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**WORLD MARITIME UNIVERSITY**

Malmö, Sweden

**INVESTIGATING THE ISSUE OF MARITIME  
DOMAIN AWARENESS: THE CASE OF GHANA**

By

**MICHAEL AGYARE ASIAMAHA**

**Ghana**

A dissertation submitted to the World Maritime University in partial  
Fulfilment of the requirements for the award of the degree of

**MASTER OF SCIENCE**

**In**

**MARITIME AFFAIRS**

**(MARITIME SAFETY AND ENVIRONMENTAL ADMINISTRATION)**

2018

**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):  .....

(Date): 18 September, 2018.

Supervised by: Associate Professor Dimitrios Dalaklis

Supervisor's affiliation: Maritime Safety and Environmental Administration

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## Abstract

Title of Dissertation: **Investigating the Issue of Maritime Domain Awareness: The Case of Ghana**

Degree: **Master of Science**

The dissertation is a study of how agencies collaborate for effective Maritime Domain Awareness in order to enhance safety and security in the maritime space of Ghana in particular and the Gulf of Guinea in general.

A brief look is taken at the benefits derived from the maritime environment of Ghana, as well as the threats associated with harnessing those benefits. The definition of maritime domain, maritime safety, maritime security and the role of surveillance systems in gathering information about maritime activities is examined, taking into consideration, existing surveillance systems and the mandate of establishment of all the various maritime stakeholders that operate these systems. The various maritime domain awareness tools, which should be embedded within good surveillance systems so as to improve their operations, are also investigated.

Programs that have been initiated by the national agencies, regional groups and international partners to contribute to maritime domain awareness in Ghana, in particular, and the Gulf of Guinea, at large, are interrogated, and the performance of the various agencies in meeting the proposed outcomes of the initiatives are addressed to the letter.

Additionally, 4 out of 6, representing 67% of agencies that operate maritime surveillance systems in Ghana participated in answering questionnaires, which paralleled case studies, and responses were noted for comparison. The results were collated and appraised for effectiveness in relation to collaboration between the agencies in gaining authentic maritime domain awareness.

The concluding chapters examine the responses to the questionnaires, and discuss the provisions in place to encourage cooperation among maritime stakeholders who operate surveillance systems. A number of recommendations are proposed, with regard to improving collaboration between the various agencies so as to effectively maintain a complete picture of the maritime domain of Ghana.

**KEYWORDS:** Gulf of Guinea, Maritime Domain, Maritime Security, Maritime Safety, Collaboration, Surveillance System

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## List of Abbreviations

Act 645	-	Ghana Shipping Act 2003
AFRICOM	-	US Africa Command
AIMS	-	Africa Integrated Maritime Strategy
AIS	-	Automatic Identification System
CPA	-	Closest Point of Approach
CRESMAC	-	Regional Maritime Security Centre for Central Africa
CREMAO	-	Regional Maritime Security Centre for West Africa
ECCAS	-	Economic Community of Central African States
ECDIS	-	Electronic Chart Display
ECOWAS	-	Economic Community of West African States
EEZ	-	Exclusive Economic Zone
EIMS	-	ECOWAS Integrated Maritime Strategy
EPA	-	Environmental Protection Agency
GGC	-	Gulf of Guinea Commission
GMA	-	Ghana Maritime Authority
GMDSS	-	Global Maritime Distress Safety System
GoG	-	Gulf of Guinea
GPHA	-	Ghana Ports and Harbours Authority
GPS	-	Global Position System
ICC	-	Inter-Regional Coordinating Centre
ICT	-	Information Communication Technology
IDF	-	Information Distribution Facility
IMB	-	International Maritime Bureau
IMO	-	International Maritime Organisation
ISM	-	International Safety Management
ISPS Code	-	International Ships and Port Facilities Security Code
IUU	-	Illegal, Unregulated, Unreported fishing
JOF	-	Jubilee Oil Fields
LRIT	-	Long Range Identification and Tracking
MCS	-	Monitoring Control and Surveillance

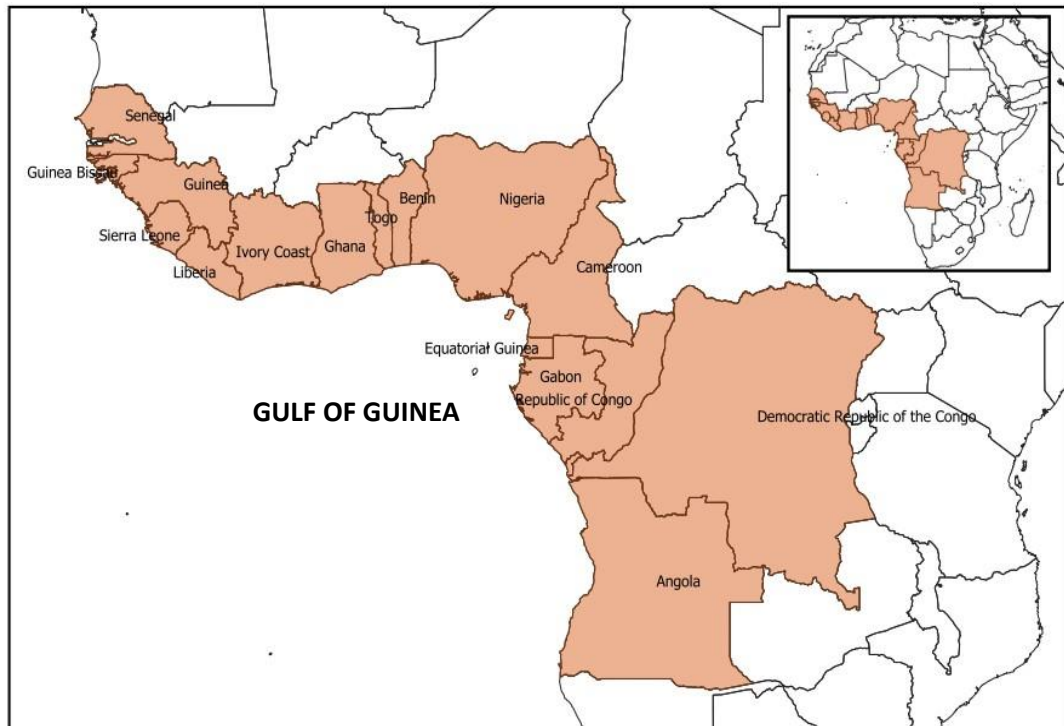
MDA	-	Maritime Domain Awareness
MF	-	Medium Frequency
MIO	-	Maritime Interdiction Operation
MMCC	-	Maritime Multinational Coordinating Centre
MOC	-	Maritime Operation Centre
MOFAD	-	Ministry of Fisheries and Aquaculture Development
MOWCA	-	Maritime Organisation for West and Central Africa
MSA	-	Maritime Situational Awareness
NACOB	-	Narcotics Control Board
NADMO	-	National Disaster Management Organisation
NAVAF	-	US Naval Forces Africa
NSSC	-	National Security Coordinating Council
RSS	-	Remote Sensor Site
SAR	-	Search and Rescue
SOLAS	-	International Convention on Safety of Life at Sea
SOP	-	Standard Operating Procedure
SRS	-	Ship Reporting System
UNCLOS	-	UN Convention on Law of the Sea
VHF	-	Very High Frequencies
VBSS	-	Visit, Board, Search and Seizure
VMS	-	Vessel Monitoring System
VTMIS	-	Vessel Traffic Monitoring Information System
VTS	-	Vessel Traffic Service

## **CHAPTER ONE**

### **RESEARCH BACKGROUND**

#### **1.1 Introduction**

The Gulf of Guinea (GoG) is one of the world's busiest shipping routes; it connects an extended number of countries and also provides a major source of revenue for oil producing countries along its coastline. It is located partly in the North and partly in the South Atlantic Ocean, along the Western and Central African coasts with 17 coastal and 2 island states, as presented in Figure 1. Its ecosystem is the Guinea Current Large Marine Ecosystem. The GoG produces about 70% of Africa's total oil production and this figure is expected to increase over the next few years as new discoveries of offshore hydrocarbon deposits spring up (Giorgis, 2013). Moreover, this region contributes significantly to global energy needs by supplying oil products to Europe and Asia, as well as providing an estimated quarter of the US oil requirement (Akah and Dalaklis, 2017).



*Figure 1: Map showing coastal states in GoG region*

Source: Created by the author with the aid of QGIS software

The heavy maritime traffic within the GoG region is associated with safety, security and environmental challenges to the coastal and island nations. Even though it is a resource laden region, the GoG is under-utilized because of the high incidence of piracy, armed robbery and associated crimes within its maritime domain (Ifesinachi and Nwangwu, 2015). According to the International Maritime Bureau (IMB) piracy reporting centre, there is high risk in the region based on the fact that, during the first half of 2018, it was involved with a very significant number (25 crew members) of crew kidnappings in 6 separate incidents (IMB, 2018). To make matters even worse, the IMB holds the view that the number of incidents is more than what is reported. These maritime crimes impede the realisation of the marine environment's full potential, undermine efforts aimed at increasing economic development and integration by the GoG states, and thus, aggravate poverty and political instability (ECOWAS, 2016). Ghana, as the gateway to West Africa and a new entrant in the production of oil in commercial quantities, has a vested interest and there is an important role to play in addressing maritime safety and security issues in the GoG.

Within the last few years, piracy and armed robbery have been on the ascendency within the region at an alarming rate (UNODC, 2017). There are several regional initiatives to help countries ensure safety and security within their coastal waters. The African Integrated Maritime Strategy (AIMS 2050) developed by the African Union (AU) entreats African states to confront and overcome major challenges in their maritime domain, while building security capacity. As a result, there is an increased political will and ability by certain West African states to take serious action for maritime safety and security using electronic means. For instance, Nigeria, the largest economy within the region, has launched a Maritime Safety Information (MSI) portal as well as the relevant Data Centre to promote maritime safety and security in the country's waterways (Ezeobi, 2017).

The International Maritime Organization (IMO), in April 2017, outlined a strategy to enhance maritime security in West and Central Africa, that could counter piracy, armed robbery against ships and other illicit activities (IMO, 2017). This strategy also aims at supporting the development of a vibrant and sustainable maritime sector. The IMO seeks to improve upon the information sharing network and ensure compliance with and enforcement of measures to enhance maritime safety, security and search and rescue procedures. To this end, it is prudent to identify and assess the existing Maritime Domain Awareness (MDA) attributes, including any facilities that may be integrated with them, with a view to enhancing safety, security and protection of the marine environment along the West and Central African coast.

The territorial waters of Ghana abound in enormous natural resources, including fisheries, beautiful beaches, minerals and hydrocarbon deposits. Moreover, Ghana has become a major maritime trading hub for West Africa in recent times (GPHA, 2015). Recently, the country joined other states in West Africa that produce and export oil in commercial quantities. The protection of oil installations, and vessels engaged in the vibrant fishing industry as well as tourism has created the need for constant monitoring of the maritime area. With increasing maritime traffic especially in the GoG, regulatory and law enforcement agencies are under pressure to mitigate pressing problems such as Illegal, Unreported, Unregulated (IUU) fishing, piracy and armed robbery as well as the trafficking of drugs and people, and transport of illegal goods by sea (Hoyle, 2015).

Against this backdrop, the Ghana Maritime Authority (GMA) in 2014 introduced the use of an integrated Vessel Traffic Management Information System (VTMIS), for the surveillance of the country's maritime domain. Within the system, there are embedded functionalities to identify and transmit information on vessels fitted with Automatic Identification System (AIS). Its main purpose is for monitoring and surveillance of the coastline of Ghana, so as to increase safety and security of the maritime environment. Whilst achieving the results, the system has also, the capacity to share the needed information with other neighbouring countries about movement of vessels along the GoG (GPHA, 2015).

Other stakeholders in the maritime industry have also moved into the digital revolution to independently monitor various activities of interest within the territorial waters of Ghana. These stakeholders include the Ghana Navy, the Monitoring, Control and Surveillance (MCS) unit of the Ministry of Fisheries and Aquaculture Development (MOFAD) as well as the National Security Coordinating Council (NSCC). These unrelated MDA tools have the potential to increase the capacity of monitoring and surveillance of the maritime space of Ghana in order to enforce the relevant laws. However, effective use has not been attained as of now. There seems to be a lack of optimized co-ordination between the various stakeholders, in achieving the common goal of ensuring the safety and security of Ghana's maritime integrity.

## **1.2 Problem Statement**

The maritime domain according to the United States Department of Defense includes *“all areas and the things on, under, relating to, adjacent to, or bordering on a sea, ocean or other navigable waterway including all maritime related activities, infrastructure, people, cargo and vessels and other conveyances”*. On the other hand, MDA is defined by IMO as the *“effective understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment”* (IMO, 2010).

The main objective behind MDA, according to Dalaklis (2017), is the surveillance of the maritime environment to gain sufficient knowledge in order to detect and prompt necessary action on illicit maritime activity in ample time to avoid harm. Furthermore, according to Bueger (2015), MDA is one of the preconditions for coordination and

cooperation between diverse maritime law enforcement agencies, which aims at developing shared understandings of developments and threats at sea. Transport Canada (2015) goes on to define the global concept of MDA “*as having true and timely information about everything on, under, related to, adjacent to, or bordering a sea, ocean or other navigable waterway*”.

The above concepts mean that the main idea of MDA is to gather maximum information and intelligence on ships and related matters with the use of embedded technological aids like AIS, LRIT and coastal radars. After collecting those data, inferences about all the maritime areas of interest could be drawn for informed decision making. The resolve to achieve a comprehensive situational awareness of all associated threats to the maritime environment is what is known as MDA. Having a good picture of the maritime environment helps in the prevention and repression of piracy and armed robbery at sea, interdiction of Vessels of Interest (VOI) as well as the apprehension of maritime criminals by the swift deployment of Maritime Interdiction Operation (MIO) teams.

Effective MDA, therefore, entails integrated management of different sets of collection and processing capabilities, aimed at identifying and understanding activities of interest. These are further associated with the MDA tools and related functionalities with enough endurance, repeatability, and quality to identify trends and anomalies, so as to enhance situational awareness to help in making informed decisions. MDA improves maritime safety and security through the following:

- a. Quickly identifying actual or potential threats
- b. Making informed decisions
- c. Taking effective action
- d. Sharing knowledge with appropriate partners

With the increase of shipping and other activities in the maritime space of Ghana, it is critical to ensure its safety and security. As a basis for improvement, it is prudent to investigate the effectiveness of the current MDA tools and further assess the need to upgrade them in order to identify and interdict the new dangers posed by illicit maritime activities. The potency of employing the current generation of monitoring and control systems within the MDA tools is also investigated.



Crimes associated with the maritime industry are trans-boundary in nature. Moreover, *“the maritime environment is vast and complex, and with the massive amount of legal maritime traffic, finding a security, environmental or resource threat is very difficult”* (Hoyle, 2015). To mitigate these illicit maritime activities, there is a need for trans-border cooperation between coastal nations (Ifesinachi and Nwangwu, 2015). This cooperation cannot be achieved without synergy and collaboration between stakeholders within one particular country. For that matter, it is necessary to investigate all the various MDA tools in Ghana and their association with each other. These MDA tools (used by the various stakeholders) have advantages but also, disadvantages. Their work should be seen as complimentary toward an overarching purpose of ensuring maritime safety and security within the territorial waters of Ghana.

### **1.3 Aims and Objectives**

The purpose of this research was to investigate Ghana’s MDA capabilities, ascertain the related technical and operational capacity and to bring to the fore major challenges that prevent effective collaboration between maritime agencies, while identifying workable solutions. The research further identified the security and safety costs associated with all the tools required to maximize effective maritime safety and security operations by the law enforcement agencies in the country. It also ultimately sought to increase Ghana’s maritime security capacity by assessing the impact of the MDA tools within Ghana’s territorial waters with a view of enforcing relevant laws within the country, specifically, and the GoG in general.

