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Vessel traffic service as a maritime security tool: vessel traffic management information systems (VTMIS) in Ghana

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DISSERTATION

VESSEL TRAFFIC SERVICE AS A MARITIME SECURITY TOOL: VESSEL TRAFFIC MANAGEMENT INFORMATION SYSTEMS (VTMIS) IN GHANA

By

JOSEPH AKWASI KUMA
Ghana

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

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2015

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

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ABSTRACT

Tittle of Dissertation: **Vessel Traffic Service as a Maritime Security Tool: Vessel Traffic Management Information Systems (VTMIS) in Ghana**

Degree: **MSc**

The dissertation is an assessment of the role of the VTMIS in enhancing efforts to bring down maritime security in the threats in the Gulf of Guinea in West Africa focusing on Ghana.

According to the International Maritime Organisation (IMO), Vessel Traffic Service (VTS) is implemented by a Competent Authority to improve the safety and efficiency of vessel traffic and to protect the environment. Technological development today has led to significant improvements in vessel traffic service. Vessel Traffic Management Information Service is the integration of Management information systems to improve the quality of vessel traffic services. Vessel traffic services essentially are used for information services, navigational assistance services, traffic organisation services, and similar allied services. Increasingly, threats to maritime safety and security in the Gulf of Guinea area are becoming major issues in the world. This study investigated the role of the VTMIS in Ghana in enhancing and combating maritime security threat such as piracy, smuggling and trafficking, in the Gulf of Guinea area. The study collected primary qualitative data from respondents from agencies in Ghana that uses information from the VTMIS for the assessment. It also relied on secondary data from the IMO and Ghana Maritime Authority on incidence of piracy in the Gulf of Guinea. The study revealed that VTMIS in Ghana contributes significantly to security of offshore installations in Ghana. It also reveal that Ghana's VTMIS contributes significantly in monitoring and reporting maritime security issues in the Gulf of Guinea area.

KEYWORDS: Assessment, Vessel Traffic Service, Maritime Safety and Security, Gulf of Guinea, Offshore installations

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LIST OF ABBREVIATIONS

AIS	Automatic Identification System
AU	African Union
AVR	Automatic Voltage Regulator
CCTV	Closed Circuit Television
DSC	Digital Selective Calling
ECC	Eastern Control Centre
ECOWAS	Economic Community of West African States
FPSO	Floating Production Storage and Offloading
GMA	Ghana Maritime Authority
GMDSS	Global Maritime Distress and Safety System
GoG	Gulf of Guinea
GPS	Global Positioning System
HQ	Head Quarters
IMO	International Maritime Organisation
IALA	International Association of Lighthouse Authorities
ITU	International Telecommunication Union
ISPS	International Ship and Port Facility Security Code
IEEE	Institute of Electrical and Electronic Engineers
IMO	International Maritime Organisation
IUU	llegal, Unreported and Unregulated
I. COAST	Ivory Coast

ICT	Information Communication Technology
LRIT	Long Range Identification and Tracking
MSM	Maritime Security Matrix
MSC	Maritime Safety Committee
NATO	North Atlantic Treaty Organisation
NCC	National Control Center
NM	Nautical Mile
VTS	Vessel Traffic Service
VTMIS	Vessel Traffic Monitoring Information Systems
RBS	Remote Based Station
RSS	Remote Sensor Site
SAR	Search And Rescue
SOLAS	Safety of Life at Sea
STCW	Standard of Training Certification and Watchkeeping
UNCLOS	United Nations Convention on the Law of the Sea
UPS	Uninterruptible Power Supply
VHF	Very High Frequency
WAGP	West African Gas Pipeline
WAPCO	West African Gas Pipeline Company Limited
WCC	Western Control Centre

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Maritime security is an integral to the success of the worldwide maritime transportation chain. Major threats to maritime security include terrorism, unlawful acts such as piracy and arm robbery at sea, smuggling of migrants and drugs, threats to resource security, and environmental threats such as pollution incidents and illegal dumping (Ameri and Shewchuk, 2007). Maritime Security is therefore the combination of preventive and responsive measures to protect the maritime domain against threats and intentional unlawful acts (Feldt, Roell, and Thiel, 2013). According to researchers such as Ameri and Shewchuk (2007), maritime security and safety are complimentary concepts with common objectives. Feldt et at. (2013, p1) stated that "maritime safety is the combination of preventive and responsive measures intended to protect the maritime domain against, and limit the effect of, accidental or natural danger, harm, and damage to the environment, risks or loss."

Both security and safety have been major areas of concern to the International Maritime Organization (IMO) and the international community. The International Convention for the Safety of Life at Sea (SOLAS), 1974 has provided standard guidelines for enhancing maritime security. Following the 9/11 attacks in the United States (US) a comprehensive set of measures contained in the International Ship and Port Facility Security Code (ISPS Code) were developed to enhance the security of ships and port facilities (International Maritime Organization, 2015). The adoption of Resolution A.578 (14) 'guidelines for vessel traffic services' by the IMO was also focused on preventing maritime disasters and protecting the marine environment (International

Association of Marine Aids, 2012). The original guidelines for vessel traffic services were revised and adopted in 1997 as Resolution A.857 (20). IMO defined Vessel traffic service (VTS) in this new resolution as "a service implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment" (International Maritime Organization, 1997, p.3).

The purpose of a Vessel Traffic Service (VTS) is to provide active monitoring and navigational advice for vessels in busy waterways (United States Coast Guard, 2015). According to the European Commission (2008) VTS systems are intended to ensure maritime safety in particular areas of dense shipping. The IMO identifies three categories of services provided by VTS systems including information services, traffic organization services, and navigational assistance services (International Maritime Organization, 1997). VTS systems consist of land based control centers that receive information from sensors such as radar, Automatic Identification System (AIS) and closed circuit television (CCTV) (European Commission, 2008). Some VTS systems also integrate Long Range Identification and Tracking (LRIT) data centers to enable them identify and track ships globally. VTS installations therefore provide valuable surveillance information on offshore infrastructures such as oilrigs, seabed cables, and pipelines. According to the European Commission's report, VTS systems include mechanisms for tracking, receiving and reporting distress messages from vessels and therefore help in fighting maritime crime.

1.2 Problem Statement

According to the Royal Institute of International Affairs report released in 2013, piracy, armed robbery at sea, and illegal fishing are on the ascendency in the Gulf of Guinea (GoG) area. There have been collaborative actions by coastal countries in West Africa to reverse the situation in order to ensure the security of maritime activities in the GoG Region. However, although VTS is recognized as a valuable security information tool,

its establishment in many countries is very slow. One major factor accounting for this is due to the fact that there has not been much empirical assessment of its role in enhancing maritime security. Using the Vessel Traffic Management and Information System (VTMIS) in Ghana as basis, the main objective of this study is to discuss the role of VTS in enhancing maritime security in the GoG Region. This thesis will identify both weaknesses and strengths of VTS in enhancing maritime security. Anyiam (2014, p12) recommended "GoG states must invest in modern technology in their efforts to combat maritime crime." He argued that VTS systems equipped with AIS and LRIT "could be useful for purposes of maritime security surveillance." The potency of this recommendation will be tested in this thesis.

1.3 Research Objective

To assess the role of VTS in enhancing maritime security in the GoG area and work specifically to:

1. To investigate how VTS can contribute to the increase of security level of offshore installations (pipe lines, oil rigs, cables etc)
2. To access how VTS capabilities are integrated in the effort to fight against crime in the GoG.
3. To identity short falls in it use and propose ways to overcome.

1.4 Research Questions

1. How can VTS be used to provide security monitoring of offshore installations?
2. How can VTS be integrated in the effort against crime in the GoG?
3. What are the short falls in the use of VTS as a security tool and how can they be removed?

1.5 Significance of Study

West Africa is identified as part of the prone areas of maritime piracy in the contemporary era. Most of the reported incidents in the GoG are violent actions for the purpose of stealing. Although most unlawful acts against vessels in the GoG are erroneously reported, there is general consensus that the rate of such unlawful acts is on the increase in recent years (Anyiam, 2014). Anyiam's report stated that between 1995 and 2014, about 843 incidents of acts considered unlawful against vessels were reported. This study is significant because it will help understand how VTS can contribute in the reduction of unlawful acts against vessels in the GoG. It will also source of information to researchers and pave the way for future research in the area of VTS in the GoG region.

1.6 Scope, Limitation and delimitation

The scope of study is limited to the use of VTS in maritime security areas such as unlawful acts against vessels and protection of offshore infrastructure. The IMO resolution (A857 (20)) that provides the guidelines for vessel traffic services identifies three categories of services provided by VTS systems. These include information services, traffic organization services, and navigational assistance services. Primarily, the VTMIS in Ghana is being used as an information service tool and aid to maritime Search and Rescue (SAR) operations. This therefore defined the focus of the study to assess how VTMIS is used in the fight against maritime crime. If other countries like Nigeria, Liberia, and Ivory Coast had VTMIS systems the scope of the study could have been broader. However, Ghana is the only country with a VTS system in the GoG region presently. The study would therefore relay on information solely from Ghana's VTS operations for the analysis.

1.7 Structure of Thesis

The study is divided into five chapters. In chapter one the background and research problem is presented. In this chapter, the relationship between VTS and maritime security and safety is also discussed as well as the research problem and objectives. The justifications for the research and limitations have also been discussed. In Chapter Two, the research methods were discussed. Included in this chapter is a discussion on the sources of data, qualitative research method, targeted group, sampling technique, and ethical issues. The reasons for choice of qualitative method and choice of sampling techniques will be explained. Chapter Three reviewed related literature on VTS and maritime security and safety. The review focused on the use of VTS in protecting offshore installations and in fighting crime. In addition, literature on the shortfalls of VTS in achieving maritime security was reviewed. This helped identify the gaps in literature on maritime security and safety and VTMIS to be addressed. The fourth Chapter discussed qualitative data collected. The discussions are themed under the sub objectives of the study. Chapter Five will present a summary of the results in Chapter Four. It will also state the findings of the study and recommendations for policy makers and future studies.

CHAPTER TWO

RESEARCH METHODS

2.1 Sources of Data

Data will be collected from both primary and secondary sources for the study. Primary data is first hand information for a particular investigation. According to Currie (2015, p.89) "primary data are data that were previously unknown and which have been obtained directly by the researcher for a particular research project." According to ACAPS (2012, p.3); "primary data is most generally understood as data gathered from the information source and which has not undergone analysis before being included in the needs assessment. Primary data is collected directly from the affected population by the assessment team through field work." On the other hand, secondary data refers to data collected by other researchers that already exist in the literature (University of Surrey, 2014). According to ACAPS, "secondary data is information which has typically been collected by researchers not involved in the current assessment and has undergone at least one layer of analysis prior to inclusion in the needs assessment. Secondary data can comprise published research, internet materials, media reports, and data which has been cleaned, analysed and collected for a purpose other than the need assessment, such as academic research or an agency or sector specific monitoring reports." This was used in the review of literature for finding gaps that needed answers. It provided useful information and serve as a source of historical data on VTS and maritime security in the GoG.

Particularly, the following secondary data was used in the investigation: reports on VTMIS by GMA, The IALA publications, Hart (2014), Professors Dalaklis, Siousiouras and Nikitakos (2009), and the International Maritime Organization, (2015). GISIS: Piracy and armed robbery. Materials on procedures, equipment, and other

documentation on VTS from IALA will. The information from Professors Dalaklis, Siousiouras and Nikitakos (2009) on the advantages of VTMIS in Greece was compared with the VTMIS in Ghana to identify similarities and differences. The data from the International Maritime Organization (2015) online database on the regional statistics on unlawful acts such as piracy and armed robbery and other related crimes served as guided information in the discussion of results. The IMO's data together with Hart (2014) reviews on trends in maritime crime in the GoG was used in understanding the nature of maritime security threats in the region.

2.2 Research Method

In every investigation, the choice of a particular method (or methods) is a very important decision because it affects the results of the entire research. The kind of data that we need determines how we should go about collecting it and what methods we should adopt (Currie, 2015). ACAPS (2012) stated that "qualitative research explores information from the perspective of both groups and individuals and generates case studies and summaries rather than lists of numeric data." Upon careful evaluation of the nature of the topic the qualitative research method was therefore employed in gathering first primary data. Parkinson and Drislane (2011) defined qualitative research as the type that uses methods such as participant observation or case studies which result in a narrative or descriptive account of a setting or practice. Such data are often textual observations that portray attitudes, perceptions or intentions. Qualitative research has also been defined as research that uses data that do not indicate ordinal values (Guest, Namey, and Mitchell, 2013). Whereas quantitative research focuses on how many and how much, qualitative data answer questions of how and why events of phenomena exist.

According to the University of Surrey, 2014 the benefits of the qualitative approach is that the information is richer and has a deeper insight into the phenomenon under study.

Research in maritime security requires detailed data. However, in many cases this information is often classified coupled with the fact that VTS systems are equipped with high tech devices that gather data for analysis and use. As stated by Guest, Namey, and Mitchell (2013), the advantage of qualitative research is the ability to probe into responses and observations as needed and obtain more detailed descriptions and explanations of experiences. Patton and Cochran (2002) added that when it comes to face validity, the qualitative data acquisition process provides an additional advantage.

Another advantage of the qualitative approach is that it explores relationships and perceptions held by affected persons and communities. Consequently, smaller sample sizes chosen purposefully is advantageous because "some informants are more likely to provide greater insight and understanding of a disaster's impact to the assessment team, due to a variety of factors including their social, economic, educational, and cultural position in the community" (ACAPS, 2012, p.8). At this early stage of the VTMIS phase in Ghana a research method that allows careful consideration of participants would yield better results than when someone is selected at random to answer a qualitative question. This research method was able to collect rich and detailed information in a limited time and resources.

2.3 Research Participants

According to ACAPS (2012, p.11) key informant interviews provide vital information on individual perspectives and experiences through direct discussion. The reports defined a key informant, as a person with prior knowledge of the issues in a community who can provide information on behalf of the community on the impact of such issues and on the priority community needs. It added questions meant for key informant seek to explore the impact of the issue on the community as a whole. The data collected can be combined and analysed to develop an understanding of how for example "an issue has affected different (sub) groups of a population, why it has so affected them, and

what their ensuing priority needs and concerns are and are likely to be over time." This research was done primarily with key informants from varies state agencies that uses the VTMIS in Ghana.

The Ghana Maritime Authority is the state agency responsible for maritime administration; this agency established and operates the VTMIS in Ghana. Nonetheless other stakeholders in the maritime industry in the country are given monitoring stations to aid them in their operations. In order to collect information from different perspectives and experiences, two participants where interviewed from the GMA and the other state agencies including the Ghana Ports and Harbours Authority, Narcotics Control Board, Fisheries Department, Immigration Service, and, Ghana Navy, as well as the Customs and Preventive Service. The participants were selected to answer questions sent via email, Google docs forms, and or interviewed on phone.

