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Analysing risks in naval operations: the case of visit, board, search and seizure operations in Cote d'Ivoire navy

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ANALYSING RISKS IN NAVAL OPERATIONS

The Case of Visit, Board, Search and Seizure Operations in Côte D'Ivoire Navy

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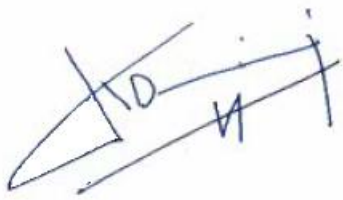
Declaration

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

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

Signature: 

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Abstract

Title of Dissertation: **Analysing risks in Naval Operations: the case of Visit, Board, Search and Seizure operations in Côte D'Ivoire Navy**

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Navies have growing interests and roles to play in addressing the numerous contemporary maritime security issues. Visit, board, search and seizure operations are the privileged *modus operandi* to deliver law enforcement at sea. However, the nature of the environment and the threats make these operations expensive and risky. Côte D'Ivoire Navy, which is one of the main organization dealings with maritime security matters in this country, faces important challenges during these operations. The concept of risk analysis represents undoubtedly a useful tool for decision making under uncertainty. Hence, this dissertation intends to analyse the risks associated with the dangers in Visit, Board, Search and Seizure operations for the purpose of developing adequate mitigation measures which will enhance their effectiveness. This research effort comes to emphasize the need for a more specific and proactive approach to attenuate risks in these operations. The aim is to stimulate a new narrative about naval forces and their role to overcome the culture of secrecy for transparency in security and safety.

First, the realities of Visit, Board, Search and Seizure operations in Côte D'Ivoire were discussed. Then, the risks were assessed based on the professional judgment and the personal experience of the naval personnel involved in the course of operations. Their inputs were introduced in a conceptual framework since no study on the topic has been formally undergone before. This framework is a combination of previous methodologies applied on safety and security risk studies. The results were scored, compared and benchmarked with other navies. Finally, the methods used were evaluated to appreciate their reliability. At the end, the conclusions demonstrated that Visit, board, search and seizure operations hold a strategic role in maritime law enforcement in Côte D'Ivoire. Despite the permanent risk factors, the level of occurrence of incidents can be considered marginal but with serious consequences. The results acknowledged that the risk management practices are subjective. Consequently, risk mitigation measures can have variable performance in bringing risks as low as reasonably practicable. In this aspect, risk mitigation can be more effective by implementing a systems approach of physical and administrative barriers with four pillars: Training, Equipment, Organizational culture and Procedures. Finally, the observations showed that the methodology used can be suitable to analyse risks in Visit, Board, Search and Seizure operations since the outputs of different methods are convergent.

KEYWORDS: Risk analysis, Risk assessment, Risk management, Maritime security, Maritime interdiction operations, Maritime law enforcement, Visit Board Search and Seizure operations, Boarding operations, Gulf of Guinea, Côte D'Ivoire Navy

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List of acronyms

ALARP	As low as reasonably practicable
BO	Boarding officer
CNS	Chief of Navy staff
CO	Commanding officer
ECCAS	Economic community of central African states
ECOWAS	Economic community of western African states
EEZ	Exclusive economic zone
EU	European Union
FI	Frequency index
FMEA	Failure mode and effect analysis
FSA	Formal Safety Assessment
GAR	General assessment of risk
GGC	Gulf of Guinea commission
GoG	Gulf of Guinea
HAZOP	Hazard and operability
HRA	Human reliability assessment
IMO	International maritime organization
ISM	International safety management code
IUU	Illegal unreported undeclared
KPI	Key performance indicator
MARAD	Maritime administration
MDA	Maritime domain awareness
MIO	Maritime interdiction operation
MOC	Marine operational centre
MSA	Maritime situational awareness
NATO	North Atlantic transnational organization
OSC	On-scene commander
OVI	Operational value index
PAA	Port of Abidjan
PASP	Port of San Pedro
PPE	Personal protective equipment

RCI	Republic of Côte D'Ivoire
RCM	Risk control measure
RCO	Risk control option
REC	Research ethics committee
RFMO	Regional fisheries management organization
RI	Risk index
RMO	Risk management option
ROE	Rules of engagement
RUF	Rules of use of force
SAR	Search and rescue
SEPCIM-AEM	Permanent secretary of the interministerial committee for the State's action at sea
SI	Severity index
SMS	Safety management system
SNAEM	Strategy for the state's action at sea
SOLAS	Convention for the safety of life at sea, 1974
SOP	Standard
SRA	Society for risk analysis
SUA	Convention for the suppression of unlawful acts against the safety of maritime navigation, 1988
TI	Threat index
UN	United Nations
UNCLOS	United nations convention on the law of the sea, 1982
UNSCR	United Nations security council resolution
USCG	United States coast guard
VBSS	Visit, board, search and seizure
VI	Vulnerability index
WMU	World Maritime University

CHAPTER I INTRODUCTION

1. Background of the study

The United Nations Convention of the Law of the Sea (UNCLOS) embodies different provisions related to maritime safety and security. These provisions define duties and obligations that shall be accomplished by different entities depending on the countries (UNCLOS, 1982). Cutting a long way short, the enforcement at sea of the compliance of all treaties and generally accepted international rules can take multiple forms depending on the maritime zones where it takes place. Nowadays, the rise of piracy off the horn of Africa, the 9/11 terrorist attacks, the emerging maritime powers and the inter-states tensions brought up maritime security to the forefront of international policy agendas (Dalaklis, 2012; Bueger, 2015), making the nature of maritime security issues even more complex than before (Krause & Bruns, 2016). Since the early 2000s, the Gulf of Guinea (GoG) has become a zone of concern for maritime security incidents. In fact, the region which is rich in natural resources attracts many maritime stakeholders like shipping companies, offshore companies and fishing vessels. These opportunities coupled with lack of law enforcement capabilities in some regions led to the surge of illegal activities (Illegal Unreported Undeclared Fishing, illegal bunkering, illegal trafficking, etc…); more importantly, the region has become a world hotspot for piracy and armed robbery at sea (Dalaklis, 2012, Okafor-Yarwood et al., 2020). Consequently, in 2013 the governments of the region came together to address the problem through a memorandum of understanding between the Economic Community of West African States (ECOWAS), the Economic Community of Central African States (ECCAS) and the Gulf of Guinea Commission (GGC) and the adoption of a document named Yaoundé Code of Conduct concerning the repression of piracy, armed robbery against ships, and illicit maritime activity in West and Central Africa. By signing this agreement, the parties engaged themselves to cooperate to the fullest possible extent in the repression of any illegal activities in the region (Judith & Dalaklis, 2017). In order to fulfil their common goal, the region was divided into maritime zones and an architecture of Maritime Security Centres has been established. This architecture requires the development of the intervention capabilities and the Maritime Domain Awareness (MDA), which is defined as “the understanding of activities carried out in the maritime

domain, and surrounding environmental circumstances, to support timely decision making in the fields of maritime security and maritime safety" (Del Pozo et al., 2010, p. 47). From a military perspective, the objective is also to build an understanding of any events, activities and circumstances within and related to the maritime environment which are relevant for the course of operations, namely Maritime Situational Awareness (MSA) (Dalaklis, 2019). Hence, the countries have devoted a lot of resources and capacities to the fulfilment of their obligations. Essential parts of this security system are the Navies and/or Coast Guard of the Coastal states. Indeed, fighting transnational organized crimes needs to coordinate maritime surveillance and interception assets at sea (Dalaklis, 2017a). Therefore, the Maritime Security Forces in the region stepped out to tackle the problems.

