break-bulk and related services, (5) the shipbuilding, ship repair and engineering sector and (6) the maritime tourism that if combine is an important fiber of the National Economy. It creates jobs, attracts foreign investments, generates further support or ancillary industries, strengthen the local purchasing power as well as offering plenty of business opportunities. The Philippines is marked as 4th place largest ship producer in the global market since 2010 has a substantial share in the country’s economy.

In relation to the above, the main goal of this study is to determine the nature of operation of Marine Autonomous Surface Ships in the international seaborne trade. It seeks to examine the views and perceptions of several stakeholders in the Philippines on how they view the impact of implementation of MASS, and what could be the strategic plans to embrace the forthcoming disruptive changes in international shipping.

In gathering the data, literature and document analysis, Focused Group Discussion and interviews of subject matter experts were used. Participants come from the different industries that is related with shipping.

The study yielded the following:

**Status, Nature and the Philippines’ Awareness on MASS.** Participants has a different perception about MASS. However, majority of the participants and respondents were already familiar with MASS. Some of them overheard the concept of MASS over news and through internet browsing and some of them have already studied or conducted a research about the technology. The respondents had different impression about MASS. Some of them considered MASS as not a threat even it may replace physical human intervention over Artificial Intelligence. Some considered MASS as an evolutionary and promising technology and that it may be
implemented in the near future of international seaborne trade considering the level of autonomy. Others considered it as opportunity as something to prepare for the future so that Filipino seafarers may continuously thrive in a disruptive nature of MASS which will brought new paradigm in international shipping. Although there is no particular effort relating to the development of MASS in the Philippines, there is a high awareness among the respondents that it is an evitable phenomenon in international shipping and something to really prepare for considering its impact its seafaring industry and its economy at large.

**Perception of Challenges of Implementation MASS.** During the interview and focused group discussion public acceptance is one of the major challenges of MASS that is being faced, so far. The reliability of its operation whether it is safe to operate in a common sea area and whether it will not lead to fatalities and maritime disaster in order not to harm the environment.

**Reception or Outlook of the Philippine Maritime Industry on the advent of the Technology of MASS.** Advent of disruptive technological change in international shipping is something that the Philippines wanted to take advantage and something to be prepared with, ahead of time. Respondents and participants of this paper seemed to aim to maintain its competitive advantage over other maritime labor suppliers in the era of technological breakthrough by foreseeing and preparing for the future work in international shipping. Apart from this, while other respondent gives particular attention to the present challenges of the maritime industry in the regular deployment of seafarers, everyone is amenable to prepare for the future challenges in the evolutionary and promising changes in shipping.

**How should Philippine Government’s plan to address this up and coming application of MASS impacting the Seafaring industry of the country.** Accordingly, this future trend in international shipping is something that has to be taken advantage of by the Philippines, being categorized as a “service economy.” Firstly, the Maritime Education and Training of the country should not just begin with the “tertiary education” level but as early as “basic education” level which need to capitalize on strengthening areas such as Science, Technology, Engineering and Mathematics. Understanding the future work in maritime is the key to understanding that the “market forces as drivers of digital transformation” is critical in preparing for this futuristic feat. Secondly, the development in the implementation of MASS has to be closely monitored by the maritime authority of the Philippines to be keen on the deployment of seafarers on conventional ship and the requirement of seafarers on the first autonomous ship to be engaged in commercial
purposes. At this point, pool of re-skilled Filipino seafarers must be up and ready in order to respond to the requirement on time. Training curriculum needed to transform the number of seafarers in order to be “battle-ready” to man lean-manned ships (ships with reduced number of manning) is the key for making this a reality. Thirdly, the maritime authority should not be confident on the success of preparations to be made ahead of time. It would be an enormous impact to the Philippine economy if the plan to address the advent of MASS will not succeed. Focusing on the other opportunities in maritime industry would be vivid strategy if the first option to prepare will fail. Clearly the 10-yr Maritime Industry Development Plan of MARINA is very timely and an important applicable strategic plan the Philippines can rely into to prepare into the future trends in maritime. During the interviews and discussions, respondents and participants were amenable that the maritime opportunities of the country are but not limited to shipbuilding, ship repair and ship breaking capability, flag registration, transforming the country as a transshipment and logistical hub in the region, developing the domestic shipping and fishing industry and the opportunities on cruise liners and other conventional ships which needs more human services onboard. The above-mentioned core and ancillary maritime industries is reflected in the MIDP of MARINA (issued on December 2018) which the Philippines has to make really happen not only as a mitigating measure should seafaring industry be adversely impacted by the digitalization in international shipping, but as measure in strengthening the Philippine economy.