### **1.4 Research Questions**

The research sought answers to the following:

- a. What are Ghana’s policies and priorities on MDA?
- b. What are Ghana’s current MDA capabilities and assessments?
- c. What challenges do the various maritime stakeholders face in collaboration and information sharing?
- d. Has adequate training been given to operators of the various MDA tools?
- e. How can the situation be improved?

## **1.5 Methodology**

The research was carried out using both primary and secondary data sources. Questionnaires were administered to both high level officials of the various stakeholder institutions as well as to selected individuals at the operational level. It involved persons with hands-on knowledge of the various MDA tools because of the nature of the desired outcome of the research. Information that was sought from respondents included the weaknesses in the surveillance systems, ways to enhance information sharing among stakeholders, as well as challenges in collaborating with other stakeholders.

For secondary sources of information, the research relied on publications and regulations, including best practices within the maritime industry. They were used as a yardstick for investigating Ghana's MDA. Moreover, dependence on books, articles and reputable internet sites, such as IMO docs, and Research Gate served as very good sources of reliable information on current best practices in the implementation of MDA.

The questionnaires were distributed through email correspondence for easy response gathering. Telephone calls to the various respondents preceded the questionnaire distribution to inform them of pending emails for prompt response. After receipt of responses from the respondents, there were follow-up telephone conversations or further emails for clarifications as necessary.

To ensure the quality of data, a section of the questionnaire required background information from the potential respondents. Among other things, their educational qualification, sea experience, years of employment, current position, age and knowledge of MDA were solicited. Respondents were selected from monitoring and surveillance departments of the various maritime stakeholder agencies for credible response.

Most of the data for this research was compiled automatically as and when questionnaires were completed online by respondents. The remaining data from interviews was collected later when the need arose. Data analysis was performed using G Suite (Google Sheets and Awesome Table).

### **1.6 Expected Results**

It was expected that after gathering enough data from various stakeholders, the following would be revealed:

- a. Existing measures for improved MDA collaboration between the various stakeholders in Ghana's maritime industry.
- b. Gaps in the usage and data exchange of existing MDA tools in Ghana.
- c. Required policies to be identified for adoption by the various stakeholders in the maritime industry.
- d. The required training and capacity building approach relevant within the framework of improving the MDA capabilities.
- e. Tried and tested solutions to improve MDA tools in developed maritime nations with a view to identifying the best ones to be adopted in Ghana.

### **1.7 Key Assumptions and Limitations**

The research was not conducted within the confines of the maritime industry alone. Other parallel government agencies with interest in maritime safety and security were contacted for information on effectiveness of implementation of agencies' mandates. Participants included personnel from the Ghana Navy, GMA, MCS division of the MOFAD, Environmental Protection Agency, Ghana Ports and Harbours Authority, Regional Maritime University, Narcotics Control Board and NSCC.

This research covered surveillance of surface ships using shore based maritime surveillance systems alone. It did not cover air and under-water surveillance. The research was conducted mainly by questionnaire. However, a follow-up telephone interview was used for clarity of response provided by respondents.

### **1.8 Basis of Literature Review**

Books, articles and publications regarding the MDA capabilities of Ghana are in short supply. However, industry experts in various parts of the globe were available for guidance within the framework of this research. Their views were utilized to the maximum extent. The research was also conducted using IMO and West African sub-regional legal regimes as guides.

The 1982 UN Convention on the Law of the Sea (UNCLOS) defines the Maritime Zones (Delimitation) framework, the basis under which Ghana can claim sovereignty and enforce its regulations over certain areas of the sea. The International Convention for the Safety of Life at Sea, 1974 (SOLAS 1974) and its protocols set out the legal framework for the safety of ships, crew and passengers. However, this convention only applies to passenger ships engaged in international voyages as well as cargo ships of 500 GT and above. The regulations do not affect warships, cargo ships of less than 500 GT, pleasure crafts or fishing vessels.

The International Convention Relating to the Intervention on the High Seas in Cases of Oil Pollution Casualties 1969 (INTERVENTION) and Related Protocols set out the legal regime for coastal states to take preventive actions that mitigate or eliminate grave and imminent danger to their coastline or related interests from pollution or threat of pollution of the sea by oil. The International Convention on Maritime Search and Rescue (SAR), 1979 as amended imposes obligations on coastal states to cooperate with other states in SAR operations. The Yaoundé Code of Conduct sets out the basis for GoG states to develop a regional framework for information sharing and operational coordination to counter piracy and armed robbery at sea.

### **1.9 Structure and Organisation**

This dissertation is divided into six (6) Chapters. Chapter 1 consists of the background, problem statement, aims and objectives, research question, methodology, expected results as well as key assumptions and limitations of this paper. Chapter 2 explains the research methodology for this study. The data sources and the participants involved in providing primary data are also identified.

A literature review is presented in Chapter 3. Important studies that have been conducted about MDA and its systems were carefully assessed, discussed and critiqued to serve as a benchmark for this study. Emphasis was laid on countries that have done extensive research and have workable solutions of MDA collaboration, such as the United States of America.

In Chapter 4, existing requirements and operations of the various maritime surveillance systems in Ghana were evaluated to identify the conditions of collaboration and information sharing among the maritime stakeholders. The scope and limitations of Ghana's current MDA were critiqued. Also, the potency of all legal, administrative and operational requirements for collaboration was tested.

Chapter 5 was used for summary of findings and analysis. Based on the primary data as well as Chapters 2, 3 and 4, the requirements to achieving effective teamwork and collaboration among various maritime agencies in Ghana were analysed. The outcome of the analysis is expected to help solve the problems identified in this research. Chapter 6 presents recommendations and conclusions for this dissertation.

## **CHAPTER TWO**

### **RESEARCH METHODOLOGY**

#### **2.1 Introduction**

The method used for the conduct of any research effort is very crucial for its success. The method used was determined largely by the kind of data that was needed. After carefully examining the selected topic, it was decided that the qualitative method of research be chosen to gather the primary data required.

The University of Utah defines qualitative research as a “*process of naturalistic inquiry that seeks in-depth understanding of social phenomena within their natural setting*” (Morse, 2015). The attention of qualitative research is mostly drawn to the "why" rather than the "what" of social phenomena and makes sense out of peoples' experiences. Qualitative research as indicated by Family Health International is “*especially effective in obtaining culturally specific information about the values, opinions, behaviours, and social contexts of particular populations*” (Mack et. al, 2011). The areas of attention for any qualitative research include individuals, societies and cultures, as well as language and communication. The qualitative method was chosen because the study is related to individuals and how they collaborate within an organisation and between two or more organisations.

#### **2.2 Data Sources and Basis of Literature Review**

Data for the study was collected in two main ways; primary and secondary. Primary data is an authentic or original data that may be collected from participants of a study. Currie (2015) identifies primary data as “*data that were previously unknown and which have been obtained directly by the researcher for a particular research project*”. According to the business dictionary, primary data is directly collected or observed from first-hand experience. It is normally collected straight from the respondents from

the affected community. Some of the methods used to collect this kind of data include questionnaire, interview and participant observation.

Secondary data is the data that is already published in literature by other researchers. The business dictionary defines secondary data as “*published data and the data collected in the past or by other parties*”. Secondary data can be retrieved from books, published research, journal articles, media reports and academic writing. This specific type of data can be very essential to every research that involves the collection of primary data. It provides a reference point to begin any research. For the purpose of this research, secondary data provided a useful source of historical background to MDA.

Questionnaires were administered to collect data about everyday operations of the various maritime stakeholders in Ghana, and created the full picture of how they cooperate and adapt to changing operational conditions. Closed-ended as well as open-ended questions were posed to solicit ideas from respondents. The questionnaires were designed in such a way not to provide identification of a particular respondent but to ensure strict confidentiality. The questionnaires were divided into two (2) parts: the general part, which was intended to explore the general background of a respondent, and part two (2) which solicited answers to the research questions.

The general section of the questionnaire consisted of straight forward questions while part 2 was comprised of both closed ended and open ended questions. The questions were posed in such a way to seek genuine responses from individuals working with the maritime surveillance departments of various maritime agencies, and who volunteered to take part in the study.

The secondary data complemented the responses from the questionnaire and interviews. It was very resourceful in interpreting the responses so that solutions to the existing MDA problems in Ghana could be identified. Data from questionnaires that are in tandem with secondary data indicates the quality of the research data gathered, while contradictory data was analysed based on the weight of people responding in a similar manner i.e. the number of people, their background and experience.

### 2.3 Research Participants

In every research, the individuals that take part must be willing to provide vital information to the best of their knowledge, and their individual perspective and experiences to best help the study. Participants included in the research were managers or directors, supervisors and operators of maritime surveillance systems in Ghana. Primary data collection for this study was conducted within the various surveillance departments of the following maritime stakeholders in Ghana:

- a. Ghana Maritime Authority (GMA). The GMA is charged with the safety of navigation in Ghanaian waters as well as fulfilling the flag state, coastal state and port state responsibilities in an effective and efficient manner, having due regard to international maritime conventions, instruments and codes.
- b. Ghana Navy. The Navy is classified as a coastal navy and its core function is to ensure the protection of Ghana's sea lines of communication, which are vital to national survival. In that sense, it is for both defence and law enforcement at sea. The Navy is one of the GoG maritime forces expected to maintain and operate an efficient fleet, to meet the maritime challenges imposed on the sub region.
- c. Ghana Ports and Harbours Authority (GPHA). GPHA is in charge of planning, development and maintenance of port infrastructure and superstructure as well as the operation and management of the port facilities. They hold the responsibility of environmental management, port security, property protection and emergency preparedness and response.
- d. National Security Coordinating Council (NSCC). The NSCC is responsible for considering and taking appropriate measures to safeguard the internal and external security of Ghana. Its members are responsible for ensuring the collection of information relating to the security of the country, so as to enable the security services and other departments and agencies of the Government to co-operate more effectively in matters relating to national security.
- e. Monitoring, Control and Surveillance (MCS) Department of MOFAD. It is the implementing agency of MOFAD, responsible for all monitoring, control, surveillance, evaluation, and compliance functions in all areas of fisheries development and management in Ghana. Its functions also relate to fish health, post-harvest activities, safety, and quality assurance.



- f. Marine Police. The Marine Police unit is responsible for policing duties related to oil and gas, inland waters, ports and harbours. The unit was established after the country discovered oil in commercial quantities in 2007, to help provide security for the oil and gas sector.
- g. Narcotics Control Board (NACOB). This agency is responsible for the formulation as well as enforcement of the country's narcotics laws. It liaises with other government agencies and departments including non-governmental organizations that have anything to do with drug abuse.
- h. National Disaster Management Organisation (NADMO). This agency is responsible for the setting up of monitoring and early warning systems to aid the identification of disasters in their formative stages, to disseminate timely information and warning, as well as creating awareness of disasters.

These government departments and agencies including law enforcement agencies were selected because their mandates have direct impact on the activities relating to the maritime environment of the country. More importantly, their roles influence environmental protection, safety and security of the maritime environment.

#### **2.4 Ethical Issues**

Data protection and confidentiality of participants in a survey are very important for every researcher. Participating in the study was not obligatory for any person at any point in time. The study required the consent of all respondents to the questionnaires and allowed them to withdraw from participating in the research anytime they deemed necessary to do so. Confidentiality of the data retrieved was ensured to the letter. In addition, anonymity of all respondents was preserved. There was no anticipated risk of physical or emotional injury to any respondent. They were not paid for contributing to the research.

#### **2.5 Data Analysis**

The questionnaire was sectioned in 2 parts; part 1 focused on the background of the respondent, with part 2 exploring the effectiveness of the surveillance system as well as the optimal use of the system by the system operator. The background sought to

understand who the respondent really is and ensure that his/her response is of good quality for the purpose of the research. The questionnaires targeted each maritime agencies' areas of interest and priorities in the maritime domain, the role of the surveillance system used by the agency, surveillance tools embedded in the system used by the agency, ways of interacting with other stakeholders as well as the range of coverage of the system. The questionnaires investigated whether adequate training is given to the system operators, whether the workload is moderate and whether system operators can configure the system after a minor breakdown, as well as how training needs can be met.

Responses from the questionnaire were finally analysed to draw conclusions as well as recommend possible ways of improving the situation. The data from this research was analysed using a commercial software package from Google (G Suite). This software package was used because of its ease to be organised and exported to other google software for analysis. Results can be generated in various ways after the data has been analysed by this software.

## CHAPTER THREE LITERATURE REVIEW

### 3.1 Introduction

The fast development of the shipping industry, coupled with the rate of development of Information and Communication Technology (ICT) has been affecting the safety and security of maritime transport and navigation since the late 20<sup>th</sup> century (Urbanski et. al., 2008). ICT is further changing the procedures, standards and processes of ensuring efficiency and safety of marine transportation, including maritime transportation systems (Baldauf et. al., 2018). Also, thorough understanding of the maritime environment was brought to the fore after the 11 September 2001 terrorist attack. It was then realised that the maritime environment can be exploited by miscreants to inflict damaging effects on the world's commercial systems, economies and societies.

IMO, for that reason, outlined comprehensive measures to respond to these and other similar security threats to ships and port facilities, thereby enhancing their security after the 9/11 attack (IMO, 2017 and Dalaklis, 2017). The measures are thus contained in the International Ships and Port Facilities Security (ISPS) Code. The ISPS Code is the most important IMO instrument that tackles security threats to ports and related infrastructure (Nordfjeld and Dalaklis, 2017).

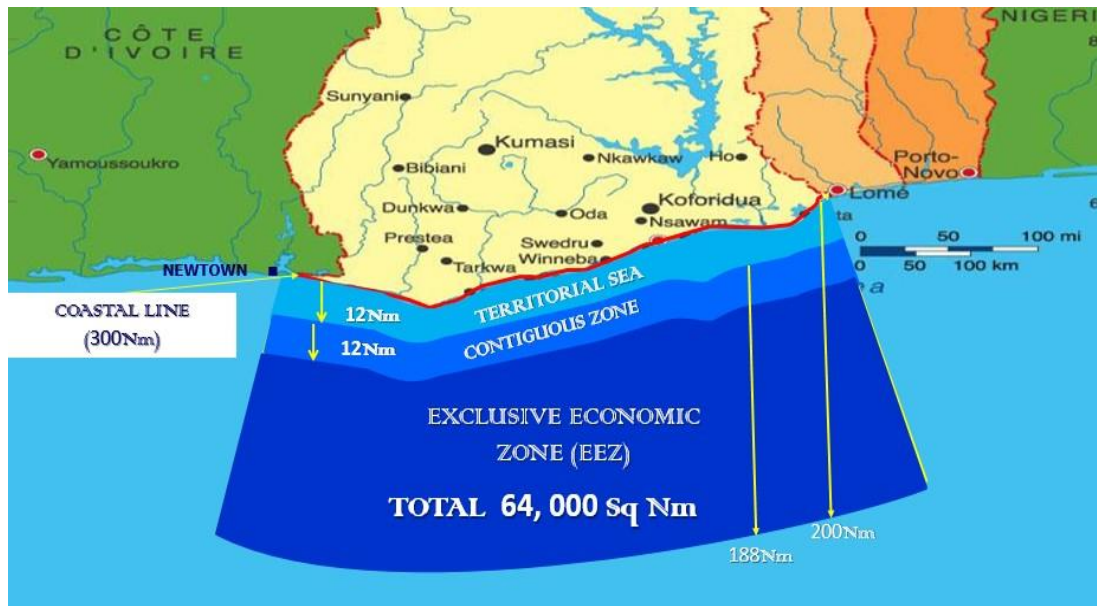
The attention of the global maritime community has been drawn to the “*serious safety and security concerns of the shipping industry and the seafaring community as a result of the attacks against ships sailing in the Gulf of Guinea*” (IMO, 2014). Maritime threats within the GoG, in general, and Ghana's territorial waters, in particular, include piracy, hijacking, drug smuggling, human trafficking and IUU. According to the GoG anti-piracy guidance developed by BIMCO, INTERTANKO, INTERCARGO, ICS and supported by NATO shipping centre in 2012, “*piracy and armed robbery in the Gulf of Guinea region is an established criminal activity and is of increasing concern to the*

*maritime sector*". The most vulnerable areas include the following: The territorial waters of Benin and Nigeria, plus; Nigerian Exclusive Economic Zone north of latitude 3° N, plus; Benin Exclusive Economic Zones north of latitude 3° N (BIMCO, 2016). Attacks and kidnapping for ransom within those places are widespread and violent.