2.4 Interview Procedure

Interviews are the central technique in qualitative inquires because it allows complexity of process to be captured with just a handful of individuals (Moayoux, 2011; Patton and Cochran, 2002). This study used in-depth interview technique in acquiring data from the participants. Open-ended interview offers the interviewer the ability to ask question in different ways and from different angles. These help the participants to understand the issues of the study and offer rich data for the researcher. ACAPS (2012, p.3) "primary data is most often collected through face to face interviews or discussions with members of the affected community, but can also be gathered through phone interviews, radio communication, email exchange, and direct observation."

On the forms that were sent via email or Google docs to participants, excerpts from the consent form that introduced the research to the participants preceded the interview

questions. During the introduction, participants were also told that all the information collected for the study would be treated with confidentiality. Participants were first asked to state the name of their organisation. In the Google Form this was set as a "required" response. This action was necessary to differentiate the government agencies that they belong. This will also guide in the interpretation of their responses, because the different agencies used the information from the VTMIS to meet their own operations.

Apart from the introduction, the main investigation was structured into fourteen questions. The interviews questions were carefully designed to cover the objectives of the study. The study intended to investigate how VTS can contribute to the increase security level of offshore installations; to access how VTS capabilities are integrated in the effort to reduce maritime crime in the GoG; and identity short falls of the system. The questions that were used for the interviews are discussed in detail bellow.

What is your background?

The first question was required to understand the participant's background, work experience, current job specification and expertise. Their shared experience brought about an understanding and appreciation of their response to questions.

Could you take me through the general set-up of the VTS system in Ghana? (in terms of infrastructure).

The second interview question was meant to understand whether, the participants who were drawn from agencies in Ghana had adequate knowledge about how the VTMIS was set-up. Although this question was meant to test their understanding of the physical set-up in terms of infrastructure and network, it is understood that these are very technical issues and only staff from GMA could answer it in a satisfactory manner. So

for other participants outside of GMA, mere understanding of the departments that were linkup as well as the source of the information was considered as enough.

What are the usefulness of the VTMIS to Ghana and the West African sub-region?

Question three, was formulated to test general theoretical knowledge of the possible uses of VTMIS in Ghana and West African region. Respondents general knowledge helped understand how they are using the system now and how they could use it in the future. This contributed information to answering the second sub-objective.

Are there other government agencies that benefit from the VTMIS? (If so list them and the nature of information they receive from VTMIS)

This was linked up to the knowledge of general usefulness of VTMIS. The system integrated government agencies in the maritime sector to share vessel traffic information for purposes of safety, planning and prevention of crime in the maritime domain. The question will help understand the various agencies linked up in the VTMIS and the kind of information deemed useful to that agencies.

Are there targeted areas during VTMIS operations? i.e.: (Restricted zones, or areas where pipeline are laid)

This question was targeted at the GMA respondents to know whether during operations they monitor certain restricted zone in Ghana's waters. Focus areas including areas demarcated as areas to be avoided, pipelines, other state protected areas, zones where fishing is not allowed etc. This question helped to investigate the first sub-objective of the study.

What are the communication mediums used in the VTMIS to contact and communicate with vessels and between VTS centres?

Question six intended to list the various options available in the system for establishing communication via voice (audio) and text to vessel. It also included medium on which internal communication between VTS centres and monitoring stations are done. This brought understanding as to what assistance the VTMIS could offer to vessels such as in time of distress. The options available and how effective they are partly determines how reliable the VTMIS is.

How far in terms of nautical miles is the coverage area of Ghana's VTMIS?

The coverage area of the system is also important. This question helped to identify the different devices that fed data into the VTMIS and how far in nautical miles the coast of Ghana was covered. This would help to understand whether the system could identify unlawful acts in the areas away from the coastline and the territorial waters.

How can VTS be used to provide security monitoring of offshore installations?

This question intended to find out how VTS is used in practical terms to monitor state and private infrastructure along the coast of Ghana. The answers brought about information on how it is used currently, and how it can be improved in the future to enhance maritime security.

What is the role of VTMIS in ensuring maritime security?

The question was meant to test the roles Ghana's VTMIS is playing in preventing and combating maritime security threats along the GoG specifically within the nations' maritime domain. Respondent's views on maritime security were different, so the definition adopted in the literature was applied to issues listed. Maritime security includes a wide variety of issues. The study adopted (Bueger, 2014) semiotics concept of defining maritime security. This looks at how maritime security relates to other

concepts such as maritime safety, blue economy, and human resilience. This question directly answered sub-objective two.

How can VTS be integrated in the fight against crime in the GoG?

Sub-objective two, intended "to access how VTS capabilities are integrated in the effort to fight against crime in the GoG." This question solicited respondents' views on the role the system is playing in fighting unlawful acts or maritime crime.

What are the short falls in the use of VTS as a security tool and how can they be removed? What are the limitations in the use of VTS as a monitoring tool?

Questions eleven and twelve, were intended to identify the short falls in the use of VTMIS in Ghana since the facilities installation. They questions directly correlate to the third specific objective.

What are the training requirements for VTS staff? (Qualifications)

This was designed to understand whether the training requirements for VTMIS personnel were in accordance with IMO regulations and IALA requirements.

Are there regulations that VTMIS authorities are expected to comply? (If so list and explain them)

Installation and operation of VTMIS must be done in accordance with IMO SOLAS convention chapter V regulation 12. This question tested whether the management was done in accordance with such regulations.

2.5 Data collection Process

Telephone calls were made to the participants to establish contact for interview and days to be arranged. The respondent were humbly asked whether they would prefer to

be interviewed on phone, receive email with the questions, or receive a link that would lead them to Google Docs for the interview.

2.6 Limitation

The study adopted a definition of maritime security to help delineate the boundaries of maritime crime. Bueger's proposed semiotics concept suited the needs of the study except that one of the concepts of projecting seapower at sea was not covered in this study. Relating maritime security to seapower is deemed beyond the scope of the study. Embracing a definition of maritime security based on seapower would invariably include other agencies even as the Navy. Since much of the information is classified, the study excluded all maritime security threats dealing with defense. Maritime security was only related by semiotics to maritime safety, blue-economy, and human resilience. This prevented the study from examining how VTMIS can assist in combating maritime threats such as arms proliferation, terrorist acts, interstate dispute or corporation which indeed qualified as maritime crime issues.

Bueger's semiotics concepts eventually led to his design of the Maritime Security Matrix (MSM). The MSM allows for the study of the types of relations established by different actors between maritime security and other concepts and provides bases for scrutinizing what actors include and exclude in their concept of maritime security. However, a weakness is that interpretations of threats can differ remarkably. What constitutes piracy for example is a matter of debate. Although IMO data on unlawful acts in the GoG indicated that the over 80% of the acts considered as piracy in the GoG should be treated as crimes with maritime jurisdictions, they are often reported as acts of piracy. The lists of threats or maritime crimes identified were subject to these differences.

Limited data on other identified threat of maritime security such as smuggling, pollution, unlawful and unregulated fishing, and human trafficking. Only data on piracy and armed robbery was readily available on IMO websites and in (Hurt, 2014).

2.7 Ethical issues

Ethical and data protection issues are very critical for all researchers. The University of Surrey (2014) stated that ethical principles seek to work towards protecting the participants, communities and environments involved in the studies against any form of harm, manipulation or malpractice. In essence, the three major principles of ethics that every research should address include informed consent, confidentiality and avoiding harm. This study will seek consent of every participant and allow him or her to withdraw from the interviews at any point they wish to do so. All data acquired was treated with confidentiality. Interviews were also done in professional manner to protect participants from any harm.

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

Maritime Transportation serves about 90 percent of global trade (Allianz Global Corporate, 2014). Shipping therefore plays a vital role in the export and import of goods in the world (International Chamber of Shipping, 2013). Technological innovations and developments in the maritime industry have affected shipping and both high sea and near the coastline fishing. There has been a transition from wind and manual powered fishing vessels to mechanized steam vessels. According to Professors Dalaklis and Siousioura, (2009, p.2), reliable electronic devices help in precise position determination of vessel at sea. They added that automatic devices installed in ship's bridges play significant roles in reducing to possibility of maritime accidents due to technical errors and that "such innovation can be considered as a major contributor to the solution of the rising transport challenges." Sewell, Jefferson, and Oakley (2006, p1) noted that improvements in innovation have "enabled fishing vessels to tow larger, heavier gear, resulting in higher catches."

However, a number of negative consequences have come with the increased international shipping and fishing. On maritime accident for example Professors (Siousiouras and Dalaklis, 2009, p.2) stated that, "they started with the very first efforts to conquer and tame the seas and the oceans and even today, in the so called "digital era", maritime disasters or mishaps appear rather frequent in the news." A total of 228 lives were lost between 2011 and 2013 around European Union (EU) waters due to maritime accidents (European Maritime Safety Agency, 2014). Maritime accidents leads to serious injuries or loss of life, damage to ships, material damage, pollution, and

damage to the environment. With regards to the increment in catches, Sewell et al. (2006) noted that this comes at the risk of greater environmental damage.

According to (Prof. Siousiouras and Prof. Dalaklis, 2009) "providing guidance from ashore to a vessel underway is quite often necessary in order to avoid unpleasant mishaps at sea, such as a collision or grounding." Implementing a VTS helps in identifying and monitoring vessels. Additionally, it enhances provision of navigational information and assistance to vessels and can assist in prevention of pollution as well as coordination of pollution response (International Maritime Organization, 1997). The International Convention for the Safety of Life at Sea (SOLAS), Chapter V, Regulation 12 sets legislative requirements for governments that intend to establish VTS to aid navigation and enhance maritime safety. IMO Resolution A857 (20) adopted in 1997 on the "Guidelines for Vessel Traffic Service (VTS)" also contains guidelines for operating a VTS. This chapter reviews literature on the use of VTS by selected group of nations to aid in safety of navigation and security in the maritime domain. The essential components of a VTS system are discussed. Maritime security statistics in the Gulf of Guinea (GoG) area is reviewed. The current chapter also reviews the roles VTS can play in maritime security in the GoG area.

3.2 Development of Vessel Traffic Service (VTS)

Maritime transportation has always been the backbone for world commerce. From the days of early voyages in the Arabian sea to the Roman expansion of trade routes in the Mediterranean Sea; from the Arabian age of discovery in the 7th century to the time the compass was invented in China in the 11th century; from the European age of discovery in the 15th century to modern maritime shipping in the 19th and 21st centuries, people have wanted to explore what was beyond the sea (Rodrigue, Comtois, and Slack, 2006). Not just the desire to transport goods, but also the need for safe and efficient voyages have been major concerns in maritime transportation.

To this end, "authorities throughout the world have provided aids to navigation in and around their coastal waters" (International Association of Marine Aids, 2012, p16). According to the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) VTS Manual 2012, the earliest aids to navigation were mostly shore-side beacons and lights, followed by the introduction of buoys. With time, these aids were improved upon and audible signals were added. In the 1940s, vessel traffic increased in major ports of Europe. Coupled with bad weather conditions, port operations were disrupted as serious traffic congestions resulted.

This meant that a new approach was needed to help decongest vessel traffic in ports as well as enhance safety of navigation. IALA VTS Manual states that the best option at the time was to use shore-based radar combined with communications components to monitor maritime traffic. Thus in combination with VHF radio, a traffic surveillance system was achieved and real time information exchange between the shore and ships became possible. The first radar based Port Control station was established in Douglas, Isle of Man in 1948, however the radar set installed in the Port of Liverpool later the same year is regarded as the pioneer of the modem VTS system (Ustaoglu and Furusho, 2014). Shore based radar controls gradually spread out and became common in most major European and North American ports and harbors in 1960s and in Asia in early 1970s (International Association of Marine Aids, 2012; Ustaoglu and Furusho, 2014). As shore based radars were being explored as aids to navigations, a series of maritime disasters including the Exxon Valdez, Torrey Canyon, Meluta and Amoco Cadiz stretching from 1960 to 1980s increased concerns for safety in shipping and protection of maritime environment. IALA pointed out that various researchers put forward the idea that the use of simple vessel traffic management would increase operational hours resulting in better utilisation of a port's capacity and has reduced the number of maritime accidents. Therefore in the wake of these disasters, radar surveillance and vessel traffic managements system were introduced in numerous ports.

3.3 IMO Guidelines for Operating VTS

However, in these early days when it become clear that radar aided traffic management was the way forward, port authorities, pilots, and shipmasters debated on the navigational regulatory system that must be used. Because there was no agreement among these stakeholders, then it was a fact that a form of international harmonization was needed on this new radar surveillance and aid system. According to Bowditch (2002, p387), the "consequences of collision or grounding for modern ship carrying tremendous quantities of high-value, perhaps dangerous cargo are so severe that authorities have instituted many types of regulations and control systems to minimize the chances of loss." He added that the regulations often concern navigation, communications, equipment, procedures, personnel, and many other aspects of ship management. Just like navigation, which was once independent throughout the world and later regulated by the IMO, reregulating VTS was a sure way to ensure uniformity in different regions and among different stakeholders.

The then Inter-Governmental Maritime Consultative Organization (IMCO) now the IMO, examined and published Resolution A.158 "Port Advisory Services" adopted by the Maritime Safety Committee (MSC) in its seventeenth session. The resolution had two main recommendations. The resolution recommended to governments that they: firstly, consider setting up VTS services in ports and their approaches that warrant it by the importance and nature of traffic. (This was recommended particularly for oil terminals and ports where noxious or hazardous cargoes are loaded and unloaded). Secondly, the resolution also recommended governments to instruct masters, to help improve safety, by early notification of appropriate authorities of expected times of arrival (International Maritime Organisation, 1968). Following this, the IMO in 1985 adopted Resolution A.578 (14) Guidelines for Vessel Traffic Service.

Bowditch (2002) explained that these guidelines contained in A.578 (14) recognized that the level of safety and efficiency in the movement of maritime traffic within a VTS service area is dependent upon close cooperation between VTS authority and participating vessels. The guidelines also recognized that different operational procedures would likely cause confusion to masters of vessels moving from one VTS area to another. Broadly, Resolution A.578 (14) addressed operation procedures and planning a VTS. Nonetheless, the guidelines failed to resolve a number of issues. According to the International Association of Marine Aids (2012), the guidelines did not address issues on liability or responsibility which needed consideration by the VTS authorities. The report maintained that, guidelines also failed to create new rights to enact legislation on the requirements for shipping. In addition, guidelines on recruitment as well as requirements on qualifications and training of VTS personnel were also left out. To address the issues left out, the IMO revised the original resolution and adopted a new Resolution A.857 (20) "Guidelines for Vessel Traffic Services" in 1997 which is still in force. According to Bowditch latest publication which includes two important annexes, namely, Guidelines and Criteria for VTS and Guidelines on Recruitment, Qualifications and Training of VTS Operators.

3.4 IMO Legislation on VTS

The major legislative instrument on VTS in the IMO is the Safety of Life At Sea (SOLAS) Convention. Chapter V "Safety of Navigation" of the SOLAS convention amended in 2000 contains regulation on the establishment of VTS by member parties. Particularly, Regulation 11, "Ship Reporting Systems" and Regulation 12, "Vessel Traffic Services" list requirements necessary for the operation of a VTS. Regulation 11 was devoted to guidelines for governments and shipmaster on adopting and implementing ship reporting system, to ensure safety of life at sea, safety and efficiency of navigation and protection of the marine environment. Regulation 12 extensively, outlined requirements for contracting governments that intend to establish VTS

systems. It is divided into five paragraphs as quoted following. The paragraphs in the Safety of Life At Sea (SOLAS) Convention, Chapter V, Regulation 12: Vessel Traffic Services are:

1. Vessel traffic services (VTS) contribute to safety of life at sea, safety and efficiency of navigation and protection of the marine environment, adjacent shore areas, work sites and offshore installations from possible adverse effects of maritime traffic.