With the adoption of its new maritime strategy in 2014, Côte D'Ivoire decided to address the challenges faced in the maritime domain. Indeed, this strategy, which is in line with the Yaoundé Code of conduct, provides the framework for an enhanced cooperation and collaboration between all the state's maritime stakeholders. This strategy clearly states, in its strategic orientations, the goal of a safer and more secure maritime space and a more diverse and dynamic cooperation (RCI, 2014). This document bestows to the Côte D'Ivoire Navy an essential role in safeguarding the country's interests at sea. In order to meet the new requirements, the Navy benefited from a complete renewal of its assets by modern and more robust vessels between 2014 and 2020 (Groizeau, 2014). Thanks to those capacities, Navy's assets covered 132 days of operations at sea according to the 2020 Review of operational activities of Marine Operational Centre (MOC) Abidjan. As part of those demanding operations, the naval assets conducted multiple Visit, Board, Search and Seizure (VBSS) operations to fulfil their missions. In general terms, VBSS operations, which is a term used interchangeably with boarding operations, are seaborne enforcement measures to intercept the movement of platforms into or out of a state jurisdiction or the high seas (NATO, 2005). According to Yoe (2019), Risk is everywhere, so uncertainties, which exist in those operations, make them subject to certain levels of risk either known or not. Naturally, VBSS operations are hazardous in nature because, first they require sometimes multiple movements of naval platforms and persons at sea, sometimes in poor conditions and second the personnel have to deal with a new environment with uncertainties. Looking at the hazards in the maritime environment

and the nature of these missions, one can easily deduct that the fulfilment of the associated tasks implies a level of risk acceptance. For the purpose of this dissertation, risk is the probability of occurrence of an unwanted event coupled with the consequence if such event happens. Therefore, an analysis of risks represents a valuable tool for supporting decision making in those operations in order to strengthen their efficiency.

2. Statement of the problem

Any activities carried out at sea come with a level of risk and VBSS operations are surely not excluded. These operations support the enforcement of national and international regulations in the waters under the jurisdiction of Côte D'Ivoire. The country plans to acquire bigger vessels in order to expand its area of competence and increase the stress on the criminal actors plaguing the seas and subsequently fulfil its regional obligations of participating in the surveillance of the GoG. Henceforth, navy personnel will contribute more, leading to a longer exposure to dangers. Since no records of similar work have been found on the topic in the country, this dissertation intends to analyse risks in VBSS operations in Côte D'Ivoire Navy to develop objective measures which could mitigate effectively these risks. The Risk analysis approach was chosen for this study because of its objectivity and transparency in providing inputs for decision makers. This research can be of great interest for the country as it may point out weaknesses and the way of improving one component of its maritime safety and security system. In addition, this dissertation can complement studies of Risk analysis in the maritime field.

3. Aims and Objectives

This dissertation endeavoured to use risk analysis principles to come up with solutions which could attenuate effectively risks associated with the conduct of VBSS operations. The completion of the research aimed to achieve the following objectives:

- To identify dangers associated with VBSS Operations in Côte D'Ivoire and to estimate risks associated with these dangers
- To analyse the different factors which influence the development of Risk Control Measures
- To develop a list of Risk control options (RCOs) for this type of operations.

4. Organization of Research

4.1 Research Questions

The following research questions drove the itinerary process of this dissertation:

- What are the hazards and the threats in VBSS Operations in Côte D'Ivoire?
- What are the risks acceptance criteria and levels?
- How does the risk assessment method influence the development of RCOs?
- How can these risks be managed and communicated effectively?

4.2 Research Design

By analysing the nature and the dynamics between the different systems and the procedures of boarding operations, a list of possible dangers was developed. Following the identification of dangers, an online survey (administering questionnaire) was submitted to the maximum number of available stakeholders in order to gather knowledge based on professional judgement and personal experience in order to benefit from their inputs as keys actors considering the fact that no casualty reports were available in the country. The questionnaires online were delivered to allow the researcher to touch a wide number of respondents and to remove bias in the process. The risks were assessed using the two different methods, one using the frequency and the severity and the second using the value of the assets at risk in addition. The results were prioritized by risk level; subsequently the risk scenarios were developed.

Furthermore, semi-structured interviews of principal actors served to investigate the risk scenarios in order to identify issues that might have been missed by the researcher. Indeed, these methods allowed to assess the risk scenarios through the perception of experts in the field of study, using the critical incident technique for a qualitative interviewing, which is a technique used to learn from people's experience through reflections on a critical incident (Kuada, 2012). Thus, the list of dangers and the risks scenarios associated was complemented since few information can be found on the problem and that it is one expert's judgment was used to get failures and their causes.

Then, the analysis of research data evaluated which Risk analysis's principles could be applied in VBSS operations and assessed which Risk assessment method proves more objectivity and transparency for the use in this case. Lastly, a list of possible RCOs, which describe a set of risk mitigation measures to implement, was developed based on the outcomes of previous steps. Figure 1 presents an overview of the itinerary of this dissertation.

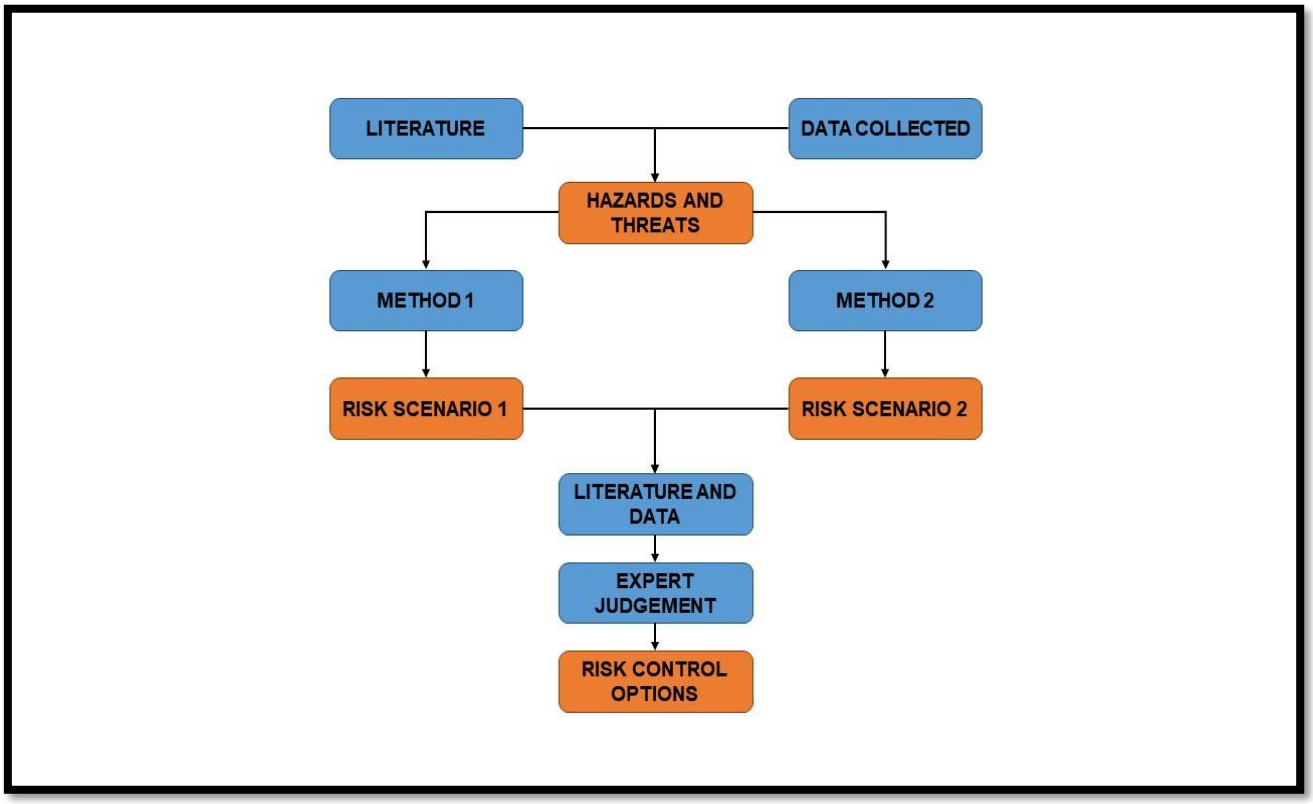

Figure 1: Research design (Author)

5. Structure of the dissertation

This dissertation is structured in six chapters with ten appendices, which contain the questionnaires and interviews questions and the analytical tools used. Following this introductory chapter, chapter 2 reviews the relevant works in the literature addressing risk analysis and VBSS operations. In chapter 3, boarding operations are briefly presented in the specific context of Côte D'Ivoire. The chapter 4 presents the conceptual framework used for the research. Then, the research findings are presented and discussed in chapter 5. Finally, chapter 6 gives concluding remarks and recommendations.