Conclusions

- With the state-of-the-art ships that are in service today, as per Lloyd’s description on the level of autonomy of MASS, ships are already at Autonomous Level 1 and the advent of remote-controlled ships means transition to Autonomous Level 2. This further implies lesser number of crew onboard as support systems onshore will be inplaced to support ships operation and more automation of systems onboard the ship which dictates lesser requirement of human intervention.
- One of the challenges in the implementation of MASS that was given utmost concern in this research is the issue on public acceptability due to doubt as to whether MASS can really reduce the number of maritime incidents leading to loss of life, environmental damages and whether it can safely navigate in a common sea area with other conventional ships;
- MASS will be evolutionary considering the timeline of implementation rather revolutionary, promising and disruptive in the sense that new curriculum is needed for the training and
education in order to re-skill the seafarers to fit into the jobs description to operate the MASS;
• In the Philippines, there is quite a high awareness of the MASS technology considering the participants and respondents of this research;
• Maritime authorities in the Philippines are very much aware of the disruptive changes that MASS can bring and that necessary preparation must be in place ahead of time in order to maintain its competitive stature in seafaring among other maritime labor suppliers;
• However, no particular effort yet from the maritime authority that would really define its preparation for MASS at present time. Issues on the deployment of seafarers onboard conventional ships is and still the primary focus of attention of the authority;
• Taking advantage of the emerging disruptive technology is one of the strengths of the Philippine workforce, early preparation by incorporating the demand of the future of work in its educational system is a long term and more competitive solution to address this future challenge in international shipping; and
• In order to mitigate possible adverse impact of digitalization in the seafaring industry of the Philippines, in the event that early preparation to embracing MASS herein mentioned has failed, the 10-year Maritime Industry Development Plan (MIDP) of MARINA is a very suitable document to address the negative economic repercussions MASS could bring to the maritime industry of the Philippines. The document laid out specific action plan based on the competitive advantages of the maritime sector of the country. These are development of shipbuilding, ship repair and shipbreaking capability, developing maritime tourism and enhancement of services and talents for the cruise liner industry, development of local shipping and fishing industry, transforming the Philippines into a transshipment and logistical hub in the region and the flag registration services the Philippines.

Recommendations
• Further study about designing the appropriate maritime training curriculum in order to be utilized for the present seafarers for their re-skilling;
• Further study about designing the appropriate maritime education curriculum in order to be utilized for the future maritime students;
· Awareness about autonomous ship in this research work is only limited to the participants and respondents, information drive about the future of work in international shipping can motivate younger generations to choose maritime career path that Philippines may continuously thrive in the competitive maritime labor force;

· While addressing the present challenges on regular deployment on the present types of ships, the maritime authority of the country must consider to put this issue of preparing its present and future seafarers as one of the priority agenda in the maritime affairs of the Philippines;

· Apart from preparing for the trend in the future of work of maritime sector, the action plans laid in the MIDP needs to be part of the serious effort for the Philippine Maritime Authorities for it to be realized in order to boost the country’s economy.
References


CBINSIGHTS. (2019). 38 ways drones will impact society: From fighting war to forecasting weather, UAVs change everything.


Dalaklis, D. (2019). In Dennis Pandeagua, WMU-MSEA Class 2019(Eds.), IMO’s vision for the human element

DTI. (2017). Philippines in the shipbuilding global
value chain series no. 2017-08. ()


GMT. (2013). Changes driven by MASS.


Komianos, A. (2018). The autonomous shipping era;


Mukherjee, P. K., & Brownrigg, M. (2013). *Farthing on international shipping*


Shanghai Maritime University, et al. (2018). Research on the impacts of marine autonomous surface ship on the seafarer’s career and MET