2. Contracting Governments undertake to arrange for the establishment of VTS where, in their opinion, the volume of traffic or the degree of risk justifies such services.

3. Contracting Governments planning and implementing VTS shall, wherever possible, follow the guidelines developed by the Organization. The use of VTS may only be made mandatory in sea areas within the territorial seas of a coastal State.

4. Contracting Governments shall endeavour to secure the participation in, and compliance with, the provisions of vessel traffic services by ships entitled to fly their flag.

5. Nothing in this regulation or the guidelines adopted by the Organization shall prejudice the rights and duties of Governments under international law or the legal regimes of straits used for international navigation and archipelagic sea lanes

Source: Lloyd's Register 2005, p.469

Regulation 12, explains that, the overall purpose of VTS's to protect human life, enhance navigation, and protect the environment. It provides the requirement to

establish and operate a VTS to the discretion of government and advises parties to arrange to provide VTS service when the volume of vessel traffic as well as the risk in navigation justifies such services. The regulation points contracting governments to the Resolution A.857(20) "Guidelines for Vessel Traffic Services" as a major guide to establishment. Nonetheless, it categorically noted that both the requirements in SOLAS and Resolution A.857(20) "shall prejudice the rights and duties of Governments under international law or the legal regimes of straits used for international navigation and archipelagic sea lanes" (Lloyd's Register, 2005, p.462). This means that governments should be mindful for example of the legal implications of accidents cause by VTS instructions. Whilst the IMO publishes guidelines such as those given in Resolution A.857 (20), it is this portion of the SOLAS convention that is the most important with respect to VST (Huges, 2009).

3.5 Definitions and Clarifications of VTS Terms

There are quite a number of terminologies defined by the IMO in Resolution A.857 (20) that are examined in this study. The terms most used and require definition in this study include Vessel Traffic Service, Competent Authority, VTS authority, VTS area, VTS centre, VTS operator, and VTS service. The definitions of these terminologies are adopted from IMO, Resolution A.857 (20). The International Maritime Organization (1997, p.3) defines the following;

> Vessel traffic service (VTS): a service implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area"

Competent authority: the authority made responsible, in whole or in part, by the Government for safety, including environmental safety, and efficiency of vessel traffic and the protection of the environment.

VTS authority: the authority with responsibility for the management, operation and co-ordination of the VTS, interaction with participating vessels and the safe and effective provision of the service.

VTS area: the delineated, formally declared service area of the VTS. A VTS area may be subdivided in sub-areas or sectors.

VTS centre: the centre from which the VTS is operated. Each sub-area of the VTS may have its own sub-centre.

VTS operator: an appropriately qualified person performing one or more tasks contributing to the services of the VTS.

VTS services: VTS should comprise at least an information service and may also include others, such as a navigational assistance service or a traffic organization service, or both, defined as follows:

An information service is a service to ensure that essential information becomes available in time for on-board navigational decision-making.

A navigational assistance service is a service to assist on-board navigational decision-making and to monitor its effects.

A traffic organization service is a service to prevent the development of dangerous maritime traffic situations and to provide for the safe and efficient movement of vessel traffic within the VTS area.

In many jurisdictions such as Ghana, a Competent authority also is the VTS authority. Ghana Maritime Authority is the state agency regulating the maritime industry and ensuring protection of maritime environment. In this study the two are used to refer to the same authority. The VTS area, centre, and operators are discussed later under Ghana's VTS. A VTS can provide all the three services defined above or at least one. Ghana's system proves information service and navigational assistance service.

Another important aspect that needs clarification is the naming system used in regions where VTSs are established. According to Ustaoglu and Furusho (2014) although VTS is the only acronym that has been officially defined by the IMO, one can see various acronyms such as Vessel Traffic Information Services/System (VTIS), Vessel Traffic Management Services/System (VTMS), Vessel Traffic Management and Information Services/System (VTMIS), Vessel Traffic Control (VTC), Marine Traffic Control (MTC). To a large extent these difference are due to the political regime of the VTS area, capability of VTS elements, objectives of the Competent Authority among others. With these differences there is a high probability that there would be functional differences. For this study, VTS and VTMIS acronyms will mostly be used through out. A VTMIS is regarded as an extension of VTS. In a very simplistic description, it is an information system that stores data generated from VTS for processing and sharing among many departments.

A VTMIS provides greater level of situational awareness because it is an integrated maritime surveillance system that has multiple sensors and communication services. According to Bowditch (2002), VTS is only part of a larger and much more comprehensive information exchange system called VTMIS. He also argues that, under VTMIS "not only can vessel traffic be managed from the standpoint of navigation safety and efficiency, but also tugs, pilots, line handlers, inter- modal shipping operators, port authorities, customs and immigration, law enforcement, and disaster response agencies and others can use vessel transit information to enhance the delivery

of their services." Shelter International (2015) added on this that VTMIS is an integration of a VTS generated data to a Management Information System (MIS). Thus the MIS part is the system that hold intelligent processing capabilities of information passed on by the VTS or fed directly into a database. Ghana's VTMIS system provides both VTS services and MIS data for government agencies.

3.6 Essential Components of a VTS System

As mentioned in the previous sections, in the early days only VTS personnel and radars formed the core of VTS' but as time went on and new innovations and technologies emerged, other information gathering and communication tools were added. According to Kop (as cited in Ustaoglu and Furusho, 2014) the components of a basic VTS system can be categorized into four parts namely hardware, staff, training and procedures. In the same report Ustaoglu and Furusho also cited Wiersma et. al., that another categorization group the components into three; people, hardware and procedures. The three-component-model of people, hardware, and procedures is adopted in this study because training needs of staff can be discussed under personnel category.

According to the (International Association of Marine Aids, 2013), the people component, include VTS operators, supervisors, and managers. Operators work in VTS centres controlling traffic in the port or on approach whilst supervisors supervises and ensure that operations within a VTS centre conform to standards set by the VTS authority. VTS Managers manages and coordinates the activities of the VTS centre or centres on behalf of the VTS Authority. Training of VTS personnel is based on the recommended format of IALA. Training course 103 contains detail recommendations on training of VTS personnel. According to IALA, VTS Operators are trained by the model course V-103/1 whilst Supervisors must have V-103/2. Apart from these, IALA maintains that, certified VTS personnel should receive On-the-Job Training (V-103/3

VTS). Personnel are expected to maintain certification by refresher training and revalidation.

PROCEDURES

1. Internal procedures

2. External procedures

PEOPLE

VTS operator

VTS supervisor

VTS Manager

VTS

HARDWARE
Communication equipment, radar, AIS, CCTV, hydrological sensors, weather sensors, and VTS data, etc
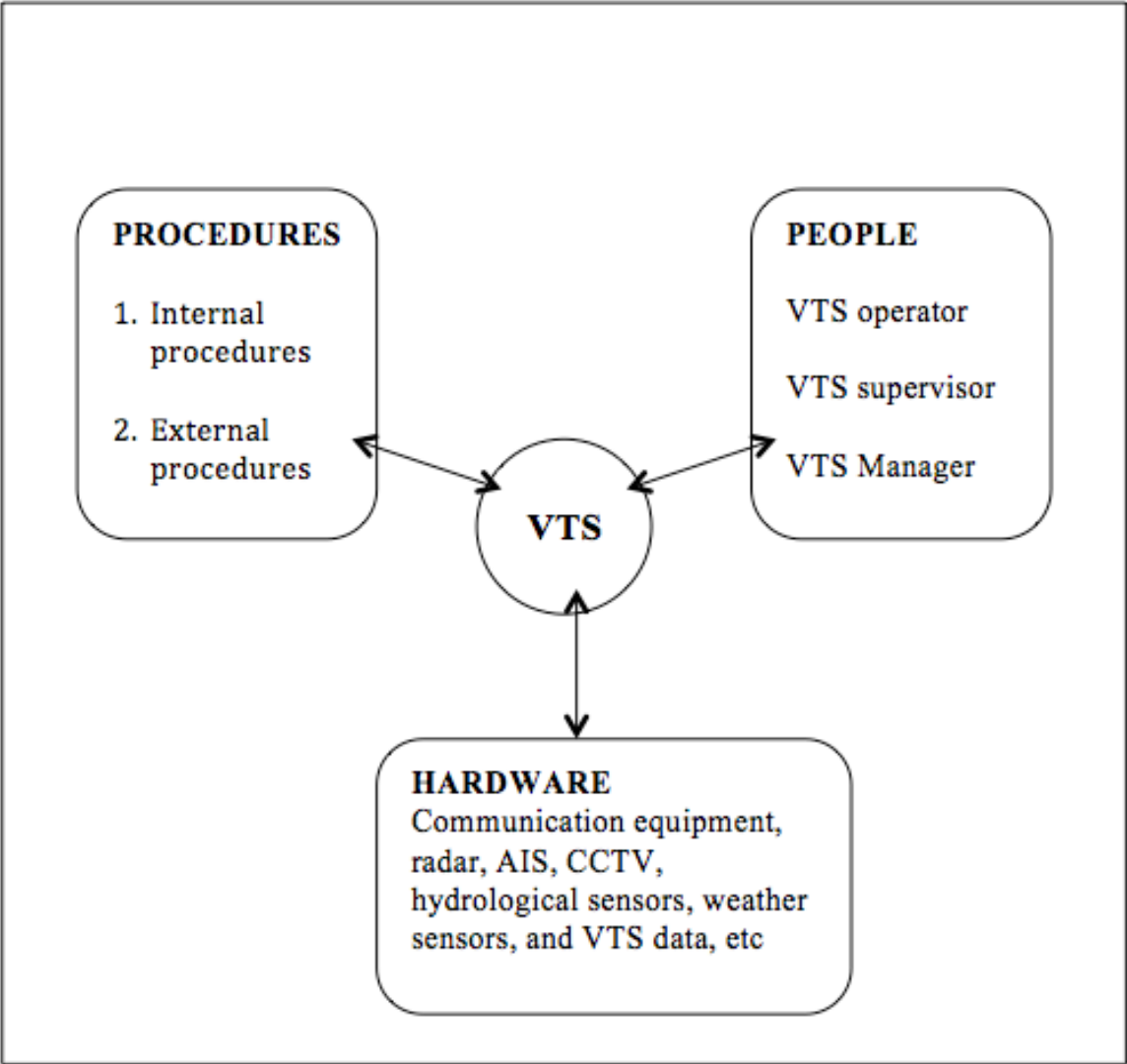
Sources: Created by the author, based on an integration of the VTS model proposed by Wiersma et.al (as cited in Ustaoglu and Furusho, 2014) and VTS components described in IALA VTS manual 2012.

Figure 1: Three-component-model of VTS

The second component of the three-component-model is procedures. International Association of Marine Aids (2011) noted that procedures should form an integral part of a verifiable safety management system for the VTS. IALA recommends VTS authorities to develop operational procedures because collection and dissemination of information involves internal and external communications. Procedures for running a VTS centre include the operation of systems and sensors, interactions among staff and the internal data processing in routine and emergency cases are seen as internal procedures. However, procedures that govern the interaction with participating vessels are considered as external procedures.

The third component of the three-component-model is hardware. VTS hardware all started with a simple radar but professors (Siousiouras and Dalaklis, 2009, p2) stated that "new technologies and especially the further exploitation of Information and Communication Technologies (ICTs) such as traffic management systems can provide new and more comfortable services to passengers, increase safety and security and reduce the associated with traffic environmental impacts." VTS equipment today comprises communication equipment, radar, AIS, CCTV, hydrological sensors, weather sensors, and VTS data system. The uses of that are associated with a particular VTS would determine what hardware is integrated. Perhaps in the case of modern VTS and VTMIS, another important subcomponent under hardware is software. This is used to manipulate and control the hardware give better meaning to the data received.

3.7 Vessel Traffic Management and Information Services/System (VTMIS)

A VTMIS extends beyond the components of a VTS with the addition of a MIS element. VTMIS process data from VTS equipment and makes it available for decision-making. The model in Figure 2, illustrates components of a basic VTMIS. Data from sensors such as radars and AIS are fed into the VTS centre and such information is communicated in a form of VTS service to vessels for navigational safety. The VTMIS

database centre also pulls information from the VTS centre and process it. Port authorities, Navy, Coast Guard department, SAR units, Maritime authorities, Policy makers, etc can be served with the information to aid them in planning. VTMIS also can be connected to Long Range Identification and Tracking System (LRIT) data centres for collecting maritime security-related information (European Commission, 2006). This system enables global identification and tracking of ships. LRIT communicates information on the identity of the ship and its position and allow Flag States to track ships under its flag everywhere in the world. The hardware component discussed under VTS in VTMIS is integrated with software under VTMIS.
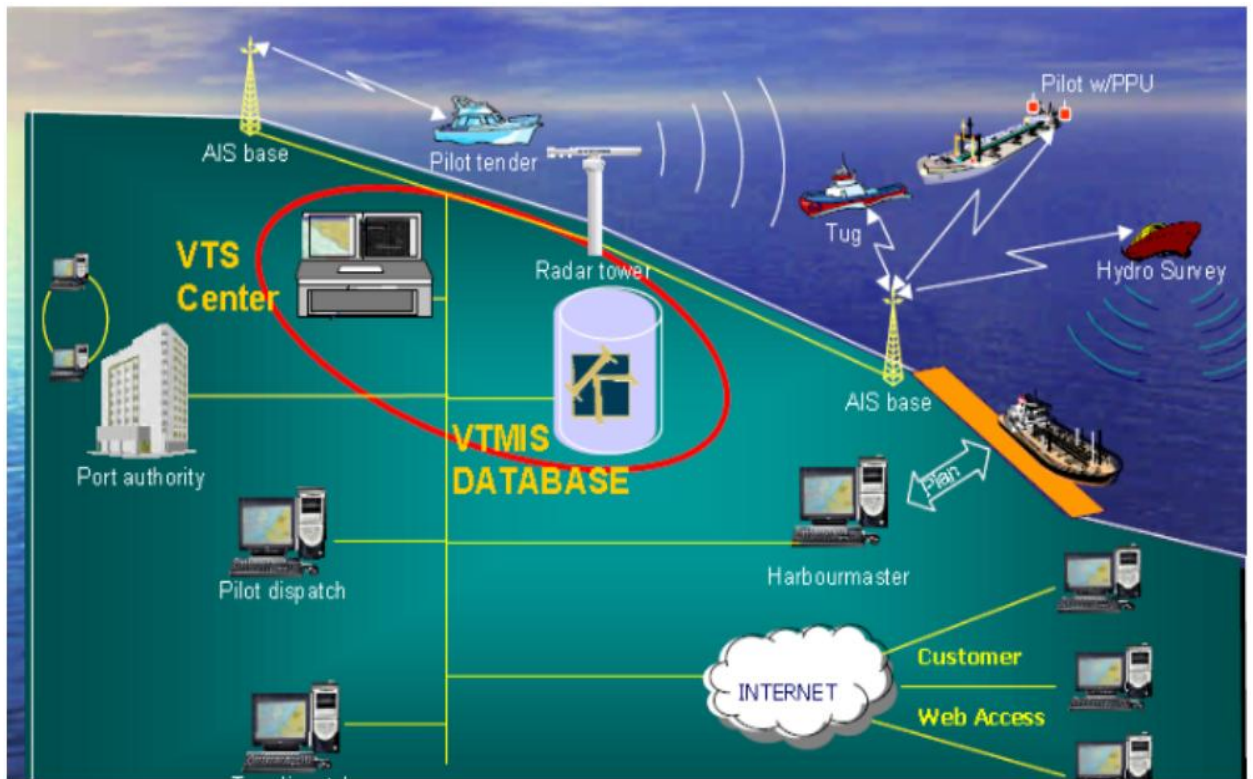
Source: Adopted from Shelter International, 2015

Figure 2: Components of a VTMIS

3.8 Definition of Maritime Security

According to Bueger (2014), today countries such as the United Kingdom (UK), United States of America (US), and organizations such as the European Union (EU), African Union, (AU), North Atlantic Treaty Organization (NATO), the MSC of IMO, all include maritime security in their list of task. However, there is no agreed definition of maritime security in the literature. Often, discussions loosely define it as the absence of threats such as maritime inter-state disputes, maritime terrorism, piracy, arms proliferation, illegal fishing, environmental crimes, or maritime accidents that prevail in the maritime domain. This approach has not been satisfactory since it does neither prioritize issues, nor provides clues of how these issues are interlinked, nor outlines how these threats can be addressed, not to talk of the puzzles over which threats to add to the list. The meanings attached to maritime security will always vary; to cope with this multi vocabulary Bueger proposed three frameworks, by semiotics, securitization, and security practice theory. Semiotics maps different meanings of maritime security by exploring the relations between it and other concepts whist securitization framework provides the means to understand how different threats are included in maritime security. To Bueger, security practice theory takes a closer look at the actions that are undertaken in the name of maritime security in trying to understand the concept.