6. Ethical considerations

The entire research considered ethical matters thoroughly. Consequently, all materials and data collected were processed in strict confidentiality with the consent of participants and the information of participants protected.

7. Key assumptions and limitations

The Risk assessment was considered from an objectivist approach as it intends to explain issues which are real and independent of the nature of the systems involved. In this research, the VBSS operations were approached as operations involving different systems, with regular and non-regular processes. The boarding teams fell in the Structural functionalism described by Parson (1951) with four Characteristics (Adaptation, Goal-attainment, Integration and Latency). The conduct of the naval operations was also assumed to have unpredictable factors. So whether consciously or unconsciously, these operations were subjected to an analysis of risks.

In this dissertation, only the risks incurred by the systems directly involved in VBSS operations were considered, risks related to the political or legal implications were excluded. Among them, the analysis addressed risks associated with undesirable or negative consequences for the targeted organization. The research was limited also by the scarcity of data that might come from the targeted organizations since all records of operations were not digitalized or disclosed. Finally, the confidentiality of some government investments did not permit a cost-benefit analysis of the recommendations.

CHAPTER II LITERATURE REVIEW

1. Introduction

This chapter examines previous works conducted in risk analysis and also focuses on the concept of VBSS operations. It intends to advocate for the possible productive and necessary links between the two concepts. First, it explores the diversity of views and opinions about risk analysis. Second, VBSS operations are revisited to highlight the challenges they pose for decision makers. And finally, the current trends and perspectives of risk analysis in these operations are analysed. In summary, this review explores the risk analysis principles and demonstrates their applicability to boarding operations for the purpose of risk mitigation.

2. Risk analysis

2.1 General principles

The scientific community has discussed extensively the concept of risk analysis. Goerlandt and Montewka (2015) classified risk definitions in nine categories based on the application area, but generally risk is a function of one or more factors among probability, event, consequence of event and uncertainty. The Society for risk analysis (SRA) described risk as the potential for realization of unwanted, adverse consequences to human life, health, property, or the environment (as cited by Ozbas, 2013). While some scholars preferred to define risk quantitatively (Kaplan & Garrick, 1981; Kaplan, 1997). Here again, researchers' views differ, yet Aven (2012) concluded that "Risk = C & U" is the most appropriate type of risk definition, where C represents the consequences and U the uncertainty. However, for a large body of literature, the aim of risk analysis is to inform a decision in order to mitigate risks by balancing costs and benefits (Aven & Zio, 2014; Cox, 2009; Goerlandt & Montewka, 2015; Ozbas, 2013, Yoe, 2019)

Evaluating alternatives before decision making has been a long lasting method for humans. Covello and Mumpower (1985) described the evolution of the risk analysis from the simple practices of interpreting the signs of gods to the modern probability theory introduced by Pascal in the late 17th century. Following the work of Pascal, many scholars used mathematical theories of probability to solve societal problems. Besides, they added that the qualitative aspect of modern risk analysis

stemmed from the scientific method for identifying the causal links between adverse consequences and hazardous activities, primarily for health issues.

The literature proved that multiple methods and techniques can be used to conduct a Risk analysis. The suitable method to use depends on different factors or circumstances (Ozbas, 2013). Yoe (2019) made a clear description of Risk analysis. He considered risk analysis like a science and a paradigm which intends to improve science-based decisions making under uncertainties for a given problem. Furthermore, the author divided the process of Risk analysis into three tasks namely Risk assessment referring to the science aspect, Risk management in relation to the social values in it and Risk communication for the interactive exchange of information. Aven (2012) advocated also a separation between risk per se and risk management and risk perception. Whereas Beck et al. (1992) argued they coincide. Hence, some fundamental issues should be tackled to reach a better conceptual understanding of risk among the scientific community (Aven & Zio, 2014). Furthermore, Yoe (2019) estimated that a difference should be made between Risk assessment and Safety analysis, where the former one considers risk broadly and focus on the risks of interest. Reason why any method used for analysing risks starts by the dangers' identification.

2.2 Identification of dangers

Yoe (2019) assimilated a hazard as any potential source of harm to a valued asset. Bennett (2018) in his book defined it as "an act or condition posing a source of potential danger or adverse condition" (p.215). So, these two definitions describe hazard like anything with potential harmful consequences. In general, risk is described as a safety or security issue. At the International Maritime Organization (IMO), the introduction of chapter XI-2, addressing maritime security, in the SOLAS convention, acknowledged the imbrication between safety and security matters (Dalaklis, 2017b; Joseph & Dalaklis, 2021). Based on the definition of maritime safety and maritime security given by Del Pozo et al. (2010) and Klein (2011), Safety primarily refers to those dangers emanating from an unwanted event like an accident, a natural disaster; in contrast Security deals rather with the threats derived from a clear human motivation to do harm. Whether it is from a security or a safety perspective, the first step in the risk analysis process is to identify those dangers.

The literature provided many different methods for the dangers' identification. It can be done using a Fault Tree Analysis, an Event Tree Analysis, a Failure Mode and Effect Analysis (FMEA), a Hazard and Operability Study (HAZOP), a Human Reliability Analysis (HRA), a What If Analysis Technique, a Risk Contribution Tree or Influence Diagrams (IMO, 2002). All these methods could require the participation of experts or knowledgeable persons and/or the use of statistical data if available (Ozbas, 2013). The literature showed that the prioritization of the hazards could be achieved by using a generic risk matrix combining the Frequency and the Severity or Consequence. In his thesis, Kontovas (2005) showed that several organizations developed different Risk Matrices to meet their needs. In this regard, he mentioned also that risk matrices may be problematic because they underestimate risk accumulation or bring discrimination between scenarios. Cox (2008b) supported also this view by arguing that little research validated the performance of risk matrices so that they should be used carefully with clear explanations of embedded judgments. In their critical review, Kontovas and Psaraftis (2009) also estimated that Frequency of an accident does not necessarily depict reality. They recommended the use of a Bayesian approach and the terminology "probability" not only in the semantic but also substantively. Such findings put forward the fact that Risk analysis needs to be reviewed in some aspects in order to enhance its effectiveness.

2.3 Risk assessment

The body of literature also acknowledged the fact that Risk assessment can be either quantitative, qualitative or mixed methods. The purpose of this process is to investigate the causes and consequences of the likelihood of scenarios resulting from the identification of hazards (IMO, 2002). Even if, the techniques promoted by the IMO rely mostly on quantitative data, several scholars thought that the definition of a qualitative risk assessment scheme should be more appropriate and reliable (Hermanski & Daley, 2010; Kontovas & Psaraftis, 2009; Rosqvist & Tuominen, 2004; Wang, 2001). Cox et al. (2005) suggested that qualitative risk rating can perform among risks separated in clusters but it is not always the case, so a practical quantitative risk assessment methods should be developed for broad classes of situations in which qualitative are not necessarily reliable. Consequently, in the maritime sector, data of accidents, like number fatalities, frequency of accidents or

the severity of their consequences, represent the basis for analysis. And three levels of risk usually express risk acceptance criteria: negligible, tolerable, and intolerable. The risks classified tolerable are meant to be As Low As Reasonably Practicable (ALARP) (Joseph & Dalaklis, 2021; Wang, 2001). Soares and Teixeira (2001) stated that individual risk criteria, including occupational risk, are measured in fatal accident rate and societal risk criteria are represented using F-N curves that link the frequency (F) and the number of fatalities in accidents (N). They also added that a criterion for environmental protection needed to be developed. In addition, many scholars advocated that the use of expert judgement can be valuable (Apostolakis, 1990; Merrick & Van Dorp, 2001; Ulusçu et al., 2009). Nevertheless, Goerlandt (2015) estimated that the Risk analysis in the maritime transport sector is centred around the Formal Safety Assessment (FSA) approach and that research should consider the development of additional frameworks and risk indicators.