Awareness of the maritime domain is required so as to deal more effectively with the safety and security implications within the maritime environment. Of course, these initiatives do not eliminate the risk of collision or use of violence by criminals, but rather increase situational awareness by the necessary means of sharing information that aids in identifying risks or threats to maritime safety and security.

### **3.2 Ghana's Maritime Boundary**

Ghana is a littoral State located in West Africa. The country shares a border with Togo to the East, Cote d'Ivoire to the West, Burkina Faso to the North and the GoG to the South. Its coastline of 300 nautical miles stretches from Aflao on the East to New Town on the West. Because of its diverse maritime interests, Ghana has established 12Nm of Territorial Waters, followed by 12Nm of Contiguous Zone, resulting in a 200Nm Exclusive Economic Zone (EEZ) (CIA, 2018) and 350Nm Continental Shelf (Daily Graphic, 2018), in accordance with UNCLOS, as depicted in Figure 2. Shipping and sea-borne trade is vital to the economic development of the country with nearly 90% of both imports and exports carried through the sea lines of communication (Ma, 2017). There is also the production of oil in commercial quantities since 2010, with several explorations on-going in the western part of the EEZ.



*Figure 2: Ghana's maritime boundary*

Source: Created by author, as a modification from Ghanaweb.com

Ghana's maritime space is used for a number of activities that boost the economy. The derived benefits to other neighbouring landlocked countries, especially Burkina Faso and Mali, as highlighted in Figure 3, cannot be underestimated. These activities include fishing, recreation and tourism, salt production, international shipping, as well as oil and gas extraction. The maritime boundary further contains breeding grounds for aquatic habitats, marine animals, offshore infrastructure (especially at the Jubilee Oil Fields) and subsea cable lines like the West African Gas Pipeline, which runs from Nigeria through Benin and Togo to discharge an average of 5 billion cubic meters of gas per year (WAGP, 2018). There are also marine protected areas which mostly preserve cultural heritage and monuments like the Christianborg Castle in Osu, Accra.

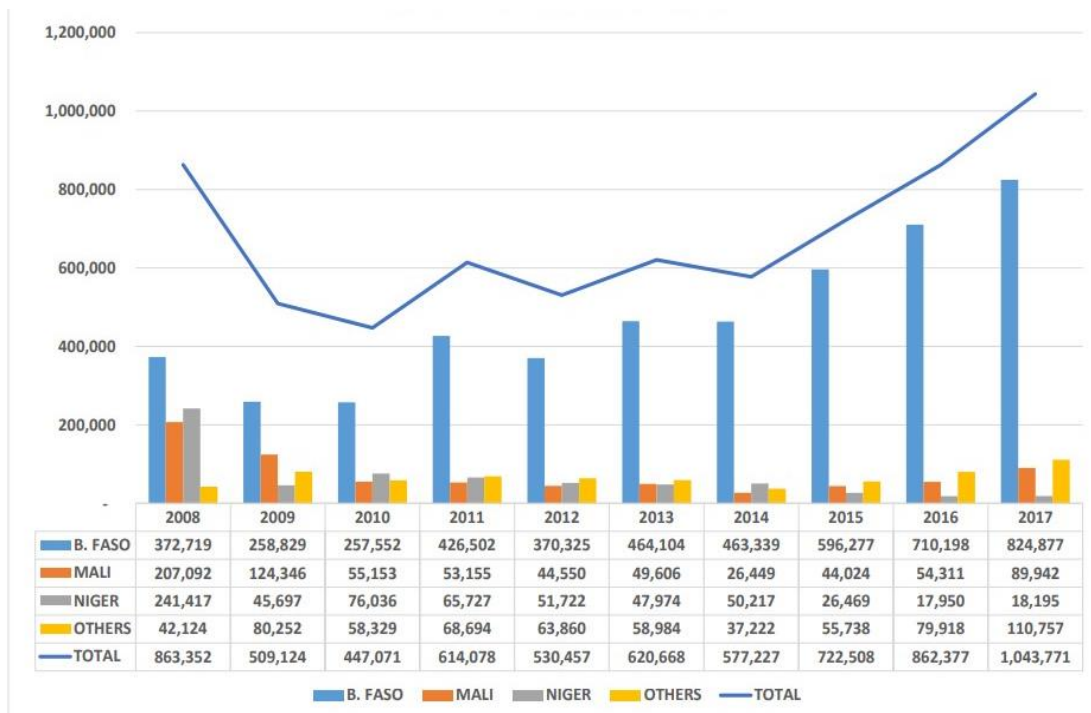


Figure 3: Transit Cargo by Destination from 2008-2017

Source: GPHA (2018)

### 3.3 Agencies Concerned with Ghana's Maritime Domain

According to Gasu (2011), MDA encompasses “*information sharing and collaboration among various stakeholders in maritime transport, trade, surveillance and security*”. MDA involves the interaction between several maritime agencies confronted with the challenge of ensuring safety and security as well as clean and environmentally friendly seas (Bueger, 2015). It is interesting to note that each one of these agencies has its specific mandate, internal bureaucracy and organisational culture. The problems encountered with internal red-tape are often translated into the national level. The maritime agencies in Ghana include the GMA, the law enforcement agencies (Navy, Police) and other regulatory agencies (EPA, MCS unit of MOFAD, GPHA, NSCC, NADMO and NACOB).

The maritime stakeholders are cross-sectoral in nature. As such, effort must be made to overcome every problematic barrier to cooperation. To begin with, there is the problem of civil-military divide. The military ensures maritime security but there are

also a number of civilian counterparts including the Police and Port security. Several write-ups have shown the difficulty in civil-military cooperation, especially with the idea of who leads and who follows (Bueger, 2015). There is need for authorities to create the enabling environment that can bridge the gap between civilians and military personnel when involved in a joint operation.

Another hurdle to overcome is the public-private divide. This has to do with coordination between the state-owned agencies and the shipping industry. For instance, the shipping industry tends to cooperate with pirates to pay compensation for the release of crew and cargo when they fall victim to pirate attacks, contrary to states recommendations (Bueger, 2015). Moreover, shipping companies will prefer the use of private security services rather than relying on state analysis and reports.

### **3.4 Ghana's Maritime Threats**

Ghana's maritime domain has changed significantly in the last decade. The discovery of hydrocarbon deposits has changed the economic environment and has become the engine of national progress. Exploration of oil and gas at the Jubilee Oil Fields (JOF), Tweneboah, Enyenra and Ntomme (TEN) Fields and other exploration sites in the territorial waters of Ghana, coupled with the fact that the Ghanaian ports of Tema and Takoradi are the gateway to West African markets, has contributed to the increase in maritime traffic (as shown in the number of port calls to Tema and Takoradi ports, respectively, in Table 1 and Table 2). Ghana like any other GoG country, is faced with increasing maritime safety and security threats. As a matter of fact, there is a need to pull all resources together by the Ghana government to curb the emerging maritime threats.

Table 1: Tema Port Calls from 2012-2017

<b>Port of Tema: Summary of Vessel Traffic</b>						
<b>SHIP CALLS BY TYPE</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
COMMERCIAL VSL	1,238	1,320	1,324	1,296	1,267	1,292
GENERAL CARGO	87	72	59	56	74	61
TANKER	128	127	122	136	124	160
FISHING VESSELS	136	131	108	140	137	140
REFRIGERATED VESSEL	104	111	101	103	105	100
ROLL-ON ROLL-OFF	162	224	207	156	149	158
OTHERS	147	102	72	79	117	125
<b>TOTAL SHIP CALLS</b>	<b>1,521</b>	<b>1,553</b>	<b>1,504</b>	<b>1,515</b>	<b>1,521</b>	<b>1,557</b>

Source: GPHA (2018)

Table 2: Takoradi Port Calls from 2012-2017

<b>Port of Takoradi: Summary of Vessel Traffic</b>						
<b>SHIP CALLS BY TYPE</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
TUG / SUPPLY VESSEL	1,053	758	844	919	928	884
TANKER	99	79	63	55	82	181
FISHING VESSELS	13	15	51	102	86	106
CONTAINER MULTIPURPOSE	25	22	3	2	1	1
BULK CARRIER	173	169	143	139	150	189
BARGE CARRIER	7	4	4	7	55	0
EXHIBITION/TOURIST VESSELS	7	13	4	5	6	2
<b>TOTAL SHIP CALLS</b>	<b>1,664</b>	<b>1,364</b>	<b>1,387</b>	<b>1,525</b>	<b>1,601</b>	<b>1,626</b>

Source: GPHA (2018)

The major threats mostly identified in the maritime domain of Ghana include the following:

1. Environmental. The effect on the environment of the activities associated with oil production (oil pollution), illegal discharge from ships as well as illegal dumping is enormous and needs to be given the necessary attention. Pollution of the environment by the exploration and drilling of oil is mainly in the form of oil spillage into the sea, accidental discharges at sea, the continuous distillation process of the oil, and the dumping of toxic waste.



2. Fisheries. The fishing industry in Ghana is threatened with extinction as a result of over-fishing and IUU. Industrial fishing vessels are not allowed to fish in the Inshore Exclusive Zone i.e. from the coastline to 6Nm seaward or below 30m depth, while artisanal fishing canoes are permitted to fish within those areas. However, many industrial fishing vessels defy this provision, resulting in the depletion of the fish resources. Often, IUU fishing fleets illegally scoop-up hundreds of millions of dollars' worth of fish from Ghanaian waters, a basic reason why import restrictions were imposed on Ghana's fisheries products in 2012 and 2013 by the EU (MOFAD, 2014).
3. Illegal Bunkering/Crude Oil Theft. Illegal bunkering includes the purchase of illegally acquired or refined oil products mostly at cheaper rates. It is typically acquired from stolen oil and the destruction of oil pipelines with criminal intent for mischief or for monetary gains. It also involves the diversion of crude and refined products by unauthorized persons at sea. When companies continue to patronise these cheap products, illegal bunkering has the tendency to increase criminal activities like piracy and armed robbery at sea. It is against this backdrop that MT Mammy Mary and MT Metrix 1 were both arrested by the Ghanaian Navy when they illegally traded oil consignment about 5Nm from Tema Harbour on 14 April 2018 (Ocloo, 2018).
4. Piracy/Robbery at Sea. Piracy and robbery at sea are set to be on the rise in the GoG region at an alarming rate (IMB, 2018), surpassing that in the horn of Africa. These pirates and robbers usually target ships' crews, cargo and other valuables. The first quarter of 2018 saw a string of 22 piratical attacks in the GoG region, in the maritime domains of Ghana (1 hijacked), Benin (2 hijacked) and Nigeria (1 hijacked), with very high success rates (IMB, 2018). The number of incidences surpassed those from all other regions in the first quarter of 2018.
5. Trafficking. Ghana in 2016 was identified among the major cocaine transit points, with about 61% being transported out of the country by boat (UNODC, 2016). Drug trafficking, a transnational crime, has an impact on national

security and is also directly related to other types of organised crime such as money laundering and terrorism. Moreover, it has the potential to corrupt state institutions and to affect the stability of state systems and society. Also, humans and weapons may be trafficked through Ghanaian waters if criminals find that these waters are not properly secured.

### **3.5 Existing Surveillance Systems to Tackle the Threats**

The European Commission (2017) correctly points out that “*maritime surveillance is essential for creating maritime awareness (knowing what is happening at sea)*”. To assist the Ghanaian government and security agencies to enforce security measures in the maritime domain, the GMA initiated action to implement its MDA Programme. This programme is designed to ensure availability of comprehensive information about Ghana’s maritime domain through electronic surveillance systems. The Vessel Traffic Management Information System (VTMIS) has the capability of sharing data between relevant agencies (Kuma, 2015). However, this has not been realised to its utmost.

Other maritime agencies have VTMIS monitors which cannot be fully exploited by these agencies because they are used for monitoring purposes only. Because of that, those agencies have acquired their own surveillance systems independent of the VTMIS provided by the GMA. Data exchange and information sharing is somewhat difficult because of authorisation privileges within the system. As a result, acts that pose threats at sea sometimes go unnoticed and even when noticed, enforcement becomes a problem. As reported by TV3 News, five (5) persons including one Ghanaian, a Greek, and three (3) Korean nationals were abducted and held hostage by suspected pirates believed to have come from Nigeria to launch series of piratical attacks in Ghanaian waters from 27 to 29 March 2018 (Effah, 2018).

Also, merchant vessels plying their trade along the coast of Ghana do not report incidents to the Ghanaian authorities. This is evident because a report was sent to the Maritime Domain Awareness for Trade – Gulf of Guinea (MDAT-GoG) via email on 8 March 2018, about 1700 UTC, regarding a merchant vessel that was approached by three speedboats around Takoradi in Ghana (Daily Graphic, 2018). The information flow was not swift because of barriers in collaboration and information

sharing among the maritime stakeholders. This resulted in the pirates attacking three vessels and absconding with some booty.

### **3.6 Maritime Safety and Security**

Maritime safety as defined by Ubanski et al (2008) is the “*safety of life and property at sea, and the safety of the marine environment from pollution by ships*”. Maritime safety relates to safety of ships, crew, passengers and cargo as well as the prevention of marine environmental pollution. The safety of life and property at sea is of utmost importance to IMO and the international maritime community. Maritime safety is concerned with life and property issues in the maritime domain, such as prevention of accidents and pollution and the reliability of ships and their equipment. To this end, the IMO has adopted several regulations and conventions to improve operational safety of seagoing vessels, with the SOLAS convention standing out as the most important of all (Dalaklis, 2017).

Maritime security on the other hand is concerned with activities relating to criminality, such as armed robbery and piracy, drug trafficking, smuggling and other transnational crimes. According to Feldt et al (2013) as (cited by Kuma, 2015), maritime security is a “*combination of preventive and responsive measures to protect the maritime domain against threats and intentional unlawful acts*”. Maritime security is also defined by Jones (2006) as (cited by Ubanski et al, 2008) as the security from terrorism, piracy and similar threats, as well as effective interdiction of all illegal activities at sea such as pollution of the marine environment; illegal exploitation of sea resources; illegal immigration; and smuggling of drugs, persons, weapons and other matters that can be used for terrorist activities. Maritime security, therefore, relates to maritime defence, environmental protection and management, offshore installation security, security of aquatic organisms as well as security of ships, crew, passengers and cargo.

Apart from safety issues, SOLAS in its chapter XI-2 (which is known as the ISPS Code), focuses on special measures to enhance security. The code which entered into force on 1 July 2004 after its adoption in December 2002, contains mandatory requirements in part A as well as recommendatory guidance in part B. Nordfjeld and Dalaklis (2017) assert that SOLAS, through the ISPS Code, improves maritime

security by mitigating the risk of terrorism. The ISPS Code was developed to help administrations to implement basic security plans that deal with all security threats within the maritime domain.