This study adopts one of Bueger's proposed frameworks "semiotics" to help define and understand the nature of maritime security in the GoG area. According to Bueger (2014, p.160) "in semiotic thinking the meaning of a term can be grasped by exploring the relations of the term to others." He further explained that in the case of maritime security, at least four concepts require consideration: seapower, marine safety, blue economy, and human resilience. A matrix of these four concepts and how they relate to maritime security is shown on Figure 3.

MARINE ENVIRONMENT   ECONOMIC DEVELOPMENT

MARINE SAFETY   BLUE ECONOMY

Accidents   Pollution   Smuggling

Climate
Change   **MARITIME**
Terrorist   **SECURITY**   Piracy   IUU Fishing
Acts

Arms   Human
Proliferation   Inter-state   Trafficking
Disputes

SEAPOWER   RESILIENCE

NATIONAL SECURITY   HUMAN SECURITY
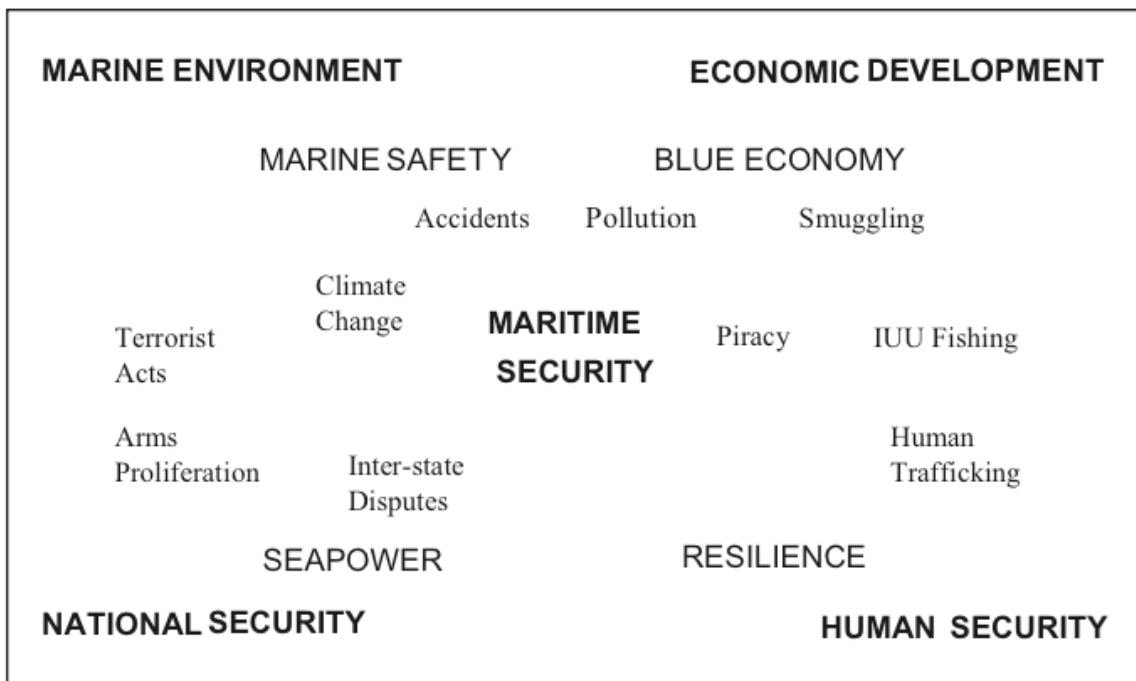
Source: Bueger, 2014, p.161

Figure 3: Maritime Security Matrix

Seapower include concepts such as a nation's comprehensive power and maritime strategy, advanced maritime technology, command of the sea, sea denial, and naval power. It relates to maritime security in areas of national security in the maritime domain and inter-state disputes. According to Bueger, firmly based in a traditionalist understanding of national security as the protection of the survival of states, seapower aims at laying out the role of state naval forces and at elaborating strategies for their use in the maritime domain. Naval forces are one of the major actors in maritime security and concerns have always been for state forces should act outside their territorial waters, engage in other regions than their own and have a presence in international waters.

Fransas, Nieminen, Salokorpi, and Rytkonen (2012) defined maritime safety as "the combination of preventive measures intended to protect the maritime domain against,

and limit the effect of accidental or natural danger, harms, damage to environment, risk or loss." According to Bueger (2014), maritime safety "in the first place implies the regulation of the construction of vessels and maritime installations, the regular control of their safety procedures as well as the education of maritime professionals in complying with regulations." Efforts at ensuring safety of ships and maritime installations are aimed towards protecting maritime professionals and the marine environment. According to Bueger, maritime safety concerns are core to maritime security given that it may involve environmental and cultural interests. This is also because the maritime industry is potential target of pirates, terrorists, trafficking of persons, illicit goods, and weapons.

Shipping, fishing, and offshore resources such as crude oil play significant roles in many economies today; coastal tourism is also important. Bueger (2014, p.161) argues that the commercial value of oceans "blue-economy" has been re-evaluated because of these contributions. Blue economy has seen significant endorsement in the world and efforts have been made at "linking and integrating the different dimensions of the economic development of the oceans and constructing sustainable management strategies for these."

Burger also supports that human security is the fourth concept necessary for understanding maritime security. The United Nations Development Program (UNDP) first proposed human security as an alternative concept for understanding national security. Burger noted that "core dimensions of human security concern food, shelter, sustainable livelihoods and safe employment." The sea is a major source of food, livelihood, and employment to many in less developed countries. In effect Illegal, Unreported and Unregulated (IUU) fishing is a major concern to human security. Issues such as security of seafarers and vulnerability of coastal populations to maritime threats are but few in this list. According to Bueger (2014, p.161), "notably the resilience of

coastal populations has been identified as a key factor in the emergence of maritime threats and is hence vital in their prevention."

Having reviewed the relationship of these four concepts and maritime security, Bueger (2014, p.161), concluded that "the semiotic perspective implies that for understanding what meaning actors subscribe to maritime security we can study the relations they suggest to those other concepts." Projected graphically, Bueger built a Maritime Security Matrix (MSM) (refer to Figure 3) that showed the relations between the concepts in ideal typical terms. Maritime security takes central place in the matrix and different issues of maritime security are plotted as they relate to seapower, maritime safety, blue economy, and human resilience. One of the advantages of working with the MSM is that it allows for the study of the types of relations established by different actors between maritime security and other concepts. It also provides bases for scrutinizing what actors include and exclude in their concept of maritime security. However, a weakness is that interpretations of threats can differ remarkably.

According to Bueger (2014, p.161), the MSM is an:

> "Ideal-typical version which reflects how the author would relate the concepts to one another. It is important to note that drawing on the matrix does not imply starting out from any idealized understanding and to argue that maritime security should integrate all of the four other concepts. The matrix is an analytical tool to grasp the differences and commonalities of understandings of different actors."

The choice of which of the four concepts of seapower, maritime safety, blue economy, and human resilience in Bueger's "Semiotics" concept in defining maritime security varies. Bueger believes that this is because security actors significantly diverge over how they draw these relations and position threats within them. He stated that whereas

maritime security strategies of some international organizations and countries such as the EU and the UK have strong relations to all four concepts and argue for a comprehensive approach that emphasizes the connectivity of the issues, others such as NATO and the African Union (AU) focuses on only some aspects of the MSM. He states that, NATO's Alliance Maritime Strategy "excludes the lower, left corner from its understanding of maritime security in arguing that these are separate so called high end tasks, and then primarily focuses on issues related to the blue economy and human resilience" (Bueger, 2014, p.162). By contrast Bueger noted that, the African Integrated Maritime Strategy of the AU "centers on the blue economy and argues that maritime security challenges are primarily relevant because they hamper economic growth. Starting out from the upper right corner the AU quite surprisingly excludes traditional considerations of interstate dispute or state rivalry from its strategy."

In applying the MSM of Bueger, this study defined maritime security as it relates to maritime safety, blue economy and human resilience. Since this study focuses on the use of VTS in enhancing maritime security, the seapower aspect is deemed beyond the scope of the study. Embracing a definition of maritime security based on seapower would invariably include such agencies as the Navy, and other national agencies. This would take the focus of the study out of context. Therefore the first concept in Bueger's proposal for understanding maritime security by semiotics is not covered in this study. In effect maritime security is used in this study unless otherwise stated to refer to the presence of issues such as maritime accidents, pollution, smuggling, piracy, robbery, IUU fishing, and human trafficking, in the GoG. These maritime security threats are also collectively called crime in this study. The focus is on the role VTMIS play in fighting these and other maritime threats that relates to maritime safety, blue economy, and human resilience.

3.9 Maritime Security in the Gulf of Guinea (GoG)

The GoG area is located in West Africa stretching to the North-Western and South-Western parts of the African continent. The definition of the GoG region shall be restricted to the area in 10° South to 30° North by 30° West to 15° East as adopted in (Greidanus, Alvarez, Eriksen, & Barbas, 2013), see map in Figure 4. There are more than 15 countries in this region by reference is made especially to the coastal countries who directly deal with issues of maritime security in the GoG area.
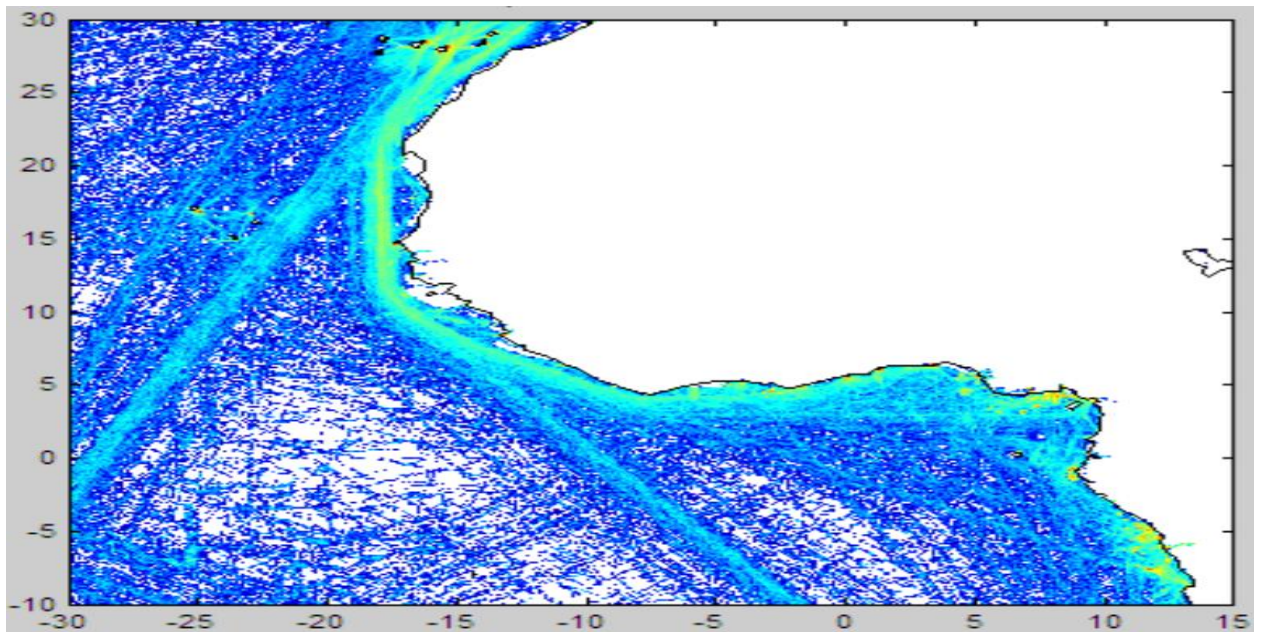
Sources: Greidanus, Alvarez, Eriksen, & Barbas, 2013, p.10

Sources: Anyiam, 2014, p2.

Figure 4: Maps of West Africa indicating the Gulf of Guinea area

Reviewing ship traffic distributions and statistics in the narrower GoG area by Greidanus and others, shows a significant vessel density of 7,000 ships visible by AIS in the area during 6 months. Their study found that "whereas density maps show that cargo ships and oil tankers normally follow the major maritime traffic routes across the Atlantic Ocean and along the coast of Africa, the position reports from the fishing fleet shows high concentrations on the fishing grounds as well as how the fishing areas change seasonally" (Greidanus, et. al, 2013, p.55). This density comes with significant maritime security threats in the area. According to Schembri (2012), the lack of any maritime security strategy amongst the 15-member Economic Community of West Africa States (ECOWAS) is having a significant effect across the region where maritime criminal activity is on the rise. The report noted that the GoG area is home to maritime security threats such as transnational organised crime, including oil bunkering,

robbery at sea, hostage taking, human and drug trafficking. According to professor (Dalaklis, 2012, p.5) "the problem of piracy is by no means limited to the Gulf of Aden and/or the Indian Ocean. Somali pirates have now expanded their operations up to the west coast of India. Many analysts believe that the worrying rise in the number of attacks off the coast of West Africa will result in the region becoming the next piracy hotspot." Schembri added that these maritime security threats are mounting concerns for the safe passage of vessel, cargo and crew through this high-risk area.