2.4 Risk management

Informing a decision is a widely accepted purpose of risk analysis, but controversial views about how to do it exist. Several researchers considered the opposing views concerning the foundations of risk analysis as a scientific activity and the nature of the concept as the root causes of the divergence (Goerlandt & Montewka, 2015). Risk assessment leads to the creation of a list of high risk profile scenarios that need to be addressed in order to develop Risk control measures (RCMs). A RCM represents a measure which provides necessary barriers either to minimize the consequence of a hazard or to reduce the likelihood of its occurrence. Then, RCMs can be grouped in RCOs in order to address risks and their underlying causes (IMO, 2002). Yoe (2019) referred to them as Risk management options (RMOs) which should reduce the risk to an acceptable or tolerable level. Even if those options must be comprehensive to cover a wide spectrum of type of risk (existing, future, historical, residual, transferred, transformed…), risk assessments may not depict the reality, they provide only information to decision makers (Yoe, 2019). In this respect, Cox (2009) claimed that risk-mitigating measures based on risk scoring systems do not consider the correlation between risks and called for the use of optimization models which consider those dependencies.

3. The concept of Visit, Board, Search and Seizure Operations

VBSS operations represent the heart of the broad concept of Maritime Interdiction Operations (MIOs). According to NATO (2005), a MIO comprises enforcement measures at sea which seeks to intercept the movement of certain types of items into or out of a nation or specific area. VBSS operations are commonly the responsibilities of Navies. However, a boarding is not the solely privilege of navies. Indeed, law enforcement authorities of a country, like Coast guard, Police or maritime inspectors, may board a ship flying its flag. As the concept of maritime security evolves coast guard and naval activities overlap and the main difference is the legal implications depending on the maritime zones in which a boarding take place (Guilfoyle, 2017).

3.1 Legal framework

In the literature, the right of visit is thought to emanate from the historical controversy around the legal principles of Mare Clausum, which claims sovereignty and jurisdiction over the seas, versus Mare Liberum, namely the principle of freedoms of the seas. Mare Clausum is thought to be the rationale behind this interference on the high seas (Papastravridis, 2011). Papastravridis (2011) demonstrated, however, that the two principles are complementary in reality and proposed three positive perspectives through which the legal order of the oceans matches with this exception of the freedoms of the seas.

The legal framework supporting VBSS operations is often qualified as the law of maritime interdiction. This legal framework stemmed from what Gavouneli (2007) qualified as the functional jurisdiction on the high seas (as cited by Papastavridis, 2011). This framework has become, over time, a combination of international law and national law of the parties involved in the course of the boarding operations. Even if, the scope extends beyond them, the most noticeable provisions for VBSS operations are found in the realm of international maritime conventions.

3.1.1 United Nations Conventions and resolutions

The UNCLOS, also widely known as the “constitution of the sea”, was the first international maritime convention to enshrine the last lasting maritime principle of the right of visit. The conduct of VBSS operations represents a direct correlative of this

right. Article 110 of UNCLOS justifies a boarding in the high seas if there is reasonable ground that the suspected ship:

- Is engaged in piracy
- Is engaged in the slave trade
- Is engaged in unauthorized broadcasting and the flag State of the warship has jurisdiction
- Is without nationality
- Though flying a foreign flag or refusing to show its flag, the ship is, in reality, of the same nationality as the warship.

This right, which is a reflection of customary international law, stands as an exception of the exclusive jurisdiction of the flag State over ships flying its flag defined in article 92 of UNCLOS which is concomitant with the principle of the freedom of the high seas in article 87. However, the principle of “further examination” in Article 110(2), if the suspicion remains after examining the ship’s papers, has different interpretation in the literature. Some argued that it should not be used for purposes other than those warranted stopping the vessel (Norquist et al. 1985). Guilfoyle (2017) estimated that this right is a general one and nothing should prevent a conduct of a search with ulterior motive if it can feed back to the flag state information concerning illegal activities.

Exceptionally, the UN Security Council resolutions (UNSCR) may authorize warships to board and visit foreign-flagged vessel under particular circumstances (Guilfoyle, 2015). States may also conclude bilateral or multilateral arrangements or treaty law for consensual boarding in accordance with international law to suppress illegal activities or to protect the marine environment (Klein, 2011). Furthermore, under the article 17 of the Vienna convention against illicit traffic in narcotic drugs and psychotropic substances, the interdiction of a suspected vessel in the high seas requires necessarily the flag state consent (Vienna convention, 1988). More collaborative efforts exist to board and inspect ships under the UN fish stocks agreement. Under the relevant regional fisheries management organization (RFMO), State parties can conduct boarding on other flag states’ vessels whether or not they are parties but they still need to report to the flag state, whose inaction within three days, can allow further enforcement measures to take place. (UN fish stocks agreement, art. 21; Warner, 2016). Likewise, Article 8 of the migrant smuggling

protocol provides for a party to give permission to take actions including boarding to another party in case where a vessel flying its flag is reasonably suspected of smuggling migrants, but the protocol reserves to the flag state the right for prosecution. Also, the inherent right of self-defence during a conflict under article 51 of the UN charter authorizes a warship to stop and to board a foreign-flagged ship when she is reasonably suspected of supplying weapons to a third party in on ongoing armed conflict. This is what is referred as the principle of belligerent right of visit and search. Nonetheless, the above-mentioned provisions apply to the high seas.

Whereas in waters under the jurisdiction of a state, UN instruments defined limitations to VBSS operations. In fact, the right of visit is in most case related to criminal jurisdiction in waters of a coastal state. The UNCLOS and the Geneva convention on the territorial sea exclude the exercise of criminal jurisdiction over a foreign ship unless the conditions of innocent passage are not met. Guidfoyle (2017) stated that, although, the right of innocent passage in the territorial seas, can be considered as an immunity from VBSS operations, in reality the only exceptions to conduct law enforcement activities are for sovereign immune ships and crimes committed before the vessel entered the territorial sea and is simply transiting without entering internal waters (UNCLOS Article 21 and Article 27(5)). Concerning the contiguous zone, Article 33(1) of UNCLOS, may provide grounds for boarding in case of infringements of customs, fiscal, sanitary and immigration laws within a coastal state's territory or territorial sea. But Shearer (1986) argued that the powers of the coastal state are limited to inspections and warnings rather than arresting vessels. Furthermore, under article 73 of UNCLOS, a coastal state can conduct a boarding to enforce its privileges, pertaining to the natural resources in the Exclusive Economic Zone (EEZ), in accordance with article 56 of the same convention. Additionally, Articles 211(5), 220(5) and 220(6) contain provisions which may grant a coastal state to conduct control in its EEZ in case where activities which jeopardize the marine and coastal environment are clearly identified. Regarding the master's authority over its vessel, recognized also in customary law, UNCLOS article 27(3) defined specific conditions where a master's consent might authorize a boarding in waters under jurisdiction of a coastal state for criminal jurisdiction. Because the aforementioned provisions are less subject to interpretation, VBSS operations are primarily backed up by the framework of the UN, particularly for a foreign-flagged vessel in the high seas.

3.1.2 IMO Conventions

The IMO is a specialized agency of the UN, ensuring through its regulations, a safe, secure, efficient and sustainable maritime transportation (IMO, 2019). Emerging issues, like piracy and terrorism, pushed the organization to orient its work towards security matters (Bueger, 2015). The organization, which is a technical body, only provides provisions to support boarding operations. Indeed, regulation XI-2/8 and regulation V/34-1 of the SOLAS 1974 Convention recognize the master's discretion in matters of safety and security. Under this principle, the master has the authority to deny access or to give permission to search the vessel in port. The ISM Code made a similar reference by defining the master's overriding authority for decisions affecting the safety of its vessel (Dalaklis, 2017b). Whereby, the 2005 SUA protocol authorizes boarding by a state party only with the consent of the flag state. However, a party to this convention can opt in to a clause, in article 8bis, that give presumption of authorization to another state party to visit and search ships flying its flag if the request exceeds a defined period of time, four hours usually. While, the master's authority is limited to the turnover of individual who is reasonably believed to have violated the regulations. Despite those provisions, it is understood that the IMO instruments did not formally define an exception of the exclusive flag state jurisdiction to allow a boarding.

3.2 Principles and dynamics

Generally, commercial vessels are boarded to ensure compliance with international law or to conform UN resolutions, but in some extent to gather intelligence for the purpose of operations (Guilfoyle, 2017). The different types of MIOs are embargo operations, drug interdiction, location of suspected vessel, environmental patrol, fishery patrol and refugee recovery. These operations are carried out by warships with small crafts and/or helicopters to transfer the personnel on the visited ship. They are usually limited to control the documents and cargoes in support of international law or in certain cases for maritime law enforcement. The composition of the command structure varies depending on factors like area of operations, goals or command intents. An indicative basic Command and Control structure, according to the doctrine followed by NATO in relation to these operations, is illustrated in figure 2.