Ghana as a flag administration has introduced the ISPS Code via its Maritime Security Act 2004 (Act 675). Provisions made there relate to the functions of the GMA, including recognised security organisations, ship security and port security. For other safety of navigation issues like seaworthiness, carriage of dangerous goods, load lines and general safety of life at sea to be binding on Ghana flagged vessels, the SOLAS convention is enacted via the Ghana Shipping Act 2003 (Act 645).

Thus, maritime safety is concerned with accidents without criminal intent, whilst maritime security concerns incidents with criminal motives. Certain researchers conclude that maritime safety and maritime security complement each other and also have shared goals (Kuma, 2015). A maritime security incident is also associated with safety issues and avoiding a maritime safety incident requires security of property against maritime criminals. The international maritime community has been doing great work with respect to both safety and security in the GoG region for some time now. A clear example is the formulation of the Guidelines for Owners, Operators and Masters for protection against piracy in the Gulf of Guinea region in 2013 which was again revised in June 2016.

Tackling the safety and security threats to Ghana's maritime domain requires a multi-stakeholder approach to succeed. Partnership between all the maritime stakeholders must be strengthened in order to facilitate and defend maritime trade in Ghana, in particular, and GoG in general.

### **3.7 Maritime Domain Awareness and Maritime Situational Awareness**

MDA is within the vital interest of the country because it assists maritime regulators as well as law enforcement agencies to exercise the appropriate response to maritime issues at the right time. A clear picture in relation to MDA can never be achieved without full cooperation among all the maritime stakeholders. Jau (2007) believes that the idea behind US MDA is to achieve an "*effective understanding of anything associated with the maritime domain that can impact the security, safety, economy or*

*environment to provide warning or identification of threats as early and as distant from its shores as possible so that appropriate operational responses can be initiated in good time”.*

On the other hand, Maritime Situational Awareness (MSA) as defined by NATO, is “*The understanding of military and non-military events, activities and circumstances within and associated with the maritime environment that are relevant for current and future NATO operations in the Maritime Environment, which includes the oceans, seas, bays, estuaries, waterways, coastal regions and ports*”. The officer on watch will have to observe, understand and be aware of his/her immediate environment so that informed decisions can be made based on the current situation for future movement of the ship. In such a case, Col John Boyd’s Observe, Orient, Decide and Act (OODA loop) is very helpful for watch officers, ship masters and pilots to make informed navigational decisions. MSA has got to do with collecting and analysing data from on-board safety systems and information sharing technologies to have a complete picture that will enhance the safety and security of a ship, from on-board the ship.

According to IMO’s guidance on acts against piracy, neighbouring countries with common borders in areas characterized as piracy and armed robbery threat areas should establish cooperation agreements with respect to preventing and suppressing piracy and armed robbery. Such agreements should include the coordination of patrol activities in designated areas. This requirement cannot be met unless organisations within a country effectively exploit it. All maritime stakeholders within a country must be able to effectively cooperate so that the spill over effect can be extended to neighbouring countries of mutual interest.

Jau (2007) claims that it is incumbent on maritime nations to have knowledge of everything that goes on in their waters so as to safeguard their safety and security domains. However, he argues that a key political challenge is cooperation between countries when it comes to information sharing. It is beholden on every maritime administration to facilitate the maritime safety and security of vessels and crafts operated within its national maritime environment. A key component of MDA is the monitoring of vessels. To monitor a vessel, there must be the capability to identify, detect and predict the vessels movement.

*“MDA is achieved by fully integrating cross-discipline capabilities in an infrastructure in which MDA partners work together to collect, fuse, analyse, and disseminate their products and services across mission areas and institutional boundaries”* (Vance et al, 2006). Jau (2017) admits that to achieve effective MDA, information sharing, information fusion and sense making of digital information received by the MDA tools is necessary. It helps authorities in making informed decisions backed by the relevant maritime legislation, which is driven by strategic policies.

President Bush in his address in 2002 as cited by Jau (2007) asserted that *“the heart of the MDA program is accurate information, intelligence, surveillance and reconnaissance of all vessels, cargo and the people extending well beyond our traditional maritime boundaries”*. According to Keane et al. (2009), MDA involves wide collaboration among various partners, whose contributions are vital to effectively understand the maritime environment. This implies that no agency can unilaterally achieve effective MDA.

MDA is concerned with building a shared information environment for partners to be able to monitor risks to their maritime areas of interests in order to promote freedom of navigation, civil liberties, and maritime trade (Vance et al, 2006). Jau (2007) believes that there is a need for capacity building and information sharing that can simplify responsive cooperation among national agencies and other maritime centres. All the maritime stakeholders have their own important roles to play in order to build a shared perspective of the maritime picture. This means that it is necessary to connect in diverse ways to contribute to the attainment of MDA.

It is worthy to note that *“Investments in MDA include improvements in gathering, analysis, integration, use, dissemination and sharing of decision quality information gained from a combination of maritime, land, air and space surveillance systems as well as the integration of intelligence and information available from major stakeholders in maritime security such as other government departments, allies and the commercial sector as well as a host of other non-governmental agencies and stakeholders”* (Keane et al, 2009). According to IMO (2015), *“advanced intelligence could also prove useful in obtaining information for Governments in order to be able to act in a coordinated manner even before an attack occurs”*.

### 3.8 Information Sharing

Various maritime information interpretation strategies abound through ICT means. For example, a database of vessel behaviour is best solicited by pattern analysis and historical trends. Accumulating information in relation to the same vessel will reveal the vessel's activities within a given time so that intelligence can be gathered on the vessel for possible remedial action to be taken should the need arise. Advantage can be taken from the vast computational power of modern ICT systems and intelligent algorithms, integrated human expertise, background knowledge and intuition (Riveiro, 2011) to identify anomalies and find possible solutions to the problems that may arise. Dedicated software can be used for data interpretation facilitated by brainstorming through research and analysis.

To share information means to create a shared understanding or unified interpretation of a sequence of events or threats at sea. The backbone of effective MDA is coordination, collaboration, cooperation and information sharing among all maritime stakeholders (Bueger, 2015). Differences in the establishment mandates of the various agencies make it difficult to generate the same meaning out of the same event. Different agencies may therefore interpret the same scenario differently.

Information that can be shared among maritime stakeholders includes incidents at sea, vessel movement at sea and other sensitive information, such as data from intelligence operations or criminal investigations, which can have a positive impact on MDA (Bueger, 2015). Incidents at sea may be real or based on suspicious activities. When information is shared in real-time, the appropriate response can easily be coordinated for a better end result. As a guiding principle, article 100 of UNCLOS obligates all states to fully cooperate in order to repress acts of piracy (Gottlieb, 2013). However, a large time gap between an incident and information sharing inhibits informed decision making, especially when a potentially dangerous situation needs to be urgently resolved (CJO, 2016). That kind of information can only help in trend or pattern analysis.

Information relating to vessels' movements at sea is normally provided by international tracking systems such as AIS and Long Range Identification and Tracking (LRIT). Other ways of tracking vessels' movements at sea include the use of satellite, air reconnaissance, radar and marine cameras fixed at advantageous

points. These means are purposefully used to identify smaller vessels including fishing or leisure crafts as well as vessels that do not comply with the applicable international regulations. Sharing information on intelligence operations or criminal investigations can be tricky at times. This is because of the associated legal concerns or the fact that it can compromise further intelligence collection. There is a need for authorities to create an enabling environment that can bridge the gap between stakeholders who are normally involved in joint operations.

### **3.9 Automatic Identification System (AIS)**

The AIS system relies on a transponder unit fixed on vessels to enable communication using VHF signals, in order to obtain information about maritime traffic around the ship. The AIS works in ship-to-ship mode for collision avoidance as well as ship-to-shore mode for traffic management. Embedded within the AIS are a Global Positioning System (GPS) transmitter and receiver and a display terminal, as the main components (Figure 4). The transponder unit transmits the vessels' identification, position, course, speed, and other details including its cargo at regular intervals.

Vessels fitted with AIS transceivers can be tracked by AIS base stations located along coast lines or, when out of range of terrestrial networks, through a growing number of satellites that are fitted with special AIS receivers (Dalaklis, Baldauf and Kitada, 2018). Within the last few years, technical developments of AIS have improved to support worldwide tracking of ships as a result of AIS position message by satellite (S-AIS), meaning that radio frequency range limitation is no longer a problem (Chintoan-Uta and Silva, 2016).

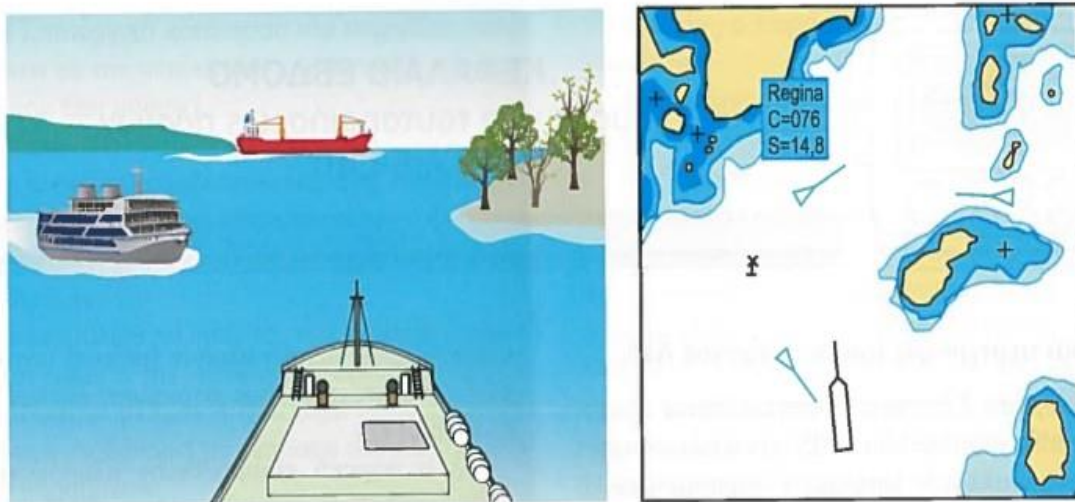




*Figure 4: AIS receiver*

Source: Pallikaris et al. (2016)

The AIS tool was developed for ships to be used primarily for identification at sea. According to Tetreault (2006), it helps in collision avoidance as well as traffic monitoring for authorities at shore including the ship's crew on-board the vessel (see Figure 5). With the AIS, authorities are able to get information on vessels within their jurisdiction. An AIS equipped ship is identified by manually inputting the ship's characteristics into the device while the geographic position is automatically taken from the GPS receiver. Any other ship's data such as voyage or cargo details has to be manually entered (static data).



*Figure 5: Visual picture and AIS picture*

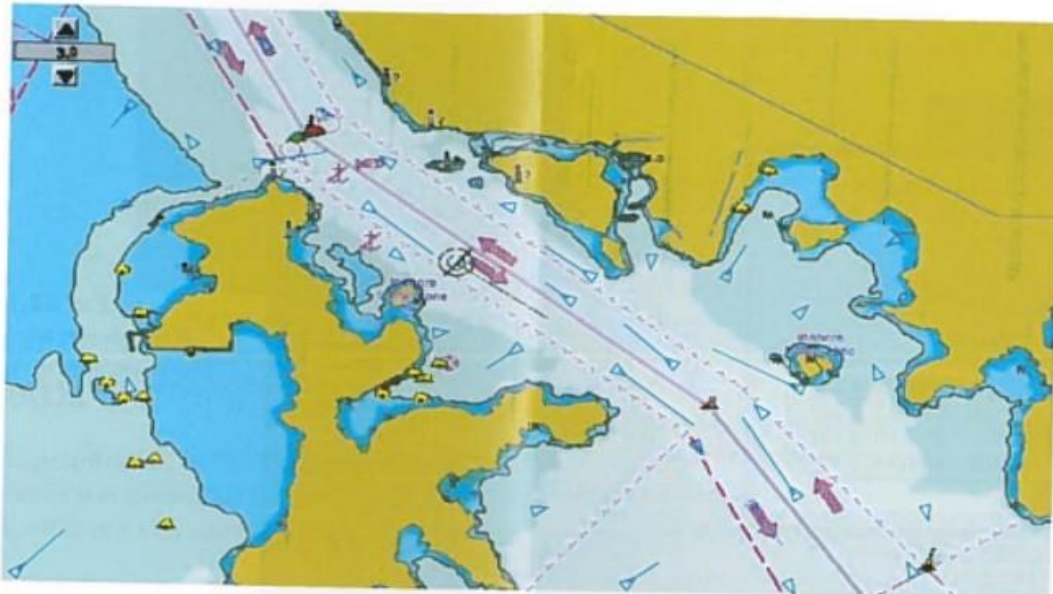
Source: Pallikaris et al. (2016)

The AIS is a critical tool that enhances MDA because it is internationally standardized and provides vessels' data (Bueger, 2015). It is a short range vessel tracking system used for vessel monitoring and safety of navigation. All vessels of more than 300 GT on international voyages, vessels more than 500 GT on domestic voyages, all passenger ships no matter the size or voyage and all tankers of any size on international voyages are obligated by IMO's SOLAS Convention to be equipped with AIS. It became mandatory on 31 December 2004. It provides most of the required information needed for authorities to be able to track vessels.

However, the AIS device is vulnerable to manipulation and display of wrong information by hackers and individuals who want to deceive the system. Data manipulation, hacking and spoofing are some potential problems that can be faced by administrations and ships' crew who rely on AIS data. These problems can be internet based or created by altering the data transmitted from the vessel. This goes a long way to affect vessel identification at sea.

The AIS broadcast covers the VHF range, which is the line of sight, and can be captured by other ships as well as shore installation receivers (Chintoan-Uta and Silva, 2016). AIS fitted vessels are able to autonomously and continuously transmit

all vessel data fed into the system as well as voyage data. The vessel data includes information on ship name, call sign, flag administration, length and draught, while the voyage data includes information on the vessel position, course, speed, last port of call, next port of call and type of cargo. Another benefit of AIS is its usage for accident investigation, SAR operations and also as aid to navigation (Figure 6).



*Figure 6: AIS vessels retrieved on ECDIS*

Source: Pallikaris et al. (2016)

Ship mounted AIS is IMO's directed shipping tracking instrument to enhance MDA (Tetreault, 2006). The device collates traffic data from other AIS and LRIT enabled ships that can be shared between ships at sea and maritime authorities ashore. The AIS is able to help monitor traffic and track other vessels in real time within the strategic maritime environment as well as heavy traffic lanes. AIS is expected to be operated, taking into account IMO's guidelines. Ships fitted with AIS shall maintain AIS in operation at all times except where international agreements, rules or standards provide for the protection of navigational information (IMO, 2013).

### **3.10 Long Range Identification and Tracking (LRIT)**

The LRIT system is a satellite based ship tracking system that was developed after the introduction of the ISPS Code by IMO, for coastal states to be able to track ships passing through their maritime boundaries. It is used for tracking and global identification of ships. LRIT enables persistent detection, identification, classification and tracking of vessels, thereby helping to enhance MDA. With LRIT, flag states are able to track their own ships. Coastal states track ships within 1,000Nm of coast; port states track ships calling on ports; SAR services track ships anywhere and security forces are able to track through an Information Distribution Facility (IDF).

The carriage of LRIT equipment was made mandatory for mobile offshore drilling units, cargo ships, including high speed craft, of 300 GT and upward and passenger ships, including high speed passenger craft, since July 2009. These ships are required to transmit their identity, their position (latitude and longitude) and the date and time that position was acquired. The LRIT device is such that it can be turned off to protect navigational information as well as for the safety and security of the ship. When such a case exists, the master will have to inform the flag administration without delay and record it in an incidence notification book. Apart from search and rescue services for persons in distress at sea, LRIT information retrieval is a paid service for contracting governments.