In the literature, there is a consensus that the rate of unlawful acts (crime) against vessels in the GoG area has been on the increase in recent years. According to Hart (2014, p.3) maritime crime in the Gulf of Guinea includes theft, robbery, and assault, kidnap and hijack. Hart claimed that between 2008 and 2013, there was a 30% increase in overall activity. There are **t**wo key trends in the Gulf of Guinea: kidnapping for ransom and hijacking for cargo; 355% increase in maritime kidnapping for ransom; and 12.5% decline in hijacking for cargo incidents. Anyiam (2014) however stated that information on the exact nature of such unlawful acts in the region is distorted and unreliable with confusing statistics hampering efforts to suppress the menace. Anyiam attributed this to confusing definition of piracy and armed robbery at sea. Critical assessment of the IMO Regional Analysis of West Africa from 1995 to 2015 on Table 1, indicated that 80.4% of the reported incidents of unlawful acts against vessels in West African (GoG) should be properly and legally classified as armed robbery. These statistics seem to prove Anyiam's claim.

Table 1: Extract from regional analysis of reports on acts of piracy and armed robbery in West Africa

LOCATION OF INCIDENT	NUMBER
In international waters	176
In territorial waters	312
In port area	412
NUMBER OF PERSONS INVOLVED IN THE ATTACK	
1-4 persons	259
5-10 persons	234
More than 10 persons	87
Not stated	300
OTHER	
Lives lost (unit: people)	48
Wounded crew (unit: people)	183
Missing crew (unit: people)	10
Crew hostage (unit: people)	614
Assaulted (unit: people)	216
Ransom	0
TOTAL NUMBER OF INCIDENTS REPORTED	**900**

Sources: International Maritime Organization (2015,

https://gisis.imo.org/Public/PAR/Reports.aspx?Name=RegionalAnalysis)

It is important to note that Anyiam's report did not set out to disprove the presence of maritime security threats in the GoG. Indeed the report states "it is impossible to have an effective solution to a problem without establishing the nature of the problem." Anyiam argue that "in formulating an effective strategy to repress the surge in unlawful acts against the safety of maritime navigation in GoG it is vital that we first appreciate the exact nature of the problem from a legal perspective." For any security measure to be fruitful in combating crimes against vessels in GoG it must be based on a sound legal footing bearing in mind the rights and obligations of states within the various maritime zones under UNCLOS with issues relating to sovereignty and jurisdiction, and also the various maritime boundary disputes in the region due to the discovery of crude oil. In view of this maritime security threats are viewed in this study in relation to Anyiam's concept. Acts of crime done in territorial waters are considered under the jurisdiction of the said maritime state whereas those done in international waters are considered as such. Piracy for example the IMOs' definition recognizes a distinction between piracy as only occurring in international waters and all other unlawful acts within internal and territorial waters and port facilities as armed robbery (Anyiam, 2014).

3.10 VTMIS and Maritime Security

Both (Anyiam,) and (Schembri,) agree that threats of maritime security in the GoG are rooted onshore. Issues such as poverty, unemployment, corruption and free access to weapons are some of the causes of threats in the GoG. There are many suggestions for combating the challenges in maritime security in the GoG area including gaining consensus between affected nations and regional cooperation, tackling the root causes ashore, enforcing legislation among many other factors. Arguable the use of VTMIS will enhance efforts at bringing down the maritime security threats or crime in the GoG. According to Anyiam (2014, p.12), "GoG States must invest in modern technology in their efforts to combat maritime crime due to the large expanse of the area to be kept under surveillance." He argued that it is possible for states to have virtual control of

their maritime domains by investing in various maritime surveillance technologies. Anyiam list AIS, LRIT, vessel monitory system, vessel detection system, and VTS as examples of available technology for maritime surveillance.

Apart from the core uses of VTS for Information Service, Traffic Organization Service, and Navigational Service the upgrading of a VTS into a VTMIS help governments in many ways. Many agencies such as fisheries, customs, immigrations service, port authorities, national intelligence units, the Navy, coast guard, Search and Rescue units would be able to utilize information stored and processed for planning, forecasting, as well as detecting maritime related crime. There are many VTS equipment that feed information into the VTMIS for analysis. Some of these equipment and how they can be used in combating maritime crime are reviewed as follows.

A VTS Radar (see pictures in Figure 5) is a system for detecting the presence, direction, distance, and speed of aircraft, ships, and other objects, by sending out pulses of radio waves which are reflected off the object back to the source. According to (International Association of Marine Aids, 2012) a VTS radars typically function like a ship's radar. However VTS radar are sometimes customized to operate simultaneously on short and long-range identification.

Source: (International Association of Marine Aids, 2012, p.81)

Figure 5: Radar (top Rotherdam-Netherlands, left side: Zandvliet-Belgium, right: Genova-Italy)

According to IALA, radar is required to be able to detect and track, for subsequent display, all specified moving or stationary targets which satisfy the detection criteria within the specified coverage areas and during all specified operating circumstances. They help in developing vessel traffic images. Plotted radar images allows for presence, direction, distance, and speed detection. In the absence of other sophisticated equipment, radar offers a rudimentary technic for identifying suspicious targets at sea and to take necessary action.

The Automatic Identification System (AIS) is intended as a supporting tool to enhance safety of life at sea, the safety and efficiency of navigation, and the protection of the marine environment. European Commission (2008, p.7) noted that the AIS is a ship-borne transponder system designed in the first instance for maritime safety and in particular collision avoidance. They are built with a transponder unit including GPS, VHF transmitter/ receiver and display / terminal. The vessel AIS broadcasts a message at regular intervals containing its identification, position, speed, course plus a number of detailed items about the ship and its cargo such as ship length, draft, cargo type, ports of providence and destination. To make it very secured, the ship identification (MMSI number) and some static data are hardwired into the device. Regulation 19 of Chapter V of the International Convention on Safety of Life at Sea (SOLAS) 1974 as amended requirement for vessels to have AIS. The benefits to AIS include the automatic identity of a vessel's MMSI or call sign, which helps to facilitate rapid radio communication and ships data reception. They provide timely, relevant, and accurate information about vessels within the area that might affect safety, security, or the decision-making of a VTMIS. Although some information in the vessel's AIS can be manipulated and the AIS can be switched off, generally together with the radar it still aid in tracking and apprehending vessels in time of maritime crime.

Another important part of a VTMIS is a Long Range Identification and Tracking (LRIT) system. European Commission (2008) reports indicates that an LRIT is a

messaging system for security and SAR purposes that is regulated by IMO through an amendment of SOLAS Chapter V regulation 19. This is a mandatory tool for passenger ships, cargo ships of 300 gross tonnage and up on international voyages and mobile offshore drilling units. Whereas the AIS device receives information as far as the line of sight the LRIT is global through the use of satellite cans. Additionally, LRIT sends data to specific recipients for confidential treatment unlike AIS which broadcasts. Another handy component of a VTMIS is Global Maritime Distress and Safety System (GMDSS). This system allows ships to alert authorities on shore as well as other ships in case of an emergency. GMDSS equipment includes VHF and MF radio with Digital Selective Calling (DSC) facility among others. These identification, tracking, and alerting systems facilitate measures aimed at preventing maritime security and crime. Some modern VTMIS also integrate satellite facilities to enhance coverage areas.

According to Professor Dalaklis, Siousiouras, and Nikitakos (2009), the VTMIS in Greece elevates the role the country plays above the regional scale and contributes to the effective protection of the Greek Seas, with change for policy-makers from suppression to prevention. VTS around the world improves the safety and efficiency of navigation, safety of life at sea and the protection of the marine environment and or the adjacent shore area, worksites and offshore installations from maritime security threats and adverse effects of maritime traffic. Ghana's VTMIS would be investigated inline with these equipment to understand the set-up, capabilities and effectiveness in improving maritime safety and security.

## 3.11 The Nature of VTS/VTMIS in Ghana

According to reports published on the commissioning of the VTMIS project by GMA, the VTMIS is an integrated system established to enhance continuous electronic surveillance of the entire coast of Ghana. Ghana Maritime Authority (2014) reports indicated that, under the auspices of the Ministry of Transport, it acquired land for

construction of control centres and erection of eleven towers for the coastal and lake sites; installed microwave/internet/WAN communication links; acquired frequencies for microwave communications, installed hydrological buoys; among others to establish a national VTMIS.

The VTMIS is made up of one national control centre and three area control centres. These include National Control Centre (NCC), area West Control Centre (WCC), area East Control Centre (ECC), and Navy Head quarters area Control Centre. GMA reports noted that these four control centres are fed with data from twelve remote sites. Eight of the twelve remote sites for coastal surveillance are called Remote Sensor Sites (RSS). They are located across the coast area of Ghana from east to west at Keta (Woe), Big Ada, Tema, Winneba, Cape Coast, Takoradi, Axim, and Epunsa (Half Assini). The remaining three remote sites for automatic identification of vessels at Volta Lake are called Remote Base Stations (RBS). They are located inland along the banks of the Volta Lake at Yeji, Kete Krachi and Anum.

In all, ten monitoring stations are also fed with information from the four control centres. These monitoring stations include National Security, Narcotics Control Board (NACOB), Naval Command East, Naval Command West, Ghana Ports and Harbours Authority (GPHA), Fisheries Department, Ghana Immigrations Service, Customs and Preventive Service (CEPS), Volta Lake Transport Company, Regional Maritime University. The physical and logical set-ups of the system are illustrated on Figure 6.

One of the respondents said, "data from the remote sensor sites in the area east and west are fed into WCC and ECC respectively." The diagram in Figure 6 (B) illustrated the direction of flow of data among the RSS, RBS, and control centres in the system. The WCC and ECC intend send the data to the NCC. Navy HQ area control centre gets it feed from the NCC. However the three inland RBS feed data direct to the NCC.
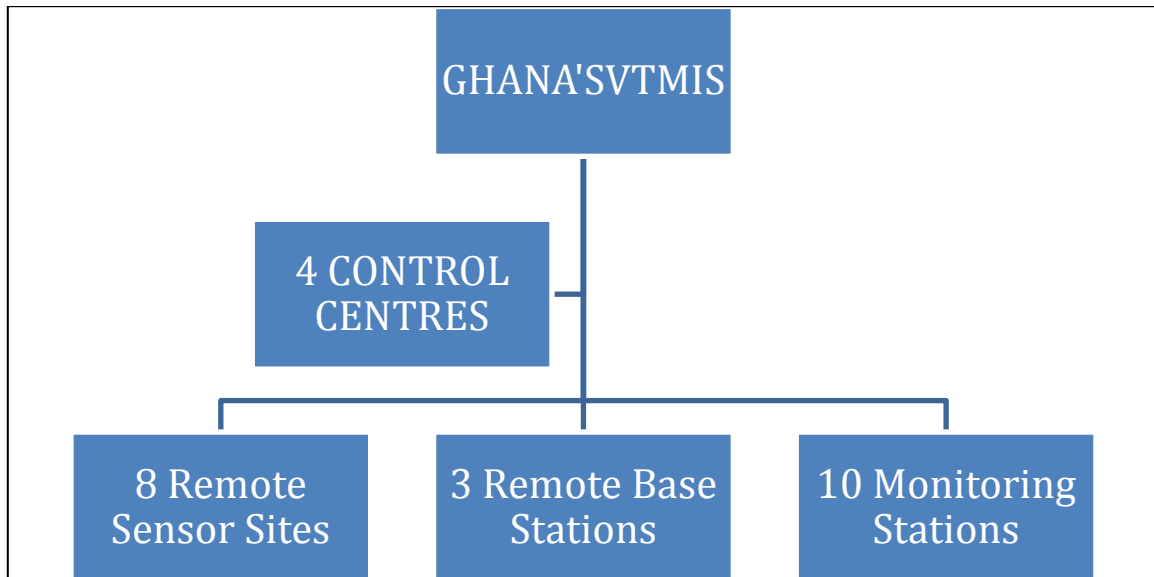
A: Physical set-up
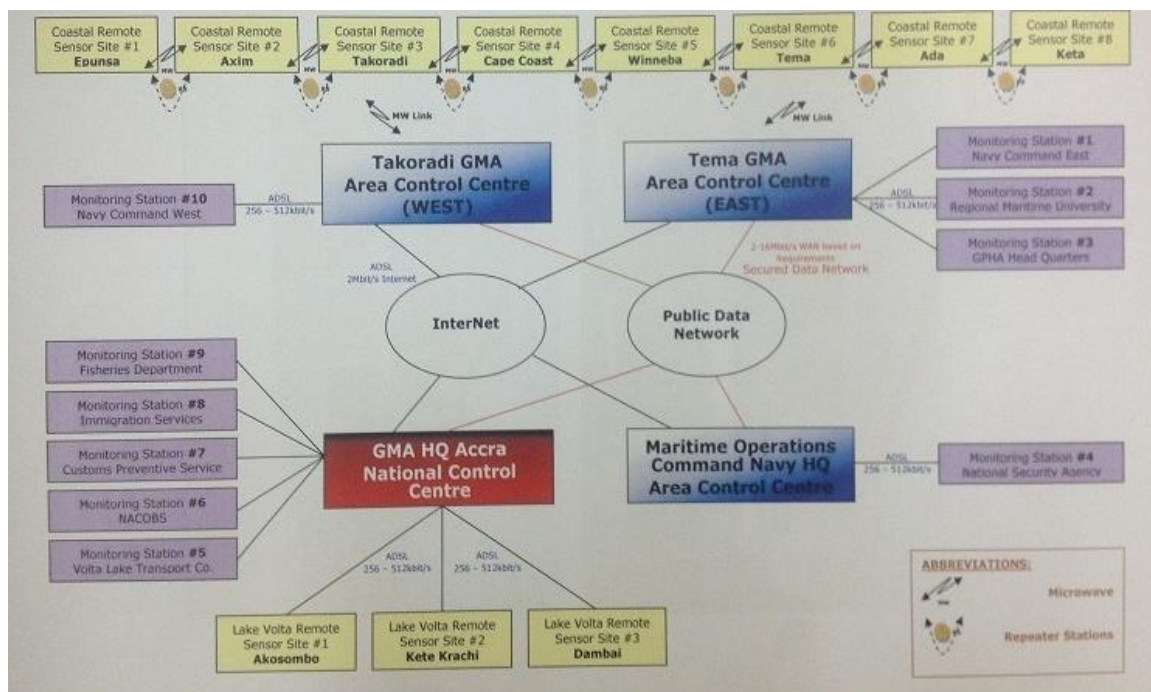
B: Logical set-up

Source: Ghana Maritime Authority, 2014, p.8

Figure 6: Overview of NCC and Area Control Centre of Ghana's VTMIS

A: National Control Centre at GMA HQ

B: VTMIS West Control Centre (WCC)

Source: GMA Dairies, 2014

Figure 7: Control Centres at A: Accra (GMA HQ) and B: Takoradi (WCC)

3.12 Hardware and Software Components

The hardware and software component of the VTMIS in Ghana is discussed under Control centres, the monitoring station, and the remote sites. The control centres are all equipped with data centres, two Global Maritime Distress and Safety Systems (GMDSS) VHF Digital Selective Calling (DSC) devices, Workstations and displays, and IP-phones. Information received for the RSS and RBS is stored at the data centres in databases. The data centres collate, stores, and process data from the RSS and RBS. The workstations and display are used for visualizing, displaying and presenting the

information to VTMIS operators (see picture at Figure 8). The operators keep watch on 24/7 bases on shifts in the control centres. The IP-phones are used for internal communication between the control centres, the monitoring stations, and the RSS and RBS. The IP-phone enables internal voice-over-IP communication between these sites.