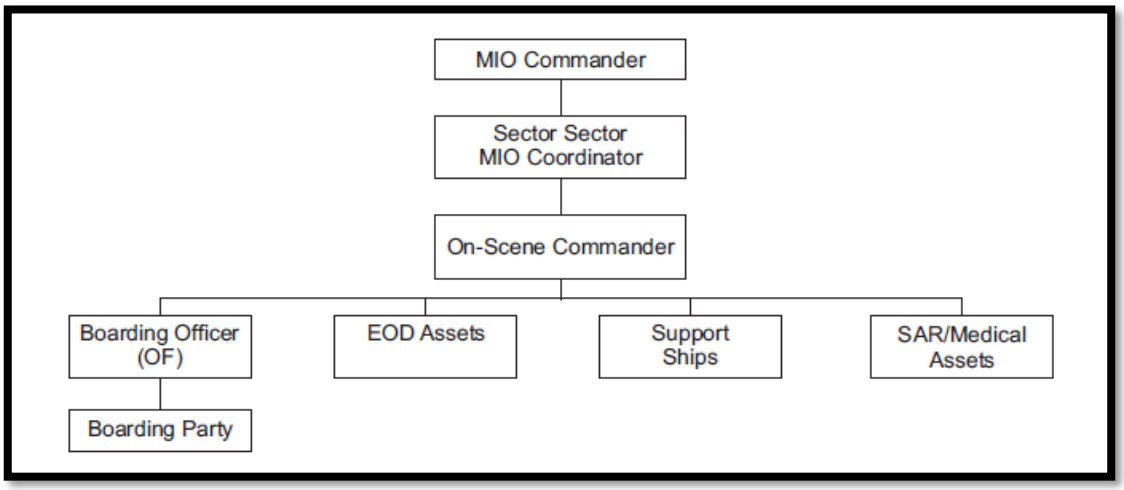

Figure 2: MIO Command and Control structure (NATO, 2005)

The On-scene commander (OSC) is the commanding officer (CO) of the boarding ship, the ship which provides the boarding party or boarding team. The boarding party is under the control of the Boarding Officer (BO) who has the responsibility to visit and to search the suspected vessel. But the overall control of the operations remains with the OSC. The composition of boarding party varies depending on the prevailing situation but figure 3 shows its typical command and control. The personnel involved are expected to carry weapons and equipment for their own protection. The course of MIOs can be divided in four main phases: the detection and surveillance phase, the interrogation, approach and stopping phase, the boarding and searching phase and the diversion phase.

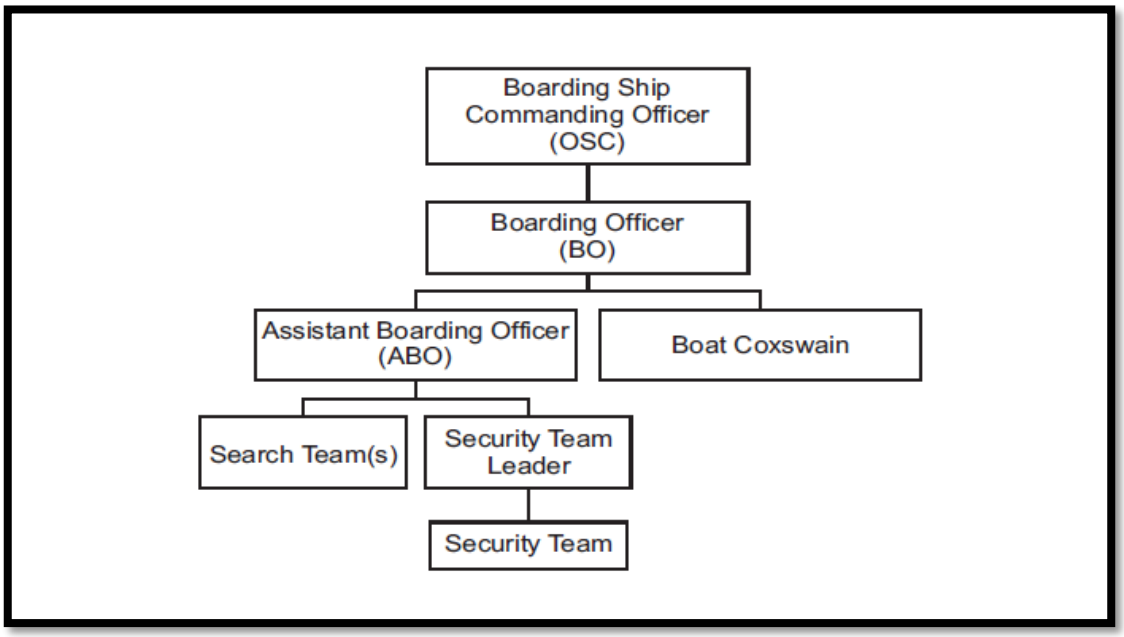

Figure 3: Boarding party command and control (NATO, 2005)

3.3 Challenges

As defined before, VBSS operations are integrated parts of MIOs. Many scholars tried to address the challenges faced in the conduct of these operations. The first challenge is the comprehension and the interpretation of the law of maritime interdiction. In fact, for a boarding to take place the prevailing circumstances have to be legally justified. MIOs revealed the long lasting paradigm of the balance between protection of security interests and the legal principles governing the use of the sea (Fink, 2010). If the right of visit under UNCLOS article 110 poses less issue of interpretation, the master's authority or consent for a boarding, implied in several legal instruments, remains subject to different points of view. Indeed, the master's authority in UNCLOS article 27 doesn't remove the flag state's consent to authorize the search of the ship. The IMO regulations also entrust masters in decisions concerning the safety and security of their ships but define the extent of this authority (Dalaklis, 2017b). Concerning a search for fighting terrorism, nothing dismisses the flag state's consent unless the person poses a direct threat to the safety and security of the ship (Hodgkinson et al., 2007). When the flag state consent is also required, the national authority for confirming registration or for giving permission may not be clearly identified, if not different (Guilfoyle, 2016). Moreover, the current MIOs are very similar

to law enforcement operations, thus the law of maritime interdiction should also include legal considerations as human rights and criminal law because the completion of the entire process requires interagency approach and all threats find their root causes on land (Fink, 2010). For instance, Moore (2016) advocated a more similar approach of the meaning of the use of force by boarding officers, whose principles derive from the Saiga case in international human rights law. Guilfoyle (2016) added that the consent for visit and search does not generally mean consent for arrest and prosecution in some legal instruments. Fink (2010) estimated also that the new political settings and the changing nature of maritime threats, the scope of the right of visit has been broadened. As a consequence, UNSCRs may not be relevant to justify in every boarding under a specific mandate and the inherent right of self-defence in article 51 of the UN charter may become subject to many interpretations (Hodgkinson et al., 2007). Therefore, from a legal perspective, all aspects of international and domestic law should be specifically reinforced in MIOs to make them effective.

The second challenge of boarding operations lies in their inherent risky nature. These operations are subject to the presence of security threats and safety hazards at the same time. Indeed, during VBSS operations the situation can go from simple to very complex in a very short period of time either because of new orders or unpredictable events. NATO (2005) classified the types of boarding according to the level of threat and the available information about the visited vessel. However, the literature discussed the dangers all together without one taking precedence. For instance, in the boarding and search phase, which is considered the most hazardous, ships have to conduct close manoeuvers from each other, making navigational risks higher. In addition, getting the boarding party on and off the suspected vessel with a small craft or a helicopter requires a pilot's ladder operation, which is risky even in the best conditions, or a fast rope-dropping operation respectively. Later, the boarding party could be dealing with non-cooperative people on board the suspected vessel especially during illegal trafficking interdiction or counter-piracy operations. Even if, it is recognized that in most cases the crew or passengers do not pose a serious threat, hostile acts can be expected from them (NATO, 2005). They are also exposed to hazards either occupational or operational characterizing the maritime industry. For example, when dealing with cargo holds or tanks, poor or inexistent lighting, structural damage of ladders, oil on the deck, noxious or hazardous vapours, deficiency of air,

bad stowage of cargo, presence of explosives or domestic animals, are all possible hazards which the boarding party may be exposed (NATO, 2005). Hence, it appears that each boarding need a level of risk taking. According to NATO (2005), safety is paramount and must not be sacrificed for any reason. This is why Guilfoyle (2016) concluded that “apart from the legal restrictions, the hazard and expense of maritime interdiction operations tends to ensure that they are an exceptional measure” (p. 265).