Ghana subscribes to an LRIT data centre and application service provider services from Pole Star Applications Limited, a London based Data Centre administrator. The firm provides Ghana with LRIT data feeds, which are in turn integrated within the VTMIS. The data feed is updated at 6-hour intervals. Pole Star, therefore, undertakes all the contracted mandatory and flag specific management functional requirements on behalf of Ghana.

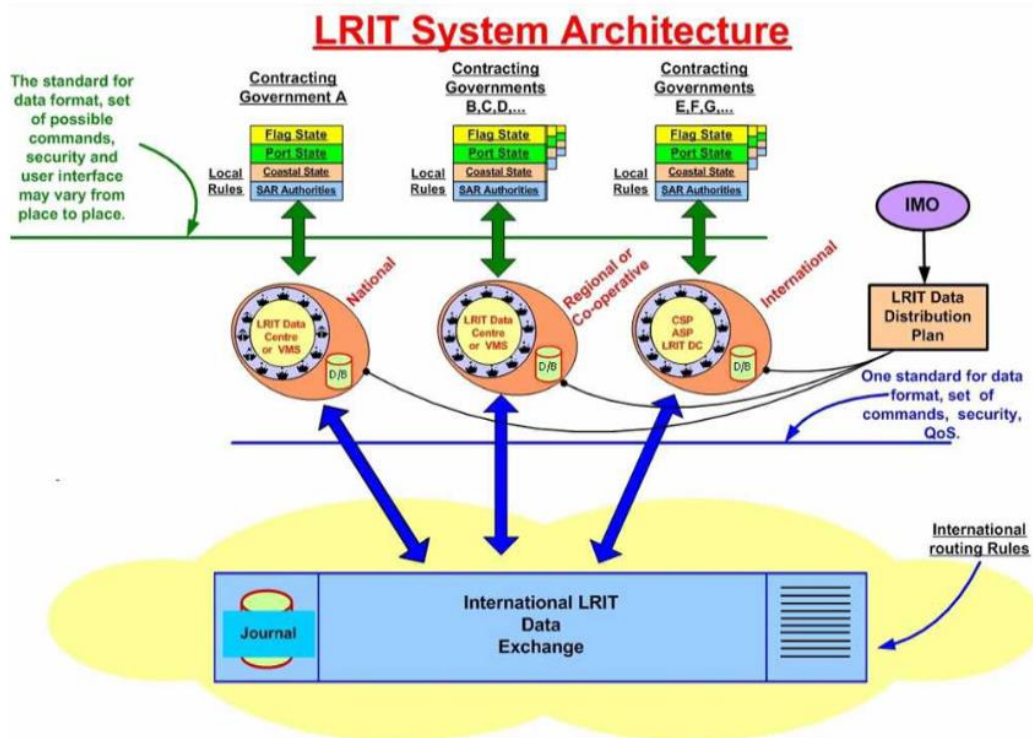


Figure 7: LRIT system architecture

Source: IMO

Unlike AIS which is open ended, with data transmitted un-encrypted over open frequencies of 161.975 MHz or 162.025 MHz, and 156.775 MHz or 156.825 MHz for terrestrial communications and satellite communications respectively (ITU-R, 2012), LRIT is encrypted end to end. LRIT data is only transmitted to that vessel's flag administration. Other flag states will have to request the LRIT information through International LRIT Data Exchange and be verified by the routing rules of a Data Distribution Plan before the information can be accessed, as portrayed in Figure 7. This makes the LRIT data highly secured, while the AIS on the other hand may be prone to vulnerabilities like data manipulation, hacking or spoofing by cyber criminals.

### 3.11 Radar

Radio Detection and Ranging (Radar), is a radio frequency technology used to detect the altitude, range, speed or direction of an object, closest point of approach (CPA), time to CPA and if necessary the size as well as the shape. The radar technology

operates on the Doppler effect principle in which a high frequency signal is transmitted in the direction of a target. The signal hits the target and is reflected onto the radar receiver. It also works on the pulse transmission and reception principle, where a transmitted high frequency signal is reflected off a surface and received at the same transmission point. The radar is used in aviation, maritime, weather, industrial and military applications. Unlike infrared and optical sensing devices, radar can detect very distant objects even under adverse weather conditions, with precision.

In the shipping industry, radar is a mandatory aid to navigation used at the bridge to identify and track other vessels so as to ensure safety of navigation. In chapter V regulation 19 of SOLAS, all passenger ships as well as ships of 300 GT and above are mandated to carry a 9 GHz radar or any device that helps assist navigation and avoid collision. All 8 RSSs that transmit data to the VTMIS have radars that are supposed to detect vessels up to 32Nm. Also, the Ghanaian Navy, with support from the US Navy, has an unidentified number of radar stations along the coast of Ghana to feed the Maritime Operation Centres (MOC).

Radar information is normally overlaid on AIS information to confirm vessel positions. The radar information helps VTMIS operators to provide navigation information service to all traffic, thereby helping to improve navigational safety. However, when AIS data is missing and activities of the radar image are suspicious, then there is the need to investigate what exactly is happening.

## **CHAPTER FOUR**

### **INITIATIVES CONTRIBUTING TO MDA**

#### **4.1 Introduction**

Piratical attacks, including armed robbery at sea have been increasing in the GoG region at an alarming rate since 2007, with incidences exceeding a quarter of worldwide reported attacks. Maritime insecurity in the region affects the transport of about 5 million tons of oil per day, which is more than half of Africa's total production per day and about 30% of the United States of America's oil imports (Vircoulon and Tournier, 2014). To address the situation, there have been a series of political level initiatives by member states of the region to implement a regional strategy for the safety and security of the maritime domain of both West and Central Africa.

During the 40th Ordinary Session of Economic Community of West African States' (ECOWAS) Heads of State and Government held in Abuja in February 2012, the ECOWAS Commission was mandated to develop a holistic maritime policy framework to guide actions and cooperation within the West African region (ECOWAS, 2017). In line with that mandate, ECOWAS, in 2014, defined its maritime security position, through the ECOWAS Integrated Maritime Strategy (EIMS).

The strategic objectives of the strategy are centred on maritime environment management, maritime safety and security, MDA, maritime governance and economy. ECOWAS collaborates with relevant regional organisations such as the Economic Community of Central African States (ECCAS), the Maritime Organisation of West and Central Africa (MOWCA) and the Gulf of Guinea Commission (GGC) in pursuance of the same objectives within the GoG maritime area.

#### **4.2 Yaoundé Code of Conduct**

The Code of conduct concerning the repression of piracy, armed robbery against ships and illicit maritime activity in West and Central Africa, popularly known as the

Yaoundé Code of Conduct, was adopted at the Yaoundé summit in Cameroon on 25 June 2013. This regional framework is an initiative of ECOWAS, ECCAS, GGC and MOWCA, and contains a comprehensive strategy that seeks to counter maritime threats within the GoG region (IMO, 2013). The IMO also provided technical support in developing the Code, knowing that its effective implementation would translate into sustainable development for the region's maritime sector. Thus, the strategy and initiatives of IMO to enhance maritime safety and security in the GoG region are aligned with the Yaoundé Code of conduct.

The Code of Conduct brings signatory states together to take appropriate measures to combat maritime threats, in accordance with international standards, and also commit to maritime information sharing among states. The Code further entreats GoG states to undertake national measures that criminalize piracy and armed robbery at sea so that individual states can prosecute perpetrators of these acts. It is of interest to note that the leading pillar of the strategy is interoperability between stakeholders to gather timely intelligence and share it among themselves at national or international levels. Through that, the various countries have developed and operationalized MOC for their navies, to facilitate information sharing.

For effective monitoring and enforcement capabilities, the Inter-Regional Coordination Centre (ICC) was established at the strategic level to implement the regional integrated strategy for maritime safety and security, contained in the Yaoundé Code of Conduct (Figure 8). At the sub-regional level, there is the establishment of the Regional Maritime Security Centre for Central Africa (CRESMAC), located in Pointe-Noire, Republic of the Congo for the ECCAS region. In addition, the Regional Maritime Security Centre for West Africa (CRESMAO), located in Abidjan, Cote d'Ivoire serves the ECOWAS region. CRESMAC has been operational since 20 October 2014. However, CRESMAO is yet to be fully operational because, for the time being, only intermediate staff from Cote d'Ivoire are staffing the centre. Although the required equipment has been donated to the centre by the German government, there seems to be a lack of funding and states' capacity to implement it to the fullest. As a result, timelines have not been completely met to date. It would be prudent for ECOWAS states to finalize all requirements for the centres to be fully functional.



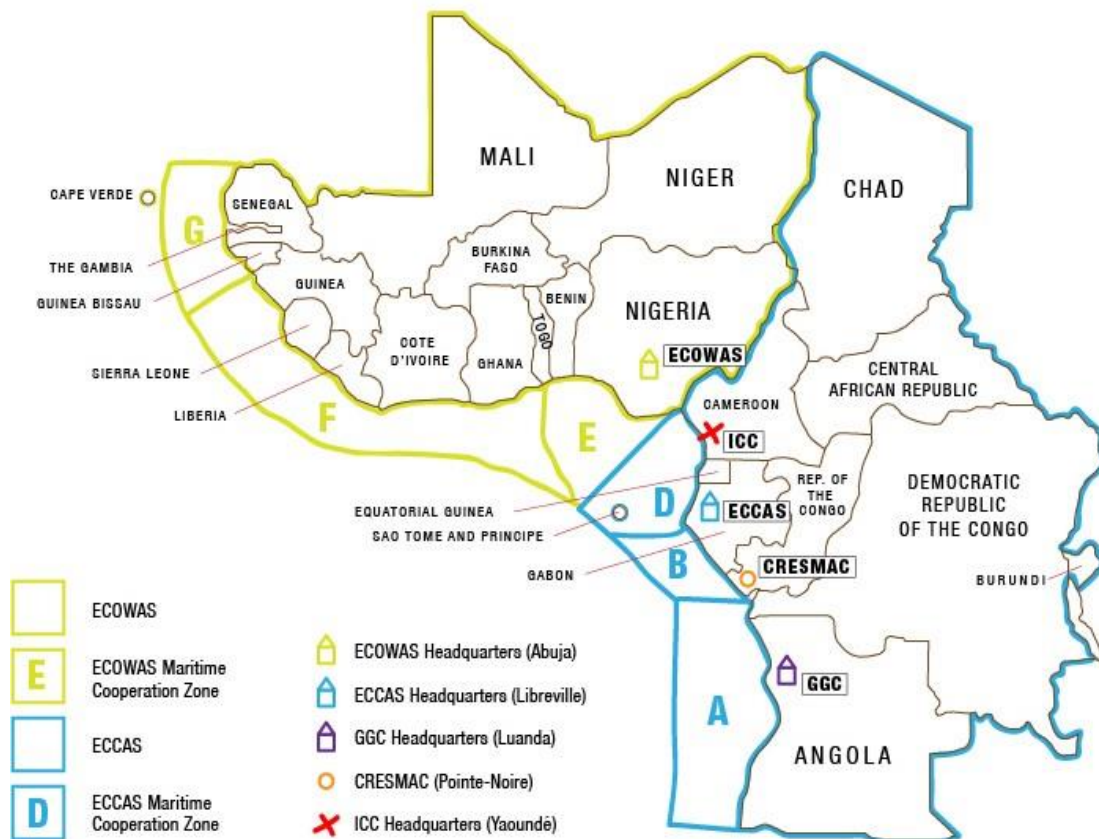


Figure 8: Gulf of Guinea Maritime Security Architecture

Source: Vircoulon and Tournier (2014)

The multi-national level has a zonal approach system (Figure 9), established to coordinate activities within the zones known as Multi-National Maritime Coordination Centres (MMCC). These centres group states together, to pursue common maritime security interests. Each zone has to be staffed with representatives from countries of that zone and equipped with monitoring including enforcement capabilities. The problem of states not fully adhering to their commitments persists here as well. For now, zones D and E are fully functioning, whilst the rest are still yet to be operational. The national level, represented by MOCs of the various representing countries, will be required to contribute immensely and work towards the realisation of the overall aim of the integrated maritime strategy.

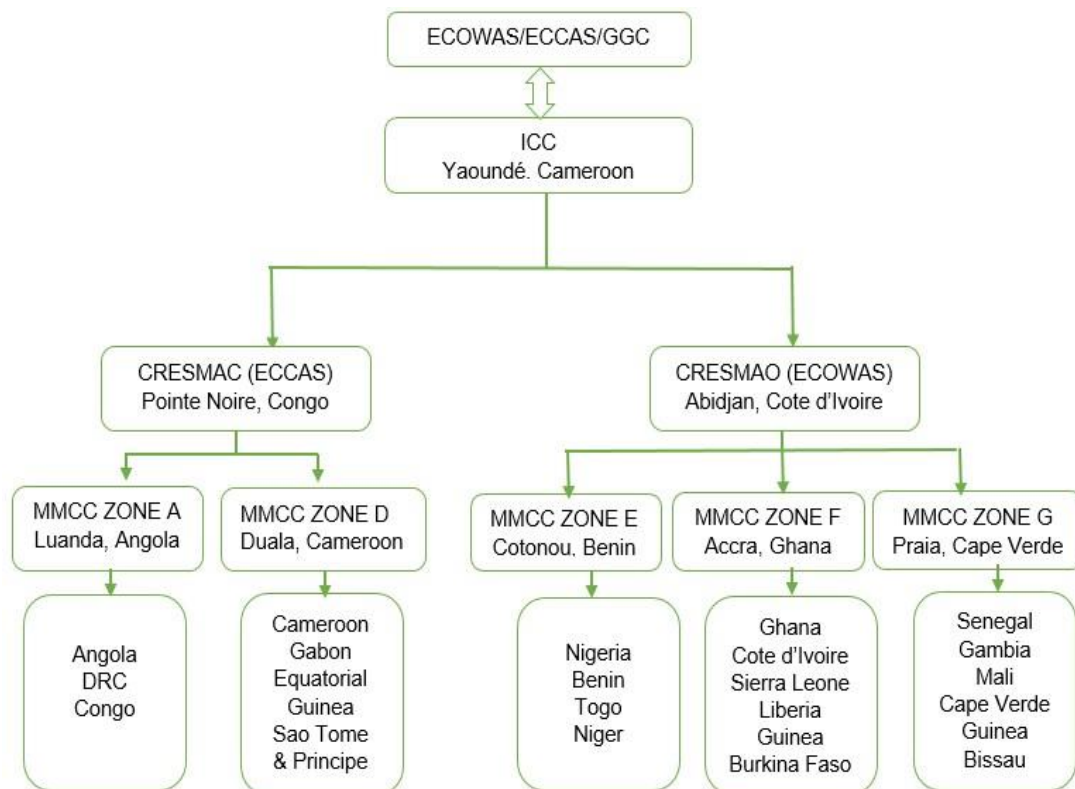


Figure 9: Gulf of Guinea Information Sharing Architecture

Source: Created by the author

### 4.3 Contribution of Foreign Assistance

The international community has been providing aid especially in the form of military training for the navies and coast guards of GoG countries. The navies are normally taken through rigorous training in policing techniques by visiting naval and army contingents, especially from the US, France, Germany and the United Kingdom. Reinforcing the military-policing option is a series of combined military exercises between navies from the GoG countries and the foreign navies. Chief among them are exercise Obangame Express organised by the US Navy and exercise NEMO organised by the French Navy. These exercises are aimed at testing the policing actions to deter maritime threats in the GoG maritime domain (US Navy, 2018).

Moreover, Japan is a big contributor to the West and Central Africa Maritime Security Trust Fund instituted by the IMO to promote maritime safety and security in the GoG region. The German government, through the Deutsche Gesellschaft für

Internationale Zusammenarbeit (GIZ) has provided immense support to the regional efforts by donating equipment to CRESMAC, CRESMAO as well as the various MMCCs.