 Source: Ghana Maritime Authority (2014)

Figure 8: Workstations and Display unites at the control centres of the VTMIS in Ghana

Ghana's VTMIS centres are equipped with GMDSS devices. According to Inmarsat (2015), the IMO adopted GMDSS in 1988 with amendments to SOLAS Chapter IV. GMDSS is an international system that uses terrestrial and satellite technology and shipboard radio systems to send automated alerting to shore-based communication and rescue authorities as well as ships in the immediate vicinity in the event of distress at sea. A core component of the GMDSS is the VHF DSC device. DSC is a paging system that uses data signals to automate the transmission and reception of calls on VHF marine radio channel 70 (see picture at Figure 9).
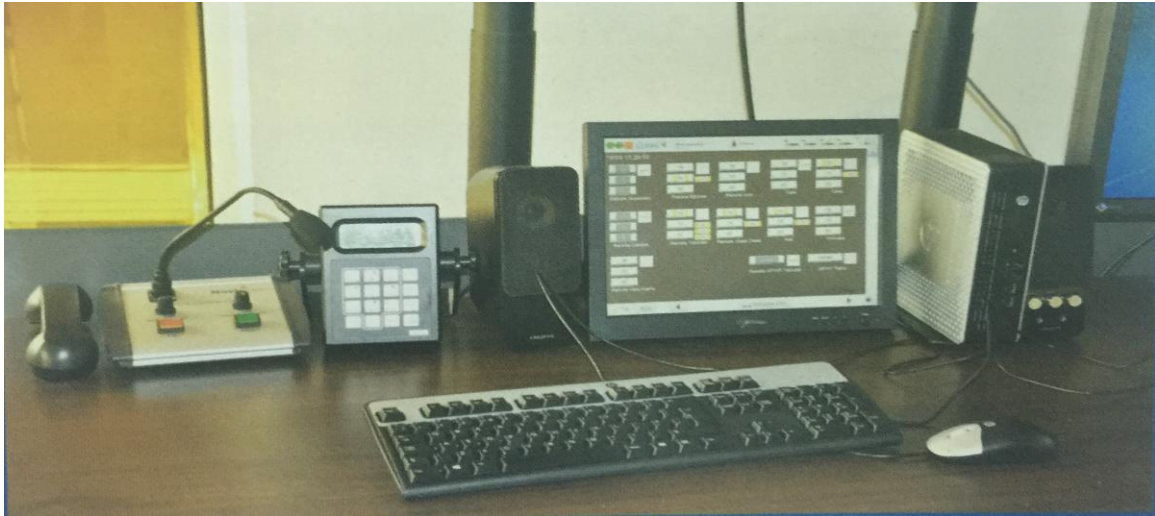
Source: Ghana Maritime Authority (2014)

Figure 9: GMDSS (VHF DSC) set at Ghana

For purposes of redundancy, 50 KVA generators, Uninterruptible Power Supplies (UPS), and Automatic Voltage Regulators (AVR) have been installed at all the control centres, monitoring stations, RSS and RBS. These centres and sites have been networked with fiber optic WAN, Internet, and microwave networks. These ensure that, the system runs without interruptions.

The monitoring stations are equipped with a set of workstation and an IP-phone. The workstation receives data from the control centres. These departments put personnel in charge to monitor activities depending on their special interests. Every monitoring station perform similar operations as the control centres except that, the features and functions are limited to the use of a monitoring station. They monitor vessel traffic and can use IP-phones to communicate with control centres for detail information that may not be available to them. A picture of the equipment setup in one of the monitoring stations is at Figure 10.

Source: Ghana Maritime Authority (2014)

Figure 10: Equipment setup at Ghana's VTMIS Monitoring Stations

The RSS and RBS are equipped with Radars scanners, CCTVs, weather sensors, VHS and AIS antennas, and microwave communication disc. These equipments are mounted on a 15 metres towers. A picture of one of the towers and equipment is at Figure 11. The RSS and RBS also have communication devices that send the data from the above devices to the data centres at control centres. The shelter that contains the communication devices also have IP-phones in them to allow officers at the sites to communicate with personnel at the control centres.

With regards to hardware component, the VTMIS in Ghana is impressive. It is yet to be integrated with satellite technologies that can extend it and increase the coverage area. however, with the right procedures and personnel, the system can be used to conduct effective surveillance along the GoG area.

Source: Ghana Maritime Authority, 2014, p.12

Figure 11: Equipment at the VTMIS RSS and RBS

3.13 Conclusion

This chapter reviewed related literature on use of VTS and VTMIS. It discussed the history of VTS and evolution to VTMIS. IMO guidelines and legislation setting requirements for establishing and operating VTS were also reviewed. The establishment of coastal surveillance system emerged in the 1950s to aid navigation and enhance safety at sea.   Eventually in 1985, IMO came out with resolution A.578(14) on guidelines for vessel traffic service and revised it in 1997 as   A.578(14) to further strengthen measures aimed at improving safety and efficiency in movement of maritime traffic. This resolution also contains the definitions of concepts and terms used in the VTS domain. Regulation 12, chapter V of the SOLAS convention included requirements for governments that established VTS.

Based on a model attributed to Wiersma et.al (as cited in Ustaoglu and Furusho, 2014), VTS components are put under three main groups. These include people/personnel, procedures, and hardware/software. A well-organized VTMIS system should have all these components developed and functioning as required. In the discussion that follows in chapter four, Ghana's VTMIS would be evaluated in light of these components to test its strengths in improving safety, security and protection of maritime environment.

Maritime security is a difficult term to define. As such the concept is seen as a buzzword and attached to different meanings in the literature. A study of this nature however needed a delimited meaning to what constitute maritime security or crime. This will enable the study to easily identify unlawful acts or crimes in the GoG. The study reviewed the work of (Bueger, 2014) on maritime security. Although Bueger proposed three frameworks, by semiotics, securitization, and security practice theory, to defining maritime security, the study adopted only the semiotic framework for defining maritime security. This framework related maritime security to four concepts: seapower, marine safety, blue economy, and human resilience. However, seapower was left out

because its inclusion would take the study out of context. Applying the MSM of Bueger maritime security is used in this study to refer to the presence of issues such as maritime accidents, pollution, smuggling, piracy, robbery, IUU fishing, and human trafficking in the maritime domain.

A review of IMO data and (Hurt, 2014) on piracy and armed robbery revealed reported cases in the GoG area. According Professor (Dalaklis, 2012), many analysts believe that the worrying rise in the number of attacks off the coast of West Africa will result in the region becoming the next piracy hotspot. Hart (2014) stated that between 2008 and 2013, there was a 30% increase in overall activity. Anyiam agreed to the presence of threats to maritime security in the GoG area but noted that the confusing definition of piracy and armed robbery at sea for example is partly to blame for the alarming reports of such cases in the GoG area. This study adopted Anyian's concept of identifying maritime security threats with regards to whether they are done within a jurisdiction of high seas.

VTS/VTMIS have evolved to become very sophisticated today. VTMIS now include a wide range of devices such as advanced Radars, AIS equipment, LRIT databases, GMDSS systems and satellite integrations. These additions have further enhanced VTS/VTMIS usage around the world to improve safety and efficiency of navigation, safety of life at sea and the protection of the marine environment. Following in chapter four, Ghana's VTMIS is investigated inline with these new technology to understand its capabilities and effectiveness in improving maritime safety and security especially in the countries jurisdiction and in the GoG area at large.

CHAPTER FOUR

DISCUSSIONS ON THE ROLE OF VTMIS AND MARITIME SECURITY IN GULF OF GUINEA AREA

4.1 Introduction

This chapter discusses results from primary qualitative data collected from interviews conducted via Google Docs forms, emails, and phone calls of staff from the Ghana Maritime Authority (GMA) and other state agencies that uses the VTMIS facility in Ghana. The discussion also used secondary data from publication of the GMA on the VTMIS project. In addition secondary data on regional piracy and armed robbery from the IMO website and maritime crime data from (Hart, 2014) is included in the discussion. The discussion is put under four themes namely, the set-up of Ghana's VTMIS; contributions of VTMIS to protecting offshore installations; usefulness of VTMIS in combating crime in the GoG; and the shortfalls of Ghana's VTMIS.

The first theme discusses the nature of the three VTS components of Ghana's VTMIS. It looks at the hardware and software equipment integrated, the coverage area; the personnel operating the facility; and the procedures (guidelines and regulations) governing the system. The second theme discusses the role Ghana's VTMIS play in securing offshore installations. This section looks at specific state or private facilities and how they are being protected by the VTMIS system. The third theme, discusses the role Ghana's VTMIS play in fighting maritime crime. The section identifies particular crimes or unlawful acts at sea according to Bueger semiotic framework and discusses a technology in the VTMIS that can help combat the threat. The fourth theme discusses the shortfalls of Ghana's VTMIS. Based on the discussion preceding this section, an evaluation of the countries VTMIS is possible in relation to current technology and capabilities of VTMIS in the world.

4.2 The Components of VTMIS in Ghana

To help understand further the composition of the components of the VTMIS in Ghana and to add to what has already been discussed in the literature, questions on the hardware and software components, the operational procedures, and training requirements of VTMIS personnel were added to the interview guide. On personnel development, the participants were asked the following questions: "what is your background?" and "what are the training requirements for VTS staff?" All the participants involved in the interviews from GMA were either Marine Radio Officers or Merchant Captains. They had worked on vessels as radio officers or as masters for some years. They all stated that IALA training and certification was required for VTMIS operators. All participants had gone through training as VTS operators according to the IALA VTS 103 modules.

The participants from other government agencies had past experiences in Information and Communication Technology (ICT) and others were just new officers recruited and trained purposely to work at the monitoring stations. Unlike the VTMIS personnel at GMA, the personnel from other agencies did not have training on VTS operation as required by IALA and IMO regulations. This is because they are only responsible for manning monitoring stations, which are not operated like VTS centres but merely for monitoring purposes. It is only in the three control centres, the NCC, WCC, and ECC that VTS assistance is provided for. However, all the participants from GMA and the other government agencies had been formally taken through the "JMAP" software used for the monitoring of vessels.

When the participants were asked whether there are regulations which VTMIS authorities are expected to comply? The responses revealed that the VTMIS is expected to be regulated by requirements of the IMO, Institute of Electrical and Electronic Engineers (IEEE), and International Telecommunication Union (ITU). IMO legislation

such as in SOLAS Chapter V, regulation 12 and guidelines contained in the Resolution A.857 (20). The IEEE define standards for communication data between electronic devices and whilst the ITU is a special UN agency that standardizes ICT technology such as wireless technologies, aeronautical and maritime navigation, radio astronomy, satellite-based meteorology, convergence in fixed-mobile phone, Internet access, among many others.

The percipients from GMA were all able to give a general structure of the nature of VTMIS in Ghana. One interviewer said "there are four control centres namely, Area West, Area East, Central, and the Navy. Area West and Area East feed data into the national HQ at central control centre. The VTMIS covers the entire coast of Ghana and the inland Volta lake." Another participant from GMA said the VTMIS is made up of "4 control centers, 8 remote sites, 3 AIS bases, and 10 monitoring centers. The data centres at the control centers stores information received for the RSS and RBS. The database software backup and process the information for consumption. The operators monitor and keep watch on Ghana's maritime domain using the workstations and displays in the control centres.

However, when participants were asked to list government agencies that benefited from the VTMIS and the nature of information they received from the system, the story was different. All respondents listed some other agencies apart from their own that are linked up to the system. Apparently, GMA had organized training sessions on the use of the software and other operational regulations for the operators of the monitoring station.

All the participants from GMA again were well vested in knowledge about the hardware components of VTMIS. Participants were asked two major questions on hardware components during the interviews. These include "What are the communication mediums used in the VTMIS to contact and communicate with vessels

and between VTS centres? Also list the various sensor devise integrated" and "How far in terms of nautical miles is the coverage area of Ghana's VTMIS?" The communication devices listed included AIS, VHF/DSC, and IP-phone. AIS texting and VHF/DSC are used for communicating with vessels whereas IP-phone are used for internal communication.

The sensors listed include AIS antennas, CCTV, Radar, Hydrological sensors, and weather sensors. The participants said that the eight RSS and three RBS are each equipped with Radar scanner, VHF antenna, AIS antenna, weather sensors, Hydrological sensors, and CCTV cameras. These devices are mounted on 55 metres steel towers. The Radar is used for scanning vessels. Particularly the radars aid in identifying vessel which have their AIS switched off or do not have them fitted at all. The coverage area of Ghana's VTMIS Radars is 50 nautical miles offshore. The advantage of the radar also includes its ability to determine course (direction) and speed. GMA participants also said the CCTV capture and feed close proximity videos to the system for monitoring areas around the ports. With the CCTV the system is able to view areas closed to the sensor sites for up to 15 nautical miles. The AIS devices pick signals from vessels fitted with AIS transponders and LRIT is able to track vessels in many parts of the world. A participant summed up the coverage areas by these devices as follows "LRIT - 1000 nm, AIS - 300 nm, Radar - 90 nm, and CCTV - 14 nm." As discussed in the literature, Ghana's VTMIS also included a GMDSS set. The GMDSS (VHF DSC) set are for communicating with vessels via broadcast and on designated channels. The GMDSS is used to receive alerts from vessels in distress so that the appropriate action can be taken.

With all these communication devices and data sensors Ghana's system has the required technology and expertise to run a well functioning VTMIS. The interviews revealed that the VTMIS operators from GMA are trained according to IALA recommended course VTS 103. It also revealed that the VTMIS authorities are aware and operate the system

in Ghana in accordance with procedures, legislation, guidance and standardization from international organizations such as the IMO and IALA, ITU, and IEEE. On hardware, the interviews revealed that the VTMIS in Ghana has the basic infrastructure necessary for conducting descent surveillance on safety and maritime security in the GoG area.

4.3 VTMIS contribution to Security of Offshore installations in Ghana

The first sub-objective of the study was to investigate how VTS can contribute to the increase security level of offshore installations. Some of the interview questions were therefore designed to aid the study investigated and the role VTMIS play in protecting offshore installations such as cables, oilrigs, and pipelines in Ghana. Reviewing the development of VTS, it was indicated that, the primary reason for its development was to ensure navigational safety. However, maritime safety is far broader than just navigational safety. According to IALA VTS Manual, traffic surveillance systems were simply made of shore-based radar combined with VHF radio to enhance real-time information exchange between the shore and ships for navigational purposes. According to (Bueger, 2014) maritime safety includes the regulation of the construction of vessels and maritime installations, the regular control of their safety procedures as well as the education of maritime professionals in complying with regulations.