4. Visit, board, search and seizure operations and Risk analysis

Various documents have acknowledged the existence of risks in boarding operations. NATO (2005) recommended a threat assessment before undertaking a boarding and preconized a wide list of guidance and equipment to ensure the safe conduct of the operation. Even though, dangers are mentioned, the document does not provide an objective method to assess them nor to prioritize them. It advises mostly to rely on intelligence to evaluate and to address the risks based on the experience of persons. The multinational character of the organization, which has different countries with different capabilities and regulations, may probably be the reason for this flexibility. As Feldt (2016) stated “members of NATO…retain their right to make national decisions” (p. 22). In addition, the risk management approach is very broad and did not target any dangers specifically. The risk management method developed by the United States Coast Guard (USCG), named the General Assessment of Risk (GAR) tool, described a similar approach to reduce risk. However, this tool applies not only to boarding operations but also to any other operation at sea. This broad and subjective risk management approach can be explained by the acceptance of some level risk which characterizes military organizations, which means that risks could exist but the overall appreciation of the situation should prevail. The USCG viewed the process as one to increase performance by lowering risk exposure because calculated risks is often the norm in operations at sea (USCG, 2018). Nonetheless, the GAR model is an analytical tool which help converting the judgement of persons in numerical score and assessing risks with a simple risk acceptance scale.

5. Summary of chapter II

The literature has widely discussed risk and the methods to address risks are as different as the nature of the subject studied differs. Yet, it is a common accepted statement that risk analysis is a useful tool serving decision making. The literature surrounding MIOs, and VBSS operations in particular, focused on the legal challenges posed by these enforcement measures. Even if the legal framework supporting boarding operations is different between international law and national law enforcement, the conduct of these operations is almost similar in the processes and the risks associated may converge. Even tough, “at-sea interdictions are logistically complex, potentially dangerous and often very expensive” (Guilfoyle, 2009, p. 95), the literature provides few insights for risk analysis in VBSS operations. Although they mentioned the hazardous nature of these operations, the measures to mitigate the dangers are general and not specific. So, the question of their real effectiveness is yet to be discussed. This research effort came to emphasize the need for a more specific and proactive approach to attenuate risks in these operations. The aim is to stimulate a new narrative about naval forces and their role to overcome the culture of secrecy for transparency in security and safety. Achieving this objective necessitated to seek reactions in response to analysis and assessment before a serious unfortunate event occurs.

CHAPTER III VISIT, BOARD, SEARCH AND SEIZURE OPERATIONS IN CÔTE D'IVOIRE

1. Introduction

The Republic of Côte D'Ivoire is one of the states bordering the GoG. It is located in West Africa, more precisely between Ghana and Liberia and South of Mali and Burkina Faso. Its EEZ extends up 200 NM from its coast line of 550 km (see figure 4). Its coastal area has also a vast network of lagoons covering 1200 km^2 and extending over 300 km (Sankaré et al., 1999). The seaborne trade uses the two ports in Abidjan and San Pedro. In 2020, these ports registered more than 2700 ship calls of all types (PAA, n.d.; PASP, 2021). In order to secure this maritime trade, Côte D'Ivoire relies primarily on its navy.

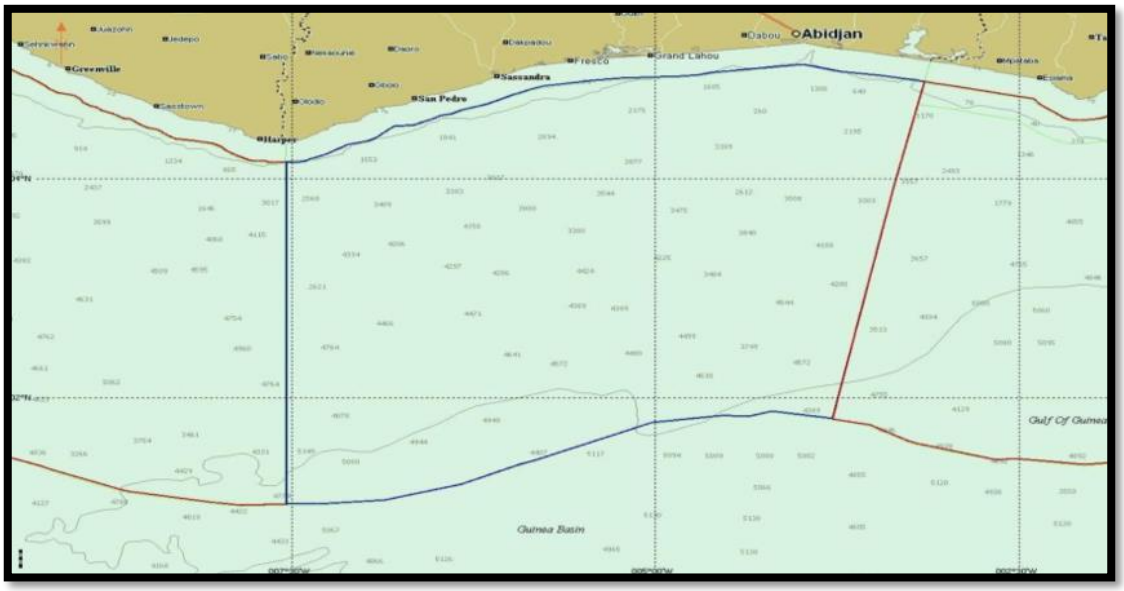

Figure 4 : EEZ limits of Côte D'Ivoire (Sylla & Kouakou, 2016)

2. National legislation

The national legislation for VBSS operations originated essentially from the National Strategy for the State's Action at sea (SNAEM), and is centred around maritime law enforcement. This latter document describes the Côte D'Ivoire Navy as the centre piece of the Coast guard function, in other words the surveillance and the

control of activities in waters under the country's jurisdiction. This strategy devotes to the navy the missions of sovereignty and protection of national interests (RCI, 2014). In addition, the law organizing the defence and the armed forces, in its article 14, stipulates that the Navy participates to actions for peace and international law. Its article 26 acknowledges the duties described in the SNAEM and adds the defence of maritime zones (RCI, 2016a). Although, these two documents do not embody any explicit mention of VBSS operations, they imply that the navy has the right and the duty to execute them in accordance with international conventions which Côte D'Ivoire is party to.

The regulations of fisheries are more precise concerning the authorization for boarding operations. First, in articles 983 and 985 of the maritime code, any fishing vessel in Ivorian waters is subject to controls and officers in command of Navy ship have the right for the search and the ascertainment of infractions (RCI, 2017). Second, the fishing and aquaculture law authorizes the conduct of visit and search without special mandate in its article 70. Finally, this law, in its article 80, bestows to the Navy the operational coordination of monitoring, control and surveillance activities of foreign-flagged vessels, which requires joint teams of Maritime administration (MARAD), Navy, Fisheries and/or Customs personnel (RCI, 2016b). In this respect, the country concluded an agreement with the European Union (EU) for the control of its vessels operating in Côte D'Ivoire waters (EU, 2018). Thus, boarding operations for fisheries control relies on clear national provisions.

3. The Côte D'Ivoire Navy

The Côte D'Ivoire Navy is one of the three main branches of the armed forces. its role is to safeguard the maritime interests of the country and to ensure the defence of the territory in collaboration with the other forces. Indeed, various legal and policy documents assign maritime law enforcement duties to the Navy. So, fisheries control, illegal trafficking interdiction, piracy and armed robbery, safety of navigation, marine pollution and SAR response are all activities under its responsibility. Despite its relative small size, all these functions are more or less accomplished.

3.1 Structure of Command

The naval units and personnel are housed by the infrastructure in the three bases of the country in the towns of Abidjan, San Pedro and Adiaké. The Navy staff is chaired by a Chief of Navy Staff (CNS) who has under his command different units. Figure 5 describes the organizational chart of this military organization. The chief of operations and his bureau plan and order missions at sea. Then, activities are placed under the supervision of two MOCs in Abidjan and San Pedro, which are information and command centres. On-scene, the command remains with the CO of the ship deployed at sea. In the case, there are several units involved, the OSC will be the most experienced CO or the designated officer. Also, different offices and units support the deployment of assets at sea in providing logistics, medical care and personnel.