#### **4.4 Exercise Obangame Express**

Exercise Obangame Express is an annual multi-national joint-military exercise, organised by U.S. Africa Command (AFRICOM) and U.S. Naval Forces Africa (NAVAF) for GoG states. The exercise is intended to enhance MDA, assess regional maritime security capabilities, and enhance regional cooperation, information-sharing, and tactical interdiction operations. The main aim of the exercise is to build stakeholder capacity to develop the collective capabilities of participant nations to counter maritime criminal activity.

The strategy of the US towards Sub-Saharan Africa focuses on stimulating development, and promoting economic growth, including advancement of peace and security. Exercise Obangame, was therefore, developed as part of NAVAF/AFRICOM's comprehensive strategy to provide opportunities for African military forces and international partners to collaborate in order to address maritime safety and security issues. The exercise tests regional cooperation and information sharing among GoG states as outlined in the Yaoundé Code of Conduct. During the exercise, GoG states' capability for Search and Rescue (SAR) operations, radio communication and information sharing techniques are tested, with the aim of improving on them.

Lessons learnt from the exercise were very helpful in the rescue of FV Lu Rong Yuan Yu 917, when it was hijacked off the coast of Ghana. Although there was an unacceptable time delay in passing the relevant information from MOFAD to the Navy, the Ghanaian Navy effectively collaborated with the Togolese Navy and Nigerian Navy to effectively pursue the pirates until they eventually abandoned the vessel off the coast of Nigeria. However, while the 2018 edition of the exercise Obangame was still on-going, successful piratical attacks occurred in the territorial waters of Ghana and Nigeria. Because of that, one would want to ask whether the aim of this multi-national maritime exercise is being achieved.

#### **4.5 Vessel Traffic Management Information System (VTMIS)**

A Vessel Traffic Management Information System (VTMIS) is an advanced electronic system that helps to increase the safety of ships and protect the marine environment from pollution by ships (GMA, 2015). It assists vessels in collision avoidance. It also functions as a system that helps to increase the level of anti-terrorist security of the shipping industry (Urbanski et al, 2008). According to the SOLAS convention, Vessel Traffic Service (VTS) helps to improve the safety of life at sea, safety and efficiency of navigation and marine environment protection. It also works to prevent work sites, and adjacent shore areas, including offshore installations, from undesirable effects of maritime traffic. As identified by Dalaklis (2017), VTS can be responsible for directly communicating and interacting with ships that navigate through its area of responsibility.

Contracting governments are entitled, with respect to the SOLAS Convention, to establish VTS when maritime traffic volume or the degree of risk justifies such services. In line with this provision, the GMA has procured and installed VTMIS for coastal surveillance of Ghana. The aim is to establish a 24-hour electronic surveillance and monitoring of Ghana's maritime boundaries so that the country's maritime resources as well as offshore installations, oil terminals, and gas pipelines are protected. Moreover, it also seeks to prevent piracy, IUU fishing and ship source pollution (GMA, 2018).

The VTMIS in Ghana is comprised of the following (GMA, 2014):

1. Eight (8) Remote Sensor Sites (RSS) located along the coast of Ghana from East near Togo to West near Cote d'Ivoire. The RSS are equipped with radio communication towers, marine radars, AIS receivers as well as CCTV for detecting and identifying ships and fast moving boats. The sites are equipped with marine radio communication equipment i.e. MF/HF and VHF, which complies with the IMO standard provisions for Global Maritime Safety and Distress Systems (GMDSS) and LRIT to enable regular receipt of ship reports.
2. Three (3) Remote Base Stations for inland waterways located along the River Volta.

3. Three (3) Area Control Centres for the West, Central and East sectors, and one (1) National Control Centre sited in Accra.
4. There are provisions to further equip the RSS with meteorological and hydrological sensors. When these come on board, the system will provide local weather data from the respective sites to the Control Centres for broadcasting.
5. The data gathered from the Remote Sites is transmitted to the Control Centres. The VTMISS operators are then able to display that vessel traffic information on screens.

The Ghanaian Navy has been provided with VTMISS control station status at its headquarters in Accra, with two (2) other monitoring stations in Tema and Takoradi respectively. The Tema port operated by GPHA, NSCC, MCS and NACOB also have monitoring stations to monitor vessel traffic. In addition, there are provisions for Monitoring Station facilities to be implemented in the Takoradi port. The system is yet to be reconfigured for Customs, Immigration and the Marine Police after they all relocated to new offices in various locations. It is of interest to note that a control centre can utilize all the functionalities of the VTMISS equipment, while monitoring centres have limited use of functionalities like flagging a vessel of interest.

VTS is a multifaceted sociotechnical system which requires constant cooperation between various maritime agencies and systems. The VTS operator performs the relevant tasks including traffic monitoring, information processing, and communication with vessels at sea to contribute to the success of the VTS (Xu et al, 2017). VTS is now very necessary because of the exponential increase in maritime trade. It helps promote vessel traffic flow, efficiency, and safety in designated geographical areas.

Ideally, the VTMISS centre in Ghana should be the first point of call for all maritime incidents in Ghanaian waters. The incident data can then be shared with other national and international stakeholders, such as the IMB Piracy Reporting Centre with regard to piracy issues.

#### **4.6 Maritime Operation Centres**

For the Ghanaian Navy to perform its military functions well, surveillance and intelligence gathering is pivotal. For that reason, the US Navy in various forms

assisted the Ghanaian Navy to set up three (3) Maritime Operation Centres (MOCs). The national MOC is located in Accra. There are also the East MOC in Tema and West MOC in Takoradi. Plans are in place for two (2) other MOCs to be established in locations near the borders to the East and West. With VTMIS, the national MOC has control centre status, while the others are only monitoring centres. The MOCs are further equipped with SeaVision and Time Zero Coastal Monitoring Systems, provided by the US Navy. SeaVision is a surveillance system that was specifically developed for the US Navy and allied partner nations to coordinate and track vessels of interest around the world. Time Zero coastal monitoring system is a maritime surveillance solution that is optimally configured for the coastal surveillance of Ghana.

The national MOC is responsible for liaising with all other national MOCs within the GoG region as well as CRESMAO. As in the case of the hijack of FV Lu Rong Yuan Yu 917, it was the collaboration between the various navies that proved beneficial for the final release of the vessel. Activities of the MOCs have been essential on several other occasions. A major instance was when the owner of MT Mariam reported its hijack on 11 January 2015, south of Warri in Nigerian waters (graphic.com.gh, 2015).

The Ghanaian Navy's assistance was sought as the ship wandered into Ghana's EEZ. A navy vessel was dispatched with MIO team on board. The warship, with vital information from the MOC was able to intercept and board the hijacked vessel 26Nm SE of Tema. After Visit, Board, Search and Seizure (VBSS) procedures, the MIO team arrested eight (8) pirates and seized their effects, including four (4) AK-47 assault rifles, one (1) pump action gun and three hundred (300) rounds of live ammunition. None of the ship's crew members sustained injuries during the operation and neither did the ship suffer any damage. At the time of arrest, however, the pirates had already siphoned the ship's cargo of 1,500 MT of crude oil.

#### **4.7 Vessel Monitoring System**

Ghana's fisheries resources generate more than US\$1 billion in revenue on a yearly basis, accounting for about 4.5% of the Gross Domestic Product (GDP) (MOFAD, 2015). It is also estimated that around 2.5 million people (10% of the population) are gainfully employed in the sector either directly or indirectly (MOFAD, 2015). Moreover, Ghanaians consume fish more than any other animal protein, representing

approximately 60% of the total animal protein intake (MOFAD, 2015). To ensure food security and sustain the socio-economic development of the country, the MCS department of MOFAD operates a Vessel Monitoring System (VMS) to control fishing vessel activities for the protection of Ghana's fishing stock.

Use of the VMS is intended to curb the problem of overfishing so that Ghana's fishing stock will not be woefully depleted. VMS is usually employed by fisheries regulatory authorities for the monitoring of position, course and speed, including time at position, of registered fishing vessels (Interpol, 2014). Unlike AIS, VMS data is limited to the government agency that installed it. All industrial fishing trawlers in Ghana are mandated by law to install VMS transmitters on-board. With that provision, the MCS is able to monitor the activities of the fishing fleet and query any suspicious activity the vessels may engage in. The vessels' details are transmitted even 72 hours after the transmitter is destroyed by criminals at sea so that authorities will be able to track the vessel in all circumstances.

Since its inception, the VMS has helped in adequately tracking licensed fishing vessels in Ghana. A major feat was the tracking of FV Lu Rong Yuan Yu 917, when it was hijacked in Ghanaian waters on 28 January 2015. The fishing vessel was attacked and hijacked by about 10 armed pirates while they were engaged in fishing at about 130Nm SE of Accra. The pirates dismantled the VMS transponder and all other tracking devices on the vessel. They then sailed the vessel to Nigerian waters and finally abandoned the vessel. However, authorities were able to track the vessel until it was finally rescued and brought back to Tema Harbour.

Although the VMS has been helpful, there still exists the problem of weak compliance when it comes to fisheries control. There are also the problems of understaffed MCS across the country, inadequate VMS coverage as well as insufficient funding for MCS activities (MOFAD, 2018).

## **CHAPTER FIVE**

### **SUMMARY OF FINDINGS AND ANALYSIS**

#### **5.1 Introduction**

One of the main objectives of this study was to investigate Ghana's MDA and identify the problems associated with collaboration among the various maritime stakeholders. The current research effort sought to provide insight into the maritime domain of Ghana. Administration of questionnaires solicited views from various maritime surveillance operators, whereas follow-up interview questions also invited responses from maritime experts.

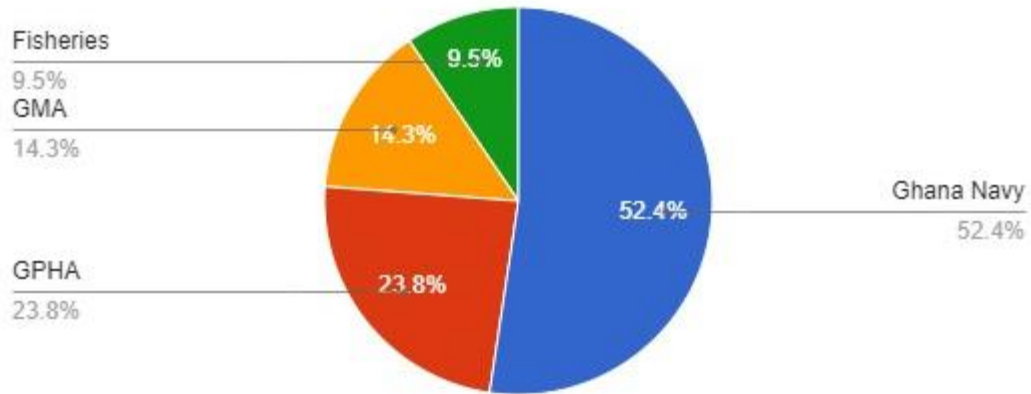
As already pointed out, this research was initially conducted in the form of a literature review. It identified several resources (including their benefits) in the maritime domain of Ghana, specifically, and the GoG at large. The major threats that hinder the realisation of optimum benefits of the maritime domain were also highlighted. Proceeding from there, further study was conducted using primary data, with emphasis on the research questions.

#### **5.2 Primary Data Findings**

Questionnaires were sent to all maritime agencies that operate any form of surface surveillance system for ships in Ghana. Four (4) out of 6 agencies, representing 67%, responded with the contribution depicted in Figure 10. Over half of the respondents were Ghanaian Navy personnel, suggesting their interest in the study. With their interest, responses provided may be very accurate and can be relied upon for inference and good recommendations at the end. It may also mean that their superiors mandated them to participate and, as in all militaries, subordinates always obey orders. Unfortunately, in such a case, responses may not be as accurate as expected. This is because, the research is not part of their core duties and so does not have any bearing on the performance of their military duties, but just the idea of satisfying their superiors.



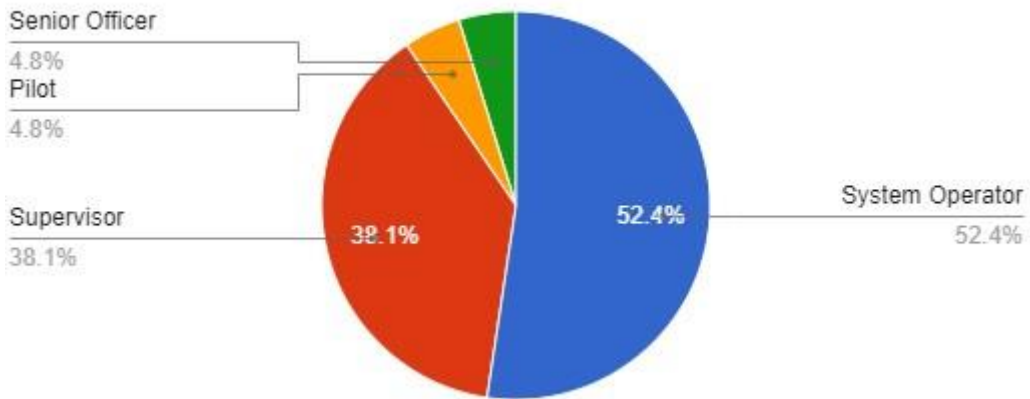
**Which agency do you work for?**



*Figure 10: Agency Response to Questionnaire*

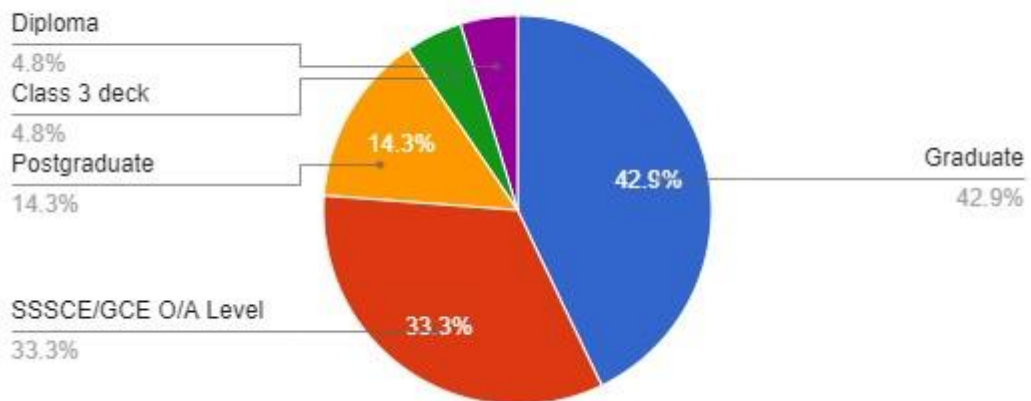
Most of the respondents were system operators, whereas others include supervisors and senior officers as indicated in Figure 11. It may mean that system operators are very much interested in the study and would want to know the outcome of the study. That does not belittle the fact that in all organisations, the number of personnel reduces in the hierarchy of command. Also, 36 out of 63, representing 57% of the respondents are either graduates or post-graduates (Figure 12), suggesting that authorities are keen on employing people with good educational background in the surveillance departments. It suggests that personnel in the department can make informed decisions on their own with little or no supervision. It also suggests the importance authorities attach to the surveillance of the maritime environment.