With developments in technology that allows for resources in remote areas in the sea to be explored, there has been the need for many installations in the maritime industry. In Ghana, there are installations at the Salt-pound and Jubilee oil fields for exploration and drilling of crude oil. In addition to resources explorations, many countries have installed pipelines to transport water, gas, or crude oil to processing units shore based. The West Africa Gas Pipeline (WAGP) and the gas pipeline linking FPSO Kwame Nkrumah to the processing units at Takoradi are examples of pipeline maritime installations in the coastal waters of Ghana. Internet revolutions have also led to many telecommunication companies running their communication cables through the sea. Main One, MTN, and

Glo all have communication cables running across the GoG linking countries of West Africa to the rest of the World.

In connection with this sub objective to investigate how the VTMIS in Ghana contributes to increase security level of offshore installations such as cables, pipe lines, and oil rigs, the participants were first asked to state the usefulness of the VTMIS to Ghana and the West African sub-region. This was meant to test general theoretical knowledge of the possible uses of VTMIS in Ghana and West African region. One of the participants called said the VTMIS could be used for:

> "Safety of navigation, prevention of vessels from entering restricted areas, control of vessels around subsea structures, anti piracy controls, anti pollution controls, vessel reporting system controls, narcotics control, aid to search and rescue, and inland water safety at the Volta lake."

Another participant said the system is used for:

> "For ensuring security at national protected areas like the oil fields, protecting private communication cables installed in through the sea, protecting the West African Gas Pipeline, and giving information to vessels along the coast of Ghana. There is also collaboration with the navy in identifying vessels patrolling in unfitting zones and vessels that may be suspected to be violating any maritime regulation. Basically, the VTMIS offices keep watch across the maritime area of Ghana to ensure safety and security."

Based on the responses, it can be said that generally the awareness of the uses of the VTMIS is high. Although the first respondent quoted above was more general, evidently the statements of the second respondent indicated that the participants were mostly listing what the system was being used for. The participant use of statements such as "we also collaborate with the navy in identifying vessels patrolling in unfitting

zones and vessels that may be suspected to be violating any maritime regulation" and "we basically keep watch across the maritime area of Ghana to ensure safety and security" both reflect involvement. This shows a state of involvement and what is being done rather than mere listing of what could be done.

The investigation further asked participants to state the targeted areas during VTMIS operations? If indeed the VTMIS was being used for protecting offshore installations then, those areas would be given a certain level of protection and identified for example as restricted zones, no anchorage zone, or no fishing zones. The responses revealed that the West African Gas Pipeline, Main One Sub Sea communication cables, Atuabo gas pipeline, Area-To-Be-Avoided near the FPSO, western oil fields, and areas around the national oil fields, are all targeted areas during operations.

The interviewees were also asked to explain how VTS could be used to provide security monitoring of offshore installations. In the words of one participant, they do so by:

> "Keeping watch 24-7 on Areas-To-Be-Avoided, and demarcated no anchorage zones. Operators' advice vessels to keep off protected areas and offshore installations. Vessels are also advised not to anchor closed to pipelines and communication cables. In addition, port authorities watch and advice vessels appropriately."

The display show tracks of vessels by radar and AIS and operators are able to see and advice vessels to keep off such areas. Broadcast messages as well as AIS messages enable VTMIS centres to communicate with vessels to ensure such areas are protected. Fishing activities in exclusive zones such as the Jubilee oil fields are also monitored and vessel in such areas are adviced to keep off.
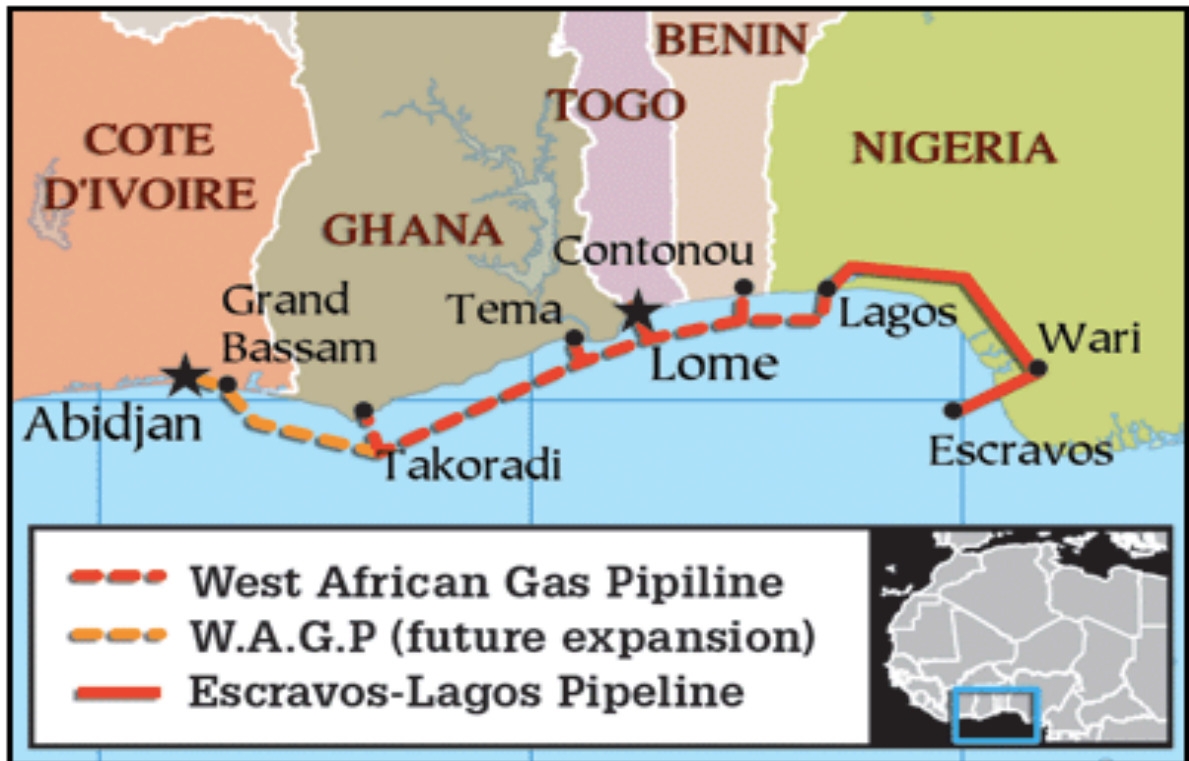
4.4 Protection of the West African Gas Pipeline

The interviews revealed that West African Gas Pipeline (WAGP) is one of the targeted offshore installation that the VTMIS is used to protect. A protection area is created along the portion of the pipeline that runs on Ghanaian waters. The WAGP is a 678 km gas pipeline that runs across coastal countries in the GoG. The pipeline delivers purified natural gas for fuel for power plants and industrial applications. WAPCO (2015) report stated that, WAGP links into the Escravos-Lagos pipeline at the Itoki Natural Gas Export Terminal in Nigeria. The pipeline then runs offshore from Lagos Nigeria to Takoradi in Ghana. The West Africa Gas Pipeline Company Limited (WAPCO) owns and operates the WAGP.

Between Lagos and Takoradi, there are three laterals extending from the WAGP to Cotonou in Benin, Lome in Togo, and Tema in Ghana. The lengths of the laterals are as follows: Cotonou 7 nautical miles (13 Km), Lome 10.3 nautical miles (19 Km), Tema 7.8 nautical miles (14 Km) (WAPCO, 2015). According to WAPCO, the average water depth of the pipeline is varied. The average depth at sections offshore Ghana is 35 metres. Along the Ghana coast, the closest range is 3.5 nautical miles (6.5 kilometers) south of Cape St. Paul. The widest range is south of Winneba at 17.5 nautical miles (32.5 kilometers). The dimensions of the WAGP are as follows: the main pipeline is 20 inches in diameter; Cotonou lateral is 8 inches, Lome lateral is 8 inches; while the Tema lateral is 18 inches. The termination point at Takoradi (Aboadzi) forms part of the main pipeline (see picture at Figure 12).

WAPCO (2015) report indicated that, activities which constitute potential risk to offshore WAGP damage include but not limited to: anchoring; ship Anchor Drag and trawl board impact; bottom trawling; and Illegal Fishing methods such as use of dynamite. Others include; mining including sand winning; construction; and any activity that risk the chance of making physical contact with the sea bed within the zone

and involves a risk of damaging the pipeline. The WAGP is very important to Ghana's economy and national security because it supplies fuel to the Thermal Power Plant at Takoradi (Aboadzi) and Sunon Asogli in Tema. Any damage to the pipeline has the ability to affect gas supply and power supply to Ghanaians.

Source: Ghana Oil Watch, 2013 (http://ghanaoilwatch.org/index.php/ghana-oil-and-gas-news/3225-gas-pipeline-95-complete-nigeria-to-resume-supply-in-days-energy-minister)

Figure 12: The West Africa Gas Pipeline

According to (WAPCO, 2015) the West African Gas Pipeline suffered a catastrophic loss of containment in early 2007 due, apparently, to damage by a ship's anchor. Similarly, the Ghanaian Chronicle, a prominent newspaper in Ghana reported that in August 2012, the WAGP was damaged by the anchor of a ship that was trying to avoid

a pirate attack. Ghanaian Chronicles (2015) stated that, Aboadzi and Sunon Asogli thermal power plants supply 580 megawatts about 32.5 per cent of electricity to Ghana. The VTMIS monitoring of the WAGP is therefore significant contribution to national security.

4.5 Protection of the Oil Fields and Private cables

Apart from the WAGP the interviews also noted the Atuabo gas pipeline, Area-To-Be-Avoided near the FPSO, western Jubilee oil fields and salt-pound oil fields are all targeted areas during operations. Just like the WAGP, these areas are monitored 24/7 at the VTMIS control centres to ensure vessels navigate safely without destroying the exclusive zones. There is an Area-To-Be-Avoided along the FPSO Kwame Nkrumah (picture in Figure 13). The Oil fields are national assets and vessels seen loitering around any filed without permit can be apprehended and questioned. Fishing vessels are also adviced to keep off exclusive zones. Last but not the least, the responses indicated that Main One Sub Sea communication cables are also being monitored. Main One is one of the first private companies in Ghana to have their cables charted and monitored by the VTMIS project. How the system could further be developed to increase it usage is discussed under shortfalls in proceeding section.
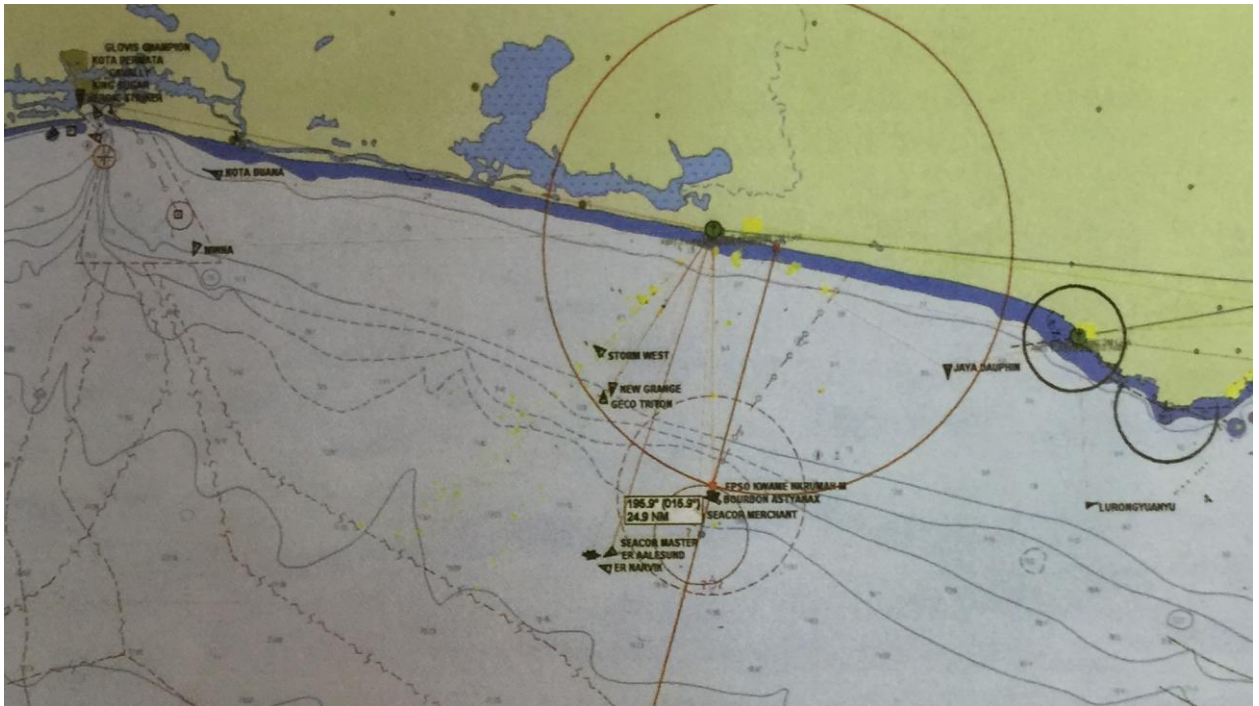
Source: Ghana Maritime Authority (2014, 16)

Figure 13: Screen shots of the Jubilee field coverage showing the FPSO and other Vessels

4.6 Fighting Maritime Crime in the GoG with VTMIS

The second specific objective is to access how VTMIS capabilities are integrated in the effort to fight against crime in the GoG. There was the need to define the parameters of maritime security and therefore maritime crime. According to (Bueger, 2014), maritime security is a major threat to international shipping in the world today. Therefore international organizations such as NATO, the AU, and the EU among others have integrated maritime security strategies aimed at combating threats in the sea. However, because security actors significantly diverge over how they draw relationships and position threats within them, there are varied definitions of maritime security. Bueger's

MSM is applied in defining maritime security as it relates to maritime safety, blue economy and human resilience. In this study it refers to the presence of issues such as maritime accidents, pollution, smuggling, piracy, robbery, IUU fishing, and human trafficking, in the GoG. These maritime security threats are also collectively called crime in this study. The focus is on the role VTMIS play in fighting these and other maritime threats that relates to maritime safety, blue economy, and human resilience.

4.7 Data on Maritime Crime

In Africa, the problem of piracy is not limited to the Gulf of Aden. Indeed, according to Professor Dalaklis, many analysts believe that the worrying rise in the number of attacks off the coast of West Africa will result in the region becoming the next piracy hotspot (Professor Dalaklis, 2012). According to Allianz Global Corporate and Specialty (2015) there were 59 total losses between 2005 and 2015 that occurred at the GoG. Their report defined total losses as actual total losses or constructive total losses recorded for vessels of 100 gross tons or over (excluding for example pleasure craft and smaller vessels) as at the time of the analysis.

Data gathered from the Ghana Maritime Authority during the interviews revealed that with regards to piracy and armed robbery, a total of 33 incidents occurred in 2014 as compared to 20 incidents in 2015. All the incidents in 2014 happened between January and August, between the same periods in 2015, the total number of incidents dropped to 20 representing 39.4 per cent decrement.