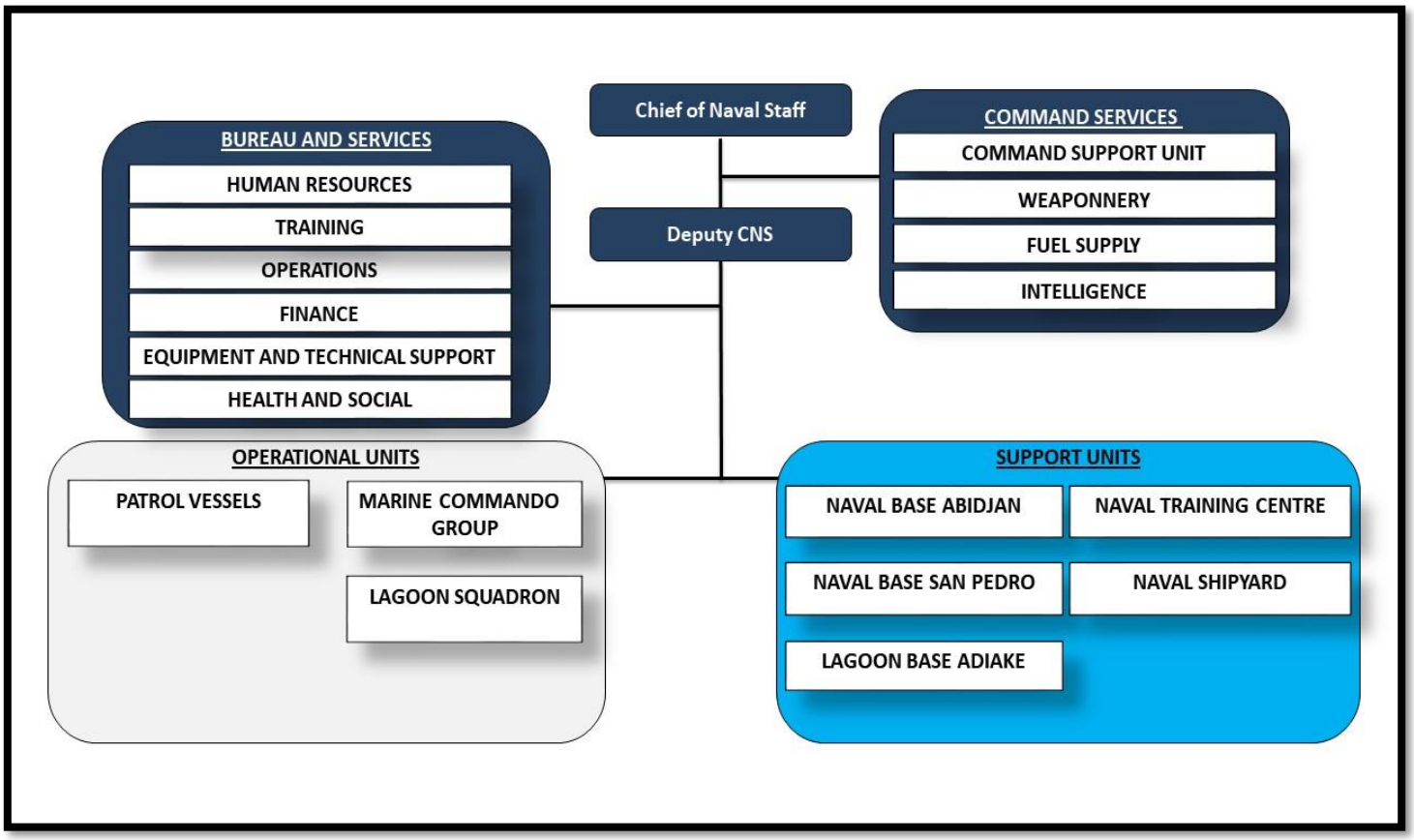

Figure 5: Organizational structure of Côte D'Ivoire Navy (Author)

3.2 Naval assets

As mentioned earlier, Côte D'Ivoire has undergone a deep restructuration and renewal of its naval force. The naval assets are mainly the fleet of patrol vessels, the lagoon squadron of small crafts and special boats and the standing group of marine commandos. Figure 6 and figure 7 represent the main naval platforms used for boarding operations.

Figure 6 : Fast patrol vessel (Plisson, n.d.)

Figure 7: Special boat (UFAST, n.d.)

4. Context of VBSS operations

4.1 Importance

Due to its capabilities, Côte D'Ivoire Navy conducts patrols, to ensure the safety of navigation and to secure the marine resources in the EEZ of the country, relatively close to the coast. Oil and Fish are the main concern among those resources. Indeed, they are threatened by illegal activities principally IUU fishing and piracy and armed robbery at sea. The country also faces a number of illegal trafficking activities especially using small craft (Mieu, 2020). This situation could have been exacerbated by the "grey" zone which prevailed during the settlement of the maritime borders dispute between the country and Ghana since the jurisdiction over the disputed area could not be defined (Ioannides, 2017). The recent discoveries of offshore oil reservoirs could also awake intentions of criminals in the country (Eni, 2021, September 01; Total energies, 2014, April 17; Tullow Oil, 2012, June 7). Furthermore, as Côte D'Ivoire expects to fulfil its regional and international commitments for the security in the GoG, VBSS operations will be more and more required. Consequently, the strategic importance of these operations for the stability of the country requires them to be effective.

4.2 Boarding party

In Côte D'Ivoire, VBSS operations are carried out by naval personnel using the vessels and small crafts described in section 2.2. The command and control is adapted from the one presented by figure 3 and varies because of the difference of size and equipment with NATO countries. The patrol vessels (see figure 6) are the main platforms used for VBSS operations. They house a rigid hull inflatable boat at the stern for the transfer of the boarding party on the visited vessel. One particularity is that the boarding party are teams, specially trained for the purpose, originated from the standing group of marine commandos. While the small craft crew members are part of the "visiting" Navy vessel's crew. However, inspectors from the fisheries department, the MARAD or the customs could be integrated to the boarding party in specific missions in order to benefit from their expertise, in accordance with the pooling of resources strategy in the SNAEM (RCI, 2014). In few occasions, the boarding can take place inside or in the vicinity of the ports using small crafts or special boats only (see figure 7).

5. Summary of chapter III

Boarding operations are essential for Côte D'Ivoire in delivering law enforcement at sea in an area where maritime "insecurity" can threaten its interests. To do so, its Navy plays has a prime role and intends to achieve this duty using the assets at its disposal. When it comes to the strategy to make these operations safer, very few literature addresses risks in VBSS operations in Côte D'Ivoire. Some reports highlighted the necessity for capacity building to improve the level of performance of the enforcement agencies despite the multiple actions undertaken (Okafor-Yarwood et al., 2020). Therefore, insights from this dissertation can contribute valuably to the improvement of their efficiency. The absence of previous similar research led this study to adopt a conceptual framework combining different risk analysis frameworks.

CHAPTER IV RESEARCH METHODOLOGY

1. Introduction

This dissertation intends to analyse the risks associated with dangers in VBSS operations for the purpose of developing adequate mitigation measures. The objective is to produce relevant outputs to inform decision makers. The novelty of the topic drove the work towards the utilization of different methods of risk assessment in order to collect sufficient data to conduct a fair analysis. For the purpose of clarity in this dissertation, “hazards” designate dangers related to safety and “threats” dangers related to security.

2. Operationalization of the research process

The methodology of the research was framed by separating the risk analysis process into risk assessment, risk management and risk communication, as described in the literature review by Yoe (2019). This three-step process allowed the research to explore boarding operations through the lens of each principle and to understand their relationship in order to enhance the adequacy of the RCOs. For this reason, the research involved all the actors in the chain of command of VBSS operations either at sea or on land, as indicated in figure 1 and 2 in section 3.2 of the literature review. The risk assessment process consisted of three main parts, namely risk profile, identification of hazards and threats, and risk estimation. The risk management and the risk communication were achieved through the development of RCOs (outputs) based on the results of the risk assessment (inputs). Regarding the dynamic and data-scarce nature of these operations, this dissertation adapted a combination of risk analysis frameworks (Merrick & Van Dorp, 2006). Figure 8 shows the structure of the methodology framework.