**Please indicate your position at work.**



*Figure 11: Positions held by Respondents*

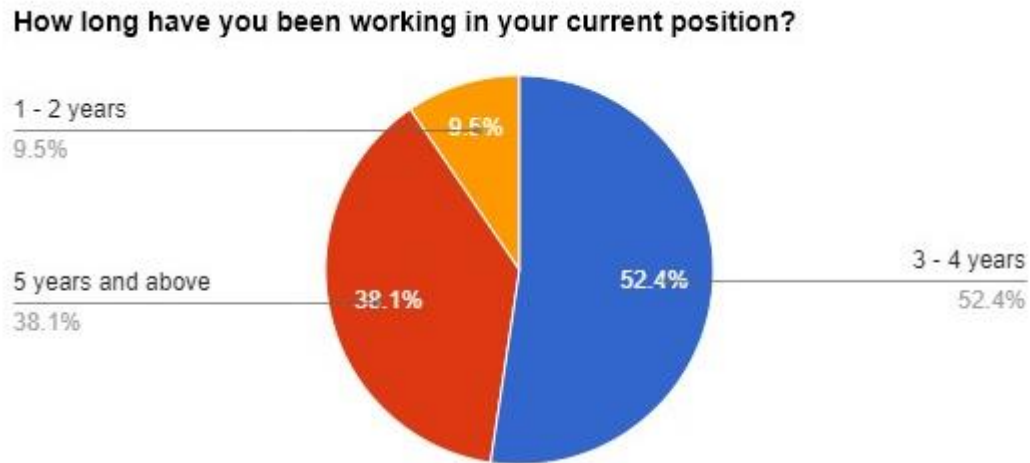
**What is your background?**



*Figure 12: Educational Qualification of Respondents*

Over 90% (i.e. 57 out of 63) of the respondents have been working in their current capacities for over 3 years (Figure 13). It presupposes that personnel that saw the installation of these surveillance systems have been retained in their capacities, indicating a very low personnel turnover in this department. This further suggests that they have a fair knowledge of what they do on a day to day basis, provided they have been given the required training needed to effectively operate the systems. It does not, however, indicate the work output of these employees because their performance

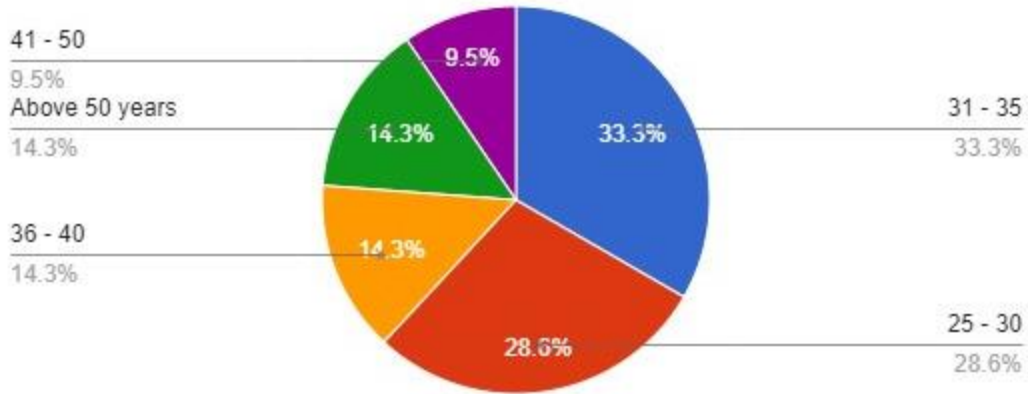
has not been audited or evaluated in any study since the systems became operational.



*Figure 13: Years of Experience at Current Position*

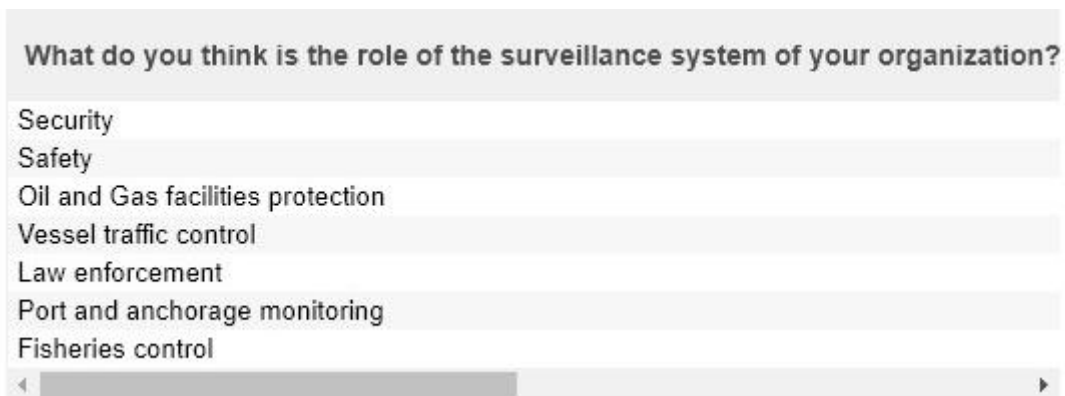
It was identified in Figure 14 that most of the respondents are fairly young (below the age of 35 years), indicating a younger generation of system operators who can be relied upon in the next few years to come. This may indicate limitations in resources (especially human resources) to apply and enforce MDA in Ghana. Most of the surveillance system operators are young and lack quality maritime experience even though experience does not necessarily only come with age. It is again believed that the system operators will gain experience with time, considering the fact that all the surveillance systems are fairly new, mostly less than 5 years in use.

**What is your age?**



*Figure 14: Age Group of Respondents*

All the respondents identified the role of their agencies' surveillance systems (Figure 15) in ensuring safety and security in the maritime space of Ghana. The responses suggest that there are specific organisational policies and priorities for each of the agencies that operators pay particular attention to. Each agency has its own interest in the maritime environment (Figure 16). Apart from the traditional responsibilities of the agencies in question, other areas of importance to the nation do not concern them. This comes about because specific policies appear to be derived from organisational mandates, which define the legal, administrative, resource and budgetary limits of each of the agencies. And for that matter, the agencies operate within the confines of their mandates backed by the relevant regulations.



*Figure 15: Organisational Roles*

**What is the area of interest for the surveillance system of your organization?**

All vessels in Ghana waters

Oil and Gas

Fisheries

Port and anchorage

Law enforcement

Oil and gas facilities

National asset

*Figure 16: Organisational Interests*

All the MDA tools discussed in the literature review section are embedded in the surveillance systems in Ghana (Figure 17). This gives the impression that Ghana's surveillance capacity can be assessed as good, if the tools are being optimised. Other than that, the object of the systems is not being fulfilled. The system operators must be knowledgeable in manipulating the systems to get the desired results. If that is not the case, the capability cannot be assessed as good. Optimal use of these tools is required to better ensure safety and security of the maritime domain. The systems are fairly new and therefore, rarely encounter any minor breakdowns. Contractual agreements demand that system manufacturers remotely fix minor problems, should they occur. But for major breakdowns, the system manufacturers will have to send experts to Ghana to physically correct defects. It can be argued that critical incidents can go unnoticed should they happen during major breakdowns.

**What tools are included in the surveillance system of your organization?**

AIS

Coastal radars

Coastal cameras

LRIT

SART

VMS

Radar

*Figure 17: MDA Tools in Used*

Most of the respondents think that the surveillance systems they use cover beyond 60Nm of the territorial waters of Ghana (Figure 18), with about 66% believing that vessels of interest can be monitored even if they are within the EEZ (Figure 19). It can mean that, per design, the systems are supposed to cover that much, but may be unable to do so physically. In such a case, it would mean that system operators have not yet exploited the systems to know their maximum effective capabilities. It again suggests that surveillance capabilities of Ghana are good. Based on that, there is the presumption that the MDA capabilities, when optimized, can effectively enhance the safety and security of Ghana's maritime space.

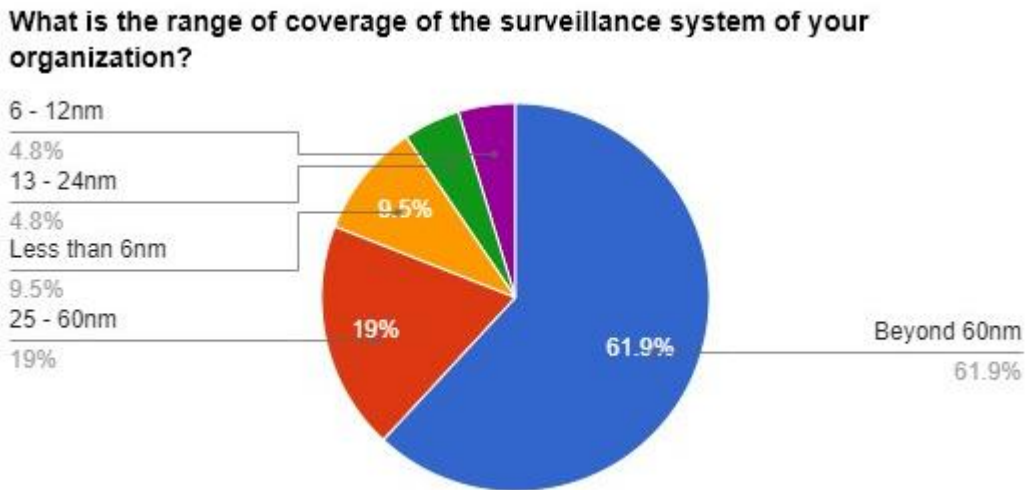


Figure 18: Range of Coverage

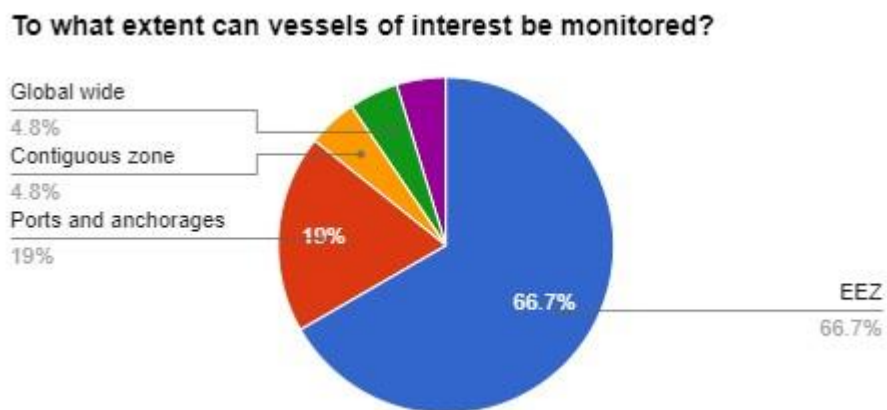
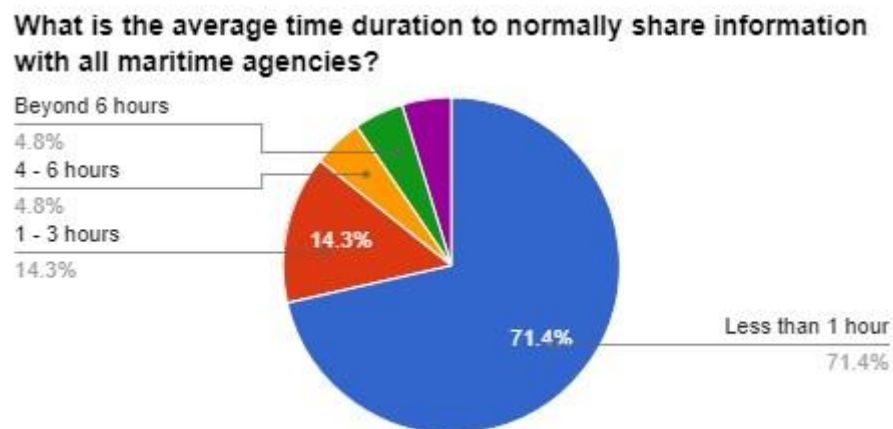


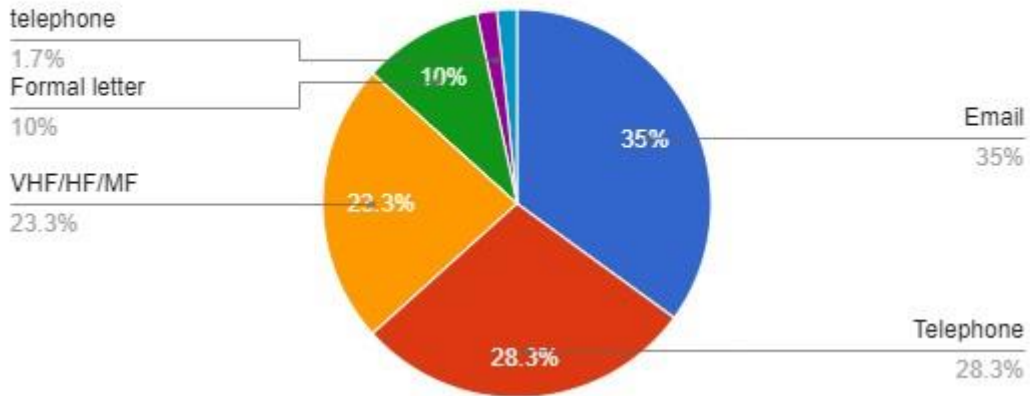
Figure 19: Monitoring Limit

It was identified that vital maritime information of interest can be shared within the first 3 hours of reception (Figure 20), mostly using email and telephone calls as the medium of communication (Figure 21). When information is shared in good time, agencies quickly get a clear maritime picture, and take quick decisions to act on the information in order to avert any negative implications. However, it is one thing sharing vital information in good time and another acting on the received information. If received information is not forwarded to the right person in time, the purpose for which it was shared will not be achieved. It is necessary to send information to the person who can act swiftly on it in order to achieve the desired result. But because of absence of a national maritime strategy, who to channel the received information to and how to swiftly act on it becomes a problem. With a maritime policy in place, information sharing between agencies will be streamlined and effective actions will therefore, be taken promptly should the need be.



*Figure 20: Information Sharing Time*

**What is the medium of communication used in the system to contact and communicate with those agencies?**

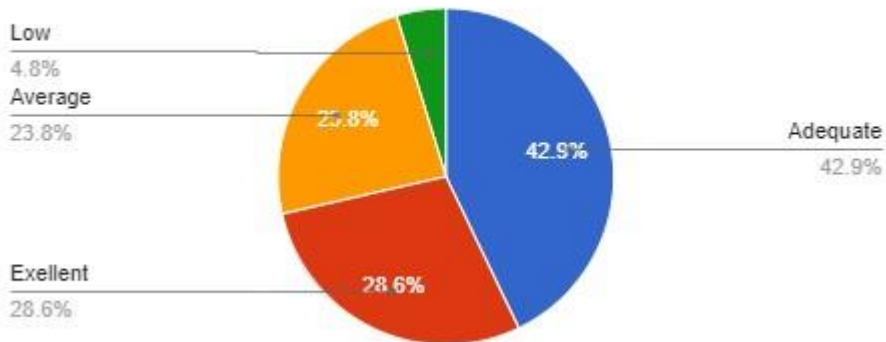


*Figure 21: Medium for Sharing Information*

Most respondents think that information sharing between the maritime agencies is either excellent or adequate (Figure 22). Such a response directly correlates with the fact that most respondents are system operators. This can be as a result of the fact that surveillance operators, ideally, are supposed to pass information to their superiors in the chain of command as soon as it is received. However, it does not necessarily indicate that other maritime agencies that need to act urgently on the information gathered have received this information at the other end, as it was identified in the case studies. Time delay in the case studies prevented immediate effective action from being carried out to prevent the hijacked ship, FV Lurong Yuan Yu, from being sailed to Nigeria.



**How efficient is information sharing among maritime agencies?**



*Figure 22: Efficiency of Information Sharing*

A data mining tool known as Advanced Summary (from Google) was used to analyse the responses shown from Figures 23-25 and Figure 29. It depicts the frequently appeared words used by the respondents. The bigger the word, the higher the frequency of the word in the responses provided. The response that cuts across for challenges to collaboration is organisational barriers (Figure 23). The various maritime agencies have their own missions and organizational goals. However, MDA is inherently cross-agency in its application (no one agency can be responsible for MDA). It is a forum where the interagency activities compete with the organic priorities of the agencies. Almost always, agencies will prioritize their own main missions over shared missions. Bureaucratic firewalls may also be a contributory factor that limits sharing of information as well as joint prioritization of interests. It can, however, be emphasized that this may not be a problem unique to Ghana.