Table 2: Incidents of Piracy in 2014 and 2015 in the GoG

2014								
INCIDENT	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**TOTAL**
Hijacked	1	0	1	0	**0**	**2**	**1**	**0**	**5**
Boarded	2	3	1	1	**2**	**1**	**0**	**5**	**15**
Attempt	0	2	2	1	**1**	**1**	**0**	**3**	**10**
Suspicious	0	0	0	1	**0**	**1**	**1**	**0**	**3**
Total	**3**	**5**	**4**	**3**	**3**	**5**	**2**	**8**	**33**
2015								
INCIDENT	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**TOTAL**
Hijacked	2	0	0	**0**	**0**	**0**	**0**	**0**	**2**
Boarded	1	0	6	**1**	**3**	**1**	0	0	12
Attempt	0	2	0	2	1	0	0	0	5
Suspicious	1	0	0	**0**	**0**	**0**	**0**	**0**	**1**
Total	**4**	**2**	**6**	**3**	**4**	**1**	**0**	**0**	**20**

Source: Ghana Maritime Authority, 2015

Table 3: Piracy in the GoG by country in 2014 and 2015

2014								
COUNTRY	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JUL**	**AUG**	**TOTAL**
Angola	1	0	0	0	**0**	**0**	**0**	**0**	**1**
Congo	0	2	1	0	**0**	**0**	**0**	**3**	**6**
Gabon	1	0	0	0	**0**	**0**	**0**	**0**	**1**
Liberia	1	0	0	0	**0**	**0**	**0**	**0**	**1**
Nigeria	0	3	3	3	**1**	**1**	**0**	**3**	**14**
Ghana	0	0	0	0	**0**	**2**	**1**	**1**	**4**
I.Coast	0	0	0	0	**1**	**1**	**0**	**1**	**3**
S. Leone	0	0	0	0	**1**	**0**	**0**	**0**	**1**
Togo	0	0	0	0	**0**	**1**	**1**	**0**	**2**
Total	**3**	**5**	**4**	**3**	**3**	**5**	**2**	**8**	**33**
2015								
COUNTRY	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JULY**	**AUG**	**TOTAL**
Nigeria	1	2	4	**1**	**2**	**0**	**0**	**0**	**10**
Ghana	2	0	0	**0**	**0**	**0**	**0**	**0**	**2**
I.Coast	1	0	1	**0**	**0**	**0**	**0**	**0**	**2**
Guinea	0	0	0	**2**	**1**	**0**	**0**	**0**	**3**
Congo	0	0	1	**0**	**1**	**1**	**0**	**0**	**3**
Total	**4**	**2**	**6**	**3**	**4**	**1**	**0**	**0**	**20**

Source: Ghana Maritime Authority, 2015.

According to the European Union (2015) the International Maritime Bureau figures of the GoG accounted for 18 per cent in 2013 and 16 per cent in 2014, of attacks worldwide. Although about 80 per cent of these crimes against ships have taken place in territorial waters, trends over the last couple of years shows a shift towards such incidents occurring on the high seas and with a wider geographical spread further West and South. Information on the incidents reported is varied. This is often attributed to underreporting. Nonetheless, there is justifiable evidence that piracy and armed robbery are on the increase in the GoG area.

According to the EJF (2012, p.4), "West African waters are estimated to have the highest levels of illegal, unreported and unregulated fishing (IUU) in the world." The EU report noted that IUU represents up to 37 per cent of the region's catch costing coastal states around $1.3 billion per year. According to (European Commission, 2015, p.8) trafficking and smuggling drugs, humans, and arms with related money-laundering, also continues to grow across porous land and sea borders in West Africa, taking advantage of continuing insecurity notably in the Sahel, and in other countries. Evidently, maritime crime is on the increase in the GoG area.

Piracy anti pollution control, and narcotic control were among many factors the participants listed under the usefulness of the VTMIS to Ghana and the West African sub-region. As already discussed in previous section a participant said that VTMIS is useful for "safety of navigation, prevention of vessels from entering restricted areas, control of vessels around subsea structures, anti piracy controls, anti pollution controls, vessel reporting system controls, narcotics control, aid to search and rescue, and inland water safety at the Volta lake." Asked specifically to state the role of VTMIS in ensuring maritime security in Ghana, a participant said:

"VTMIS is a surveillance system that informs the appropriate authorities what to do. GMA collaborate with Ghana navy to check on vessels that are suspected to

be undertaking activities that causes threats to Ghana's maritime security. With the VHF, vessels can report to the VTMIS when they are attacked by pirates."

Some participant also said that the GMDSS set provide vessels the ability to notify control centres and the Navy anytime they are in distress situation including attacks by pirates and armed robbers at sea.

Participants were further asked specifically, how VTMIS could be integrated in the fight against crime in the GoG. It was revealed that, the system allows "sharing of data between relevant GoG agencies" and "effective exchange of information being the VTMIS and enforcement units." A participant noted in the Google Docs form that:

"Vessels that disable their AIS but are identified by the radar are checked; vessels that stay in closed location for many hours are also checked; and vessels reported to have been involved in crime in neighboring countries are monitored and reported to the Ghana Navy when they appear within her jurisdiction. Other maritime administrations are informed of vessels that violate maritime regulations and leave Ghana's maritime domain for interdiction in other countries. In addition, government security agencies can plan based on the vessel traffic data over the months that VTMIS offer for necessary actions to improve security. CCTV cameras locate vessels in close proximity and some details are identified. Smuggling and offloading illegal substances into smaller boats can be seen therefor the necessary actions taken; and vessels fishing in restricted areas identified and advised or apprehended."

The responses therefore revealed that, Ghana's VTMIS contributes significantly in monitoring and reporting issues under maritime crime in the GoG area. This finding confirms what the EU recommended for action in the "EU Gulf of Guinea Action Plan 2015-2020." According to the EU, the VTMIS in Ghana is one of the good national

level examples already existing which enables access to information on cargo, namely dangerous or polluting ones, transiting or calling at ports (European Union, 2015).

4.8 Shortfalls of the VTMIS in Ghana

The advantages and contributions of the VTMIS in Ghana are many; however the system could be upgraded further to increase its usability. Participants were asked to list the short falls in the use of VTS as a security tool. They were also to explain how such shortfalls could be removed from the system. Participants noted that, the VTMIS system basically monitor and report and that it lacks the power to enforce regulations. Most of the information communicated to vessels is given with soft message markers such as "advice" or "information." Ghana has no Coast Guard Centre so only the Navy and Search and Rescue units are informed when vessel is suspected to be violating national or international regulations. The VTMIS in Ghana therefor lacks the power to enforce. According to one participant,

> "When vessels do not comply with regulations; when AIS is switched off; when LRIT data is absent; and when calls to vessels are not replied, VTMIS must be empowered to sanction offenders."

A follow up questions on the limitations in the use of VTS as a monitoring tool revealed that separation of enforcement unit from monitoring system also prolongs responses to incidents.

Another shortfall is the coverage ranges of the sensor equipment. The coverage areas of equipment such as the CCTV, Radars, and AIS are currently 14Nm, 90NM, and 300NM respectively. These could be extended by mounting and integrating equipment on patrol boats.

One participant stated that:

"If the CCTV could be extended to cover long Nautical miles, it would be very useful. Some countries have added satellite communications to their VTMIS, if our system was also integrated to a satellite, we would have better and wider coverage than we have now. Ghana also needs a Coast Guard unit to work together with the VTMIS to patrol out maritime waters. Coast guard would release the navy to play their duty as a national naval force. Patrol boats would also allow the SAR centre to contact vessels as soon as identified to be in distress."

Finally, it was also revealed, that closer collaboration among maritime administrations along the GoG would enhance effective monitoring and reporting. The VTMIS in Ghana has the ability to extend monitoring of the WAGP beyond Ghana. If there were collaboration among West African countries, the usefulness of the system would improve.

4.9 Conclusion

The great majority of participants stated that IALA training and certification was required for VTMIS operators. All VTMIS operators had been trained as VTS operators according to the IALA VTS 103 modules. The coverage area of Ghana's VTMIS is as follows; LRIT - 1000 nm, AIS - 300 nm, Radar - 90 nm, and CCTV - 14 nm.

Participants said the targeted areas during operation include: West African Gas Pipeline, Main One Sub Sea communication cables, Atuabo gas pipeline, Area-To-Be-Avoided near the FPSO, western oil fields, and areas around the national oil fields.
There is justifiable evidence that piracy and armed robbery are on the increase in the GoG area. The interviews revealed Ghana's VTMIS contributes significantly in monitoring and reporting issues under maritime crime in the GoG area. GMA collaborate with Ghana navy to check on vessels that are suspected to be undertaking

activities that are threats to Ghana's maritime security. The system also allows sharing of data between relevant GoG agencies and effective exchange of information among the VTMIS and enforcement units. Additionally, government security agencies can plan based on the vessel traffic data from the VTMIS.

A major shortfall in Ghana's VTMIS is lack of power to enforce regulation. As such, information is communicated to the Navy and Search and Rescue units for appropriate action. Another shortfall is the coverage range of the sensor equipment. The coverage areas could be extended by mounting and integrating equipment on patrol boats. Finally, it was also revealed that, collaboration among maritime administrations along the GoG would enhance effective monitoring and reporting.

CHAPTER FIVE

MAJOR FINDINGS AND RECOMMENDATIONS

This section summarizes all the important findings, conclusions and recommendations of the study. The research was set out to assess the role of VTMIS in enhancing maritime security in the GoG area and specifically to: investigate how it contributes to the increase security level of offshore installations; access how its capabilities are integrated in the effort to fight against crime in the GoG; and finally to identify short falls in its use. Participants were drawn from the VTMIS unit of the GMA and government departments where monitoring stations are installed for interviews. The discussion in the previous chapter was done based on the responses of the participants to the interview questions. The data was discussed in line with the sub objectives of the study. The rest of the chapter presents the findings and make recommendations for policy makers and other researchers.

5.1 Findings

From the discussion of the qualitative data collected and reviews of secondary data from the GMA and IMO on maritime incidents in the GoG, the following findings were revealed:

1. The study revealed that VTMIS personnel of Ghana were trained according to IALA VTS 103 modules and the system is being operated as required by IMO and IALA guidelines for VTS.
2. The VTMIS in Ghana contributes to the increase security level of the West African Gas Pipeline, Main One Sub Sea communication cables, Atuabo gas pipeline, Area-To-Be-Avoided near the FPSO, Salt pound oil fields.

3. Maritime crime such as piracy, armed robbery, and smuggling are on the increase in the GoG region and the same post threats to vessels and seafarers. According to (European Commission, 2015)

4. Ghana's VTMIS contributes significantly in monitoring and reporting maritime security issues in the GoG area..

5. It was revealed that a major shortfall in Ghana's VTMIS is the lack of power to enforce regulation effectively.

6. The study also concluded that future expansion in the range and coverage area of the equipment is necessary for better and wider monitory and reporting.

7. Finally, it was revealed that lack of collaboration among maritime administrations in West Africa limits the VTMIS usability in enhancing effective monitoring and reporting beyond Ghana's maritime jurisdiction.

5.2 Recommendations

The following recommendations are made based on the findings and conclusions of the study:

1. The responses indicated that, apart from VTMIS operators from the GMA, staff of the monitoring stations were only taken through JMAP software. The study recommends that such staff should also be trained with IALA VTS 103 course so they can fully appreciate and understand the procedures and data received.

2. The responses revealed that, Main One was the only privately owned company to have their Sub Sea communication cables monitored by the VTMIS in Ghana. The study recommends for other private sector companies to utilize the system to ensure their offshore infrastructure is protected.

3. Although the VTMIS is used to monitor and report on suspected maritime security threats issues, it is recommended for crew on board vessels to

communicate sufficient information to the control centres in times of distress to enable prompt assistance to be provided.

4. The study proposed for the VTMIS to be used by port authorities to organize traffic at the two major ports in Ghana (Tema and Takoradi).

5. The study put forward the idea that, GMA should seek collaboration from external funding organizations such as the EU who have interest in curtailing the increasing piracy and other maritime security threats in the GoG. This will enable the Authority to extend the range and coverage area of the system for better monitoring.

6. IMO regulations mandate vessels to comply with regulations of VTS areas that are recognized by IMO. Therefore GMA must strictly enforce navigational regulations in its VTMIS areas.

7. Collaboration among maritime countries in the GoG region is necessary to combat the ever-increasing maritime security threats in the GoG. The study recommends maritime Security Council of West African nations to act swiftly to increase cooperation.

8. Other West African maritime nations are recommended to install and operate VTMIS units to ensure the entire GoG region is covered. This would significantly increase monitoring and reporting across the region.

9. The study recommends for future researchers to dig more into benefits of the VTMIS data to monitoring stations.

10. Further research by the GMA is also needed in the area of operations to understand how successful the VTMIS project has been since its inauguration. The research and development should form an integral part of the project.

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APPENDIX

VESSEL TRAFFIC SERVICE AS A MARITIME SECURITY TOOL: VESSEL TRAFFIC MANAGEMENT INFORMATION SYSTEMS (VTMIS) IN GHANA
<u>**Participants Consent Form**</u>

The role of the participant

This dissertation is in partial fulfillment of the requirements for the award of the degree of Master of Science (MSc) degree at the World Maritime University. The study intends to investigate the role of VTMIS in Ghana as a security tool that can effectively assist in the fight against crime in the Gulf of Guinea region. Participants will be engaged in 30-minute interviews about the operations and usefulness of the VST to help me collect data for my investigation.

Participation and Confidentiality of data

Should you agree to participate, be informed that participation is not obligatory and you are free to withdraw from the study at any point you may wish to do so. The data gather for the investigation will be treated as confidential. In addition, anonymity of all respondents will be preserved. The interviews will be tap-recorded. I Joseph Akwasi Kuma or the World Maritime University (WMU) may retain the data gather in the interviews for up to five years after the completion of the study.

Participants will not be paid for participating in these interviews. There is no anticipated risk of physical or emotional injury.

Consent Statement

I have read and understood the information and I agree to take part in the study. By this agreement, I consent to my personal data, as outlined in the accompanying information sheet, being used for this study and other research. I understand that all personal data relating to volunteers is held and processed in the strictest confidence.

Participant's Name   Signature

………………………………   ……………………

Date:………………………….

VESSEL TRAFFIC SERVICE AS A MARITIME SECURITY TOOL: VESSEL TRAFFIC MANAGEMENT INFORMATION SYSTEMS (VTMIS) IN GHANA

<u>RESEARCH QUESTIONS FOR GHANA MARITIME AUTHORITY VTMIS STAFF</u>

1. What is your background?
2. Could you take me through the general set-up of the VTS system in Ghana? (In terms of infrastructure).
3. What are the usefulness of the VTMIS to Ghana and the West African sub-region?
4. Are there other government agencies that benefit from the VTMIS? (if so list them and the nature of information they receive from VTMIS)
5. Are there targeted areas during VTMIS operations?
6. What are the communication mediums used in the VTMIS to contact and communicate with vessels?
7. How far in terms of nautical miles is the coverage area of Ghana's VTMIS?
8. How can VTS be used to provide security monitoring of offshore installations?
9. What is the role of VTMIS in maritime security?
10. How can VTS be integrated in the fight against crime in the GoG?

11. What are the short falls in the use of VTS as a security tool and how can they be removed?

12. What are the limitations in the use of VTS as a monitoring tool?