*Figure 23: Barriers to Collaboration*

Respondents have suggested that organisational policies on collaboration be streamlined and regular joint training and exercises be conducted among the various maritime agencies to bridge the gap that seems to exist when it comes to collaboration (Figure 24). This seems to suggest disjointed maritime regulations within the maritime sector. Such a situation can lead to functional overlaps or, possibly, conflict of interest when it comes to sharing vital maritime information, which can negatively impact the maritime sector.



*Figure 24: Possible Solution to Collaboration Barriers*

Respondents were also asked about how to build the capacity of surveillance system operators. Figure 25 shows that training and education is key to human capacity building. It must also be noted that conducting joint exercises and training advances knowledge in cooperation and collaboration. The more people are trained, the more they become abreast of what they do and how to do it with ease. That said and done, proper supervision of staff activities is also vital in building human capacity. Most people tend to do something else other than do exactly what they are employed to do. But with proper motivation and supervision, employees will be able to give their best at all times. In a different direction, systems interface can also be upgraded to improve the interaction between humans and the systems they use.



Have you undergone official training as an operator?

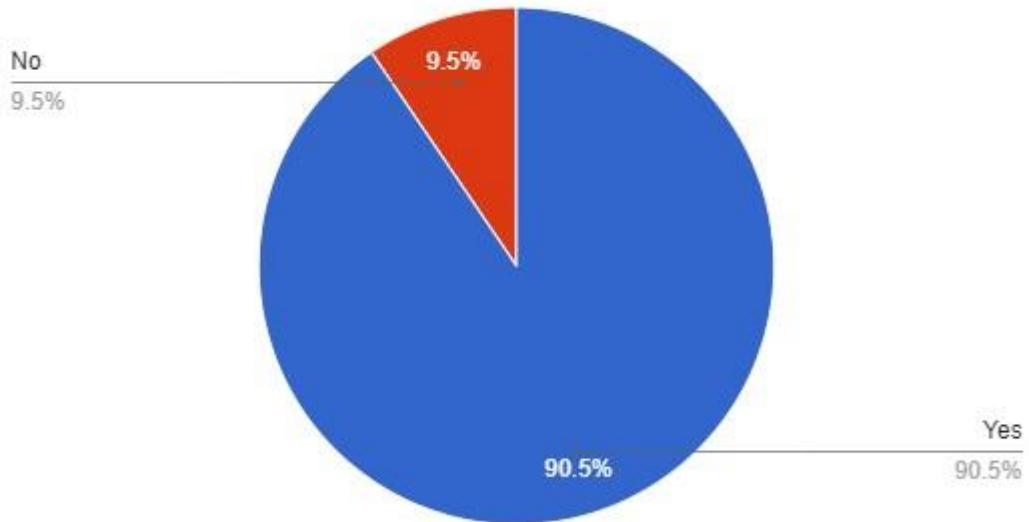


Figure 26: Response on Initial Training

What was the duration of training given?

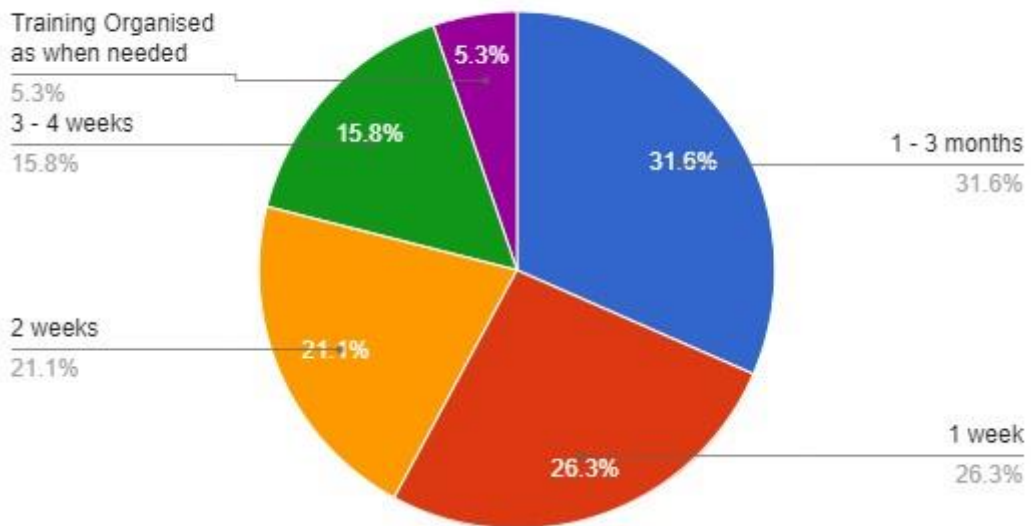


Figure 27: Duration of Initial Training



waters. However, there is no formally documented Policy on this issue. It was identified that the lack of a comprehensive and clear Maritime Strategy seems to prevent agencies from effectively cooperating. Without a maritime strategy, which should outline the roles and responsibilities of GMA and other maritime agencies, there is no guidance for these agencies, so cooperating with other parties/stakeholders is not mandatory to them. It is of interest to note that during the current research effort, it was identified that the various systems supporting information collection and handling are not interoperable because they were purchased from different manufacturers and for purposes independent of each other.

It was also identified that the coastal communities and Non-Governmental Organisations (NGOs) concerned with maritime activities have very little or even no knowledge about MDA. However, every activity that happens at sea spans from land. If the coastal communities and local fisher associations are effectively involved in sharing vital information, intelligence can be gained about illicit maritime activities, like armed robbery and piracy; this is essential in order to intervene even before these criminals proceed toward the sea.

Unfortunately, Ghana does not prioritize the maritime environment as key to economic prosperity. On the positive side, the government of Ghana acknowledges the importance of transportation in supporting the productive sector of the economy. Because of that, an Integrated Transport Plan for Ghana was developed in 2011. The plan, which was hoped to inform the budgetary allocation of government for the entire transport sector, effectively outlines policies for air, rail, road, urban, motorised and intermediate forms of transport. Strangely enough, however, the plan barely touched on maritime transport even though it is recognized that plans are not legally binding on agencies. However, the significance of maritime transport for the development and prosperity of Ghana was emphatically recognised.

GMA admits shortages in its regulatory capacity as well as insufficient financial resources. There is also a shortage of local skills and capacity in the administration and management of the maritime sector that suggests the tendency to depend on foreign technical and financial support. The Ghanaian government admits that the new oil and gas discovery poses several challenges for the maritime transport sub-sector. It has, therefore, directed the GMA to develop regulations and enforcement

mechanisms and procedures in good time. However, whilst GMA is already mandated to coordinate these activities, it faces additional challenges caused by the multi-agency environment in which maritime regulation is developed and enforced.

It was further identified that apart from diverse national interests spearheading collaboration through exercises and combined training during multinational initiatives, Ghana maritime stakeholders on their own do not organise any form of activity that enhances cooperation. To say the least, it is upsetting for these agencies, to allow any external actor to bring them together instead of initiating collaborative efforts themselves. It is only Exercise Obangame, intended for cooperation among countries in the GoG, which brings maritime stakeholders in Ghana together for a combined exercise. The GMA should institute an “national programme” that helps in exercising the various surveillance systems for enhanced interoperability.

Also, the current contractual clauses are not favourable to the continuity of operations of the surveillance systems. Most of the contractual agreements require the systems to be remotely configured after minor breakdowns, and an expert to be flown in from abroad to fix major problems. Constant monitoring of activities at sea will be adversely affected when there is any type of breakdown that takes days or extended number of hours to be rectified. If there is a delay in travel arrangements or internet connection problems, the case will even be worsened.

#### **5.4 Limitations**

As defined in the literature of this study, the maritime domain encompasses all maritime related activities. The research was however, confined to what can be visualized on the surface of the sea including ships and other platforms as well as surveillance systems used by maritime agencies in Ghana to monitor ships and other offshore platforms. The research did not consider the role of aviation in maritime activities or under-water surveillance.

A methodological limitation encountered was the fact that approximately 30% of the maritime agencies did not participate in the research even though they acknowledged receipt of the questionnaires.



## **CHAPTER SIX**

### **RECOMMENDATIONS AND CONCLUSIONS**

#### **6.1 Recommendations**

Ghana, as a littoral country, needs an all-encompassing Maritime Strategy, with an MDA policy clearly described in that document. This can be done when risk assessment is carried out to ascertain the best plan of action for each anticipated threat, with the corresponding roles of various maritime agencies in each plan of action clearly stipulated. It is recommended that authorities expedite action in developing and documenting strategies for effective MDA.

Once this strategy is approved and adopted, agencies will need to follow the associated strategic directives and work together to formulate implementation plans through harmonized procedures, policies, and Standard Operating Procedures (SOPs) that would be in line with the strategy. When that is accomplished, Interagency Working Groups could be assembled to devise Interagency MOCs, joint task forces and other groups to work in a harmonized manner to tackle maritime challenges. No single agency can achieve success in the domains of maritime safety and security alone.

One way to achieve inter-agency cooperation is to establish political or legislative top-down inter-agency directional approach to maritime issues. However, it becomes cumbersome if every issue is handled this way, and is subject to whim or politics in terms of which main issue is most important. A better way is to get all agencies together and outline a comprehensive list of national concerns, then work together to agree on how to address them, with required resources clearly allocated. Subject-matter expert exchanges and joint training are helpful in understanding the structure and workings of other agencies. In this case, the maritime agencies could agree to a framework outlining the biggest threats, key shortfalls in addressing those threats and available resources to address them.

Prioritizing maritime issues within government policies is also recommended. One of the most effective measures maritime agencies can take is to make sure that policy decision makers understand the importance of maritime safety and security to the greater economy of Ghana and the impact on the average Ghanaian. In that stead, “maritime oriented” seminars specifically designed for the attendance of politicians and government officials are of high urgency and importance. It is typical to focus more on land-based priorities because those tend to be more pressing and affect the day-to-day lives of citizens. Piracy, oil spills, illegal fishing and other maritime issues have huge negative impacts, but may not have direct impact on the average citizen. It is, however, the responsibility of the maritime agencies to communicate to government overseers and citizens the role that MDA and the maritime environment play in their economic well-being. Without this, the agencies will be acting in isolation and will never get the necessary resources to address the problems.

It is further recommended that surveillance operators are trained on information technology and cyber security. There is the need to ensure that people with criminal intent do not tamper with the information exchange within the surveillance systems. It is a fact that system manufacturers have certain security features in place. Nonetheless, operators should be trained to identify spurious activities or any tempering with the systems, and be able to effect repairs in order to ensure system integrity for effective surveillance.

It is strongly recommended to conduct regular multi-agency exercises and drills in order to enhance multi-agency cooperation. Effective decision making is based on accurate information, transmitted in good time. Exercises together will go a long way to improve timely information sharing, and reduce agencies’ response time to incidents. This could mitigate the negative effects of safety or security issues in the maritime space of Ghana. It will help avoid misunderstandings between agencies and possibly reduce response time of Maritime Interdiction Operations (MIO) when the need be.

A joint national maritime operations centre, that mimics the Maritime Multinational Coordinating Centre of the GoG information sharing architecture, should also be established. This centre can be staffed with representatives from all maritime agencies, and through these representatives, information sharing among the

agencies could be enhanced. Staff who work at this centre can be posted to the MMCC and CRESMAO in rotation. The experience of the staff in the national centre will be beneficial when such persons are employed at the sub-regional and regional maritime centres.

Furthermore, it is recommended that certain contractual clauses are reviewed to favour continuity of operations of the surveillance systems. This stems from the fact that most of the agreements require the systems to be remotely configured after minor breakdowns, and an expert flown in from abroad to fix major problems. Instead, this arrangement could be changed for locals to be trained, and equipped with the proficiency to work effectively on those systems to fix any problem that develops on them.

Finally, another important issue for consideration is that, there could also be a network with fisher associations, fishing communities and association of fishing canoe owners created, so that they can report any illegal activity they sight at sea (Human Intelligence – HUMINT). Arrangements could be made with telecom companies to provide a dialling short code for easy reporting. This network could also be complemented by certain incentives: for example, the maritime agencies could provide life jackets or marine radios as reward for those who swiftly report incidents with malicious intents. With this arrangement, any illicit activity that goes unnoticed by the surveillance systems could be identified once sighted by the fishing canoe operators.

## **6.2 Further Study**

A holistic MDA investigation encompassing all aspects of the definition of maritime domain has not been explored yet. This needs further studies especially in Ghana and the GoG in general. This proves to be important because of the need for regional bodies within the GoG to find a lasting solution to rampant illicit maritime activities within the GoG region. Collaboration and exchange of information between sovereign states, especially with respect to national security matters, is always a complex issue, owing to the uniqueness of each state and its unique policies.

### **6.3 Conclusions**

Shipping activities within the GoG, and especially the maritime space of Ghana have increased significantly since 2007, when Ghana started to produce oil and gas in commercial quantities. Other reasons include expanded fishing activities, as well as the fact that Ghanaian ports of Tema and Takoradi serve as important transit hubs for neighbouring land-locked countries, especially Burkina Faso. As a matter of fact, there have been commensurate safety and security issues within the maritime domain of Ghana. To help in the surveillance of the maritime space and enforce maritime laws, various maritime agencies in Ghana operate different and unfortunately not integrated maritime surveillance systems.

This research effort was conducted in order to investigate the Ghanaian MDA capabilities and to identify the challenges in collaboration between these maritime agencies, policies and priorities on MDA, current MDA capabilities, also to pin-point surveillance operator training requirements and finally, to suggest ways of improvement. However, this study was limited to maritime surface surveillance alone; a thorough study is further recommended encompassing aviation, as well as underwater activities in order to holistically mitigate safety and security problems in the maritime space of Ghana.

The Yaoundé Code of Conduct is a regional initiative from ECOWAS and ECCAS to help curb piracy and armed robbery against ships plying the route within the GoG region. The Code entreats interoperability between maritime stakeholders and effective sharing of maritime information. This regional aim cannot be realised if similar collaboration is not effective at the national level. The surveillance systems employed in Ghana have all the needed tools, including coastal radars, cameras, AIS receivers and LRIT embedded for effective monitoring of the maritime environment. However, the major maritime agencies like GMA, the Ghanaian Navy and MCS unit of MOFAD operate independent surveillance systems to monitor their various areas of interest. Therefore, the issue of “interoperability” and promoting cooperation, even via a “top-down” approach enforced by a national policy/guideline document are clearly standing out as priorities.

There is the perception that collaboration between these maritime agencies is effective. However, case studies reviewed indicate lack of effective cooperation

between the agencies due to the absence of a national maritime policy. Even combined maritime exercises that bring the agencies together, like Exercise Obangame Express, are spearheaded by external actors/interests. An all-encompassing maritime policy will document clear-cut roles for the maritime agencies, with the idea of achieving the national objective.

During the overall Master Thesis effort, questionnaires were administered to various maritime agencies and the responses were duly analysed. The observations and findings have been presented in line with the research objectives. The findings were summarized and necessary conclusions drawn. It was deduced that Ghana has a satisfying level of MDA capabilities that can help to deal with safety and security threats in its maritime domain. That notwithstanding, there is certain room for improvement.

In any case, technology is just a tool to enhance maritime safety and security, but a good level of performance will not be achieved until authorities take the necessary action to show commitment and willingness to document policies and procedures that can help harness the potential of technology. If the suggested remedial actions provided are implemented, most importantly when a national maritime policy is documented and sanctioned by the legislature, all the maritime stakeholders will be bound by law to adhere to the provisions of that document. They will be obliged to swiftly collaborate and ensure a collective effort to enhance maritime safety and security.

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