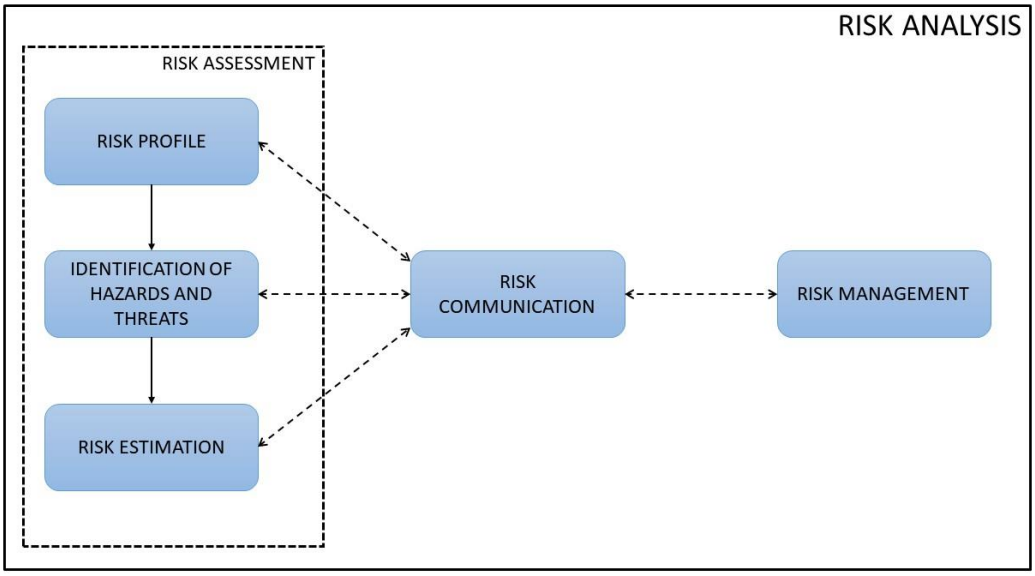

Figure 8: Research conceptual framework (Author)

3. Origin of data

Data used in this dissertation were originated from two survey questionnaires and semi-structured interviews with boarding operations stakeholders from the Côte D'Ivoire Navy and the PAA but also the Senegal Navy and the Nigeria Navy for benchmarking. In fact, Senegal Navy shares similar structure and interception capabilities with Côte D'Ivoire Navy; in contrast Nigeria Navy is better equipped and have more experience in these operations so they could represent a field of experts. Using the risk analysis principles, the questionnaires and interviews aimed to touch different respondents to generate a qualitative and a quantitative assessment of risks based on their personal experience and professional judgement. The sample of respondents encompassed all categories of naval personnel without any distinction of ranks and position, chosen based on their professional experience in boarding operations and their position. In addition, the data collection framework was assessed and approved by the Research Ethics Committee (REC) of the parent organization covering the research, namely the World Maritime University (WMU).

3.1 Questionnaires

The questionnaires were distributed to collect inputs of all personnel participating to VBSS operations. For the French-speaking respondents, the

questionnaires were translated into their language. In order to avoid errors in the translation, respondents with a good level of English language received a first draft of the questions to check the accuracy of the translation. Later, misunderstandings of specific terms, particularly naval and military vocabulary, were reduced by sending the questions to Navy officers proficient in both English and French for checking. Then, the confusing terms and the translation were clarified to ensure a greater and better understanding by the participants. The final draft was the one transmitted to all respondents. The validity of the responses can be acknowledged since the targeted audience had a direct role in the conduct of boarding operations with years of experience. In this research, the participants dedicated themselves with sincerity and honesty in providing the answers which evidenced their willingness to participate in the enhancement of capabilities in boarding operations by tackling the risks associated.

3.1.1 Questionnaire for risk profile

The structure for risk profile described by Yoe (2019) was the basis for this questionnaire (see Appendix A). The purpose was to conduct a preliminary identification of risks and to evaluate the current state of knowledge about those risks. The sample of respondents was taken from all categories of naval personnel, with a focus on participants in the top and middle level management. The questionnaire embodied 29 open-ended questions divided into three sections, which are generalities, description of risks and management of risks in boarding operations (see Appendix B). The participants received the questionnaire electronically via email using the GOOGLE FORMS platform in order to reach the maximum of persons and to obtain honest answers (see appendix G).

3.1.2 Questionnaire for risk assessment

This questionnaire intended to collect information in order to answer the informal questions of risk analysis (Kaplan & Garrick, 1981):

- What can go wrong?
- How can it happen?
- What are the consequences?
- How likely is it to happen?

The questionnaire contained 38 questions divided into 8 sections or themes (see Appendix C). The questionnaire was designed using information collected from the literature and the inputs given by the participants in the questionnaire for risk profile. It was a combination of risk assessment frameworks and intended to assess safety hazards and security threats in the same questionnaire. The structure did not separate them in order not to introduce biases in the mind of respondents who encountered those dangers simultaneously. It was shared online as a GOOGLE FORMS form or in hard paper copy to the maximum of available participants for the sake of increasing the reliability of the data. The section 1 gathered general information about boarding operations. Theme 2 and Theme 5 were focused respectively on the likelihood and the severity of hazards and threats identified. These two themes were adaptation of the Formal Safety Assessment implemented by the IMO (2002), applied on the case studied. The section 3 intended to collect information about the nature of the security threats while section 4 was dedicated to the value of the assets involved. The process for Threat analysis of the commonwealth of Kentucky office of Homeland security (Bennet, 2018) and Asset criticality evaluation defined by Bennet (2018) represented the basis for the creation of these last two sections. Theme 6 addressed information about the vulnerability of assets, which derived from the vulnerability characterization in the CARVER target analysis tool (Bennet, 2018). The questions of risk management policy and procedures were covered in section 7 in the form of Likert scale questions; the questions covered four topics: role of top management, risk awareness, procedures and organizational culture; in order to ensure reliability of the answers, two questions were in the negative form and one is a positive form with a negative connotation. And finally, section 8 targeted personal and additional information from the respondents (see appendix G).

3.2 Interviews

Considering the scarcity of data and the uncertainty characterizing this research topic, the interviews aimed to obtain deep insights about risks of interests, which were identified in the questionnaires, and to fill the gaps and to calibrate inputs on RCOs. The interviews targeted experienced professionals in their field of activity. The questions were inspired from the 4 informal questions of risk analysis abovementioned with additional themes to explore RCOs (see Appendix D). In total,

three participants were interviewed. All the interviews were conducted and recorded using the software ZOOM with the consent of the respondents (see appendix G).

3.3 Secondary data

This dissertation relied also on supplementary data extracted from an analysis of mission reports, shipboard documents and textual materials from regional maritime organizations in West Africa and Defence organizations like the NATO. The NATO ATP-71 publication was extensively reviewed.

4. Data analysis

The data collected through the questionnaires were matched together to obtain the possible risk scenarios related to safety and security matters separately. Then, the risk scenarios were identified by eliminating the unbelievable or impossible scenarios based on the literature and the nature of the assets at risk. Lastly, the information provided by the interviews were combined with those in the surveys to frame adequate RCOs.

4.1 Risk marking system

The identification of risk of interests was achieved by attributing a numerical value or index to the dangers in risk matrices. The indexes were on a logarithmic scale in order to facilitate the calculation of risk equations (IMO, 2002). The average of the index per responses determined the index for each danger:

$$\textbf{\textit{Avg INDEX} = [Sum } (n_i \textbf{ x } INDEX_i)] \textbf{ / } N$$

N : total number of responses = Sum (n_i)

n_i *: number of responses for the item i*

$INDEX_i$ *: corresponding index to item i*

The risk estimation was not meant to categorically rank the risk scenarios but to identified risks which need mitigation. These risks are referred in this dissertation as “identified risk scenarios”. The dangers with the risk index above the defined thresholds represented the identified risk scenarios.

4.1.1 Safety hazards

Safety hazards were identified by quantifying the risk using the formula **(1)** to form a matrix. The severity represented the index attributed to the consequence of a scenario. The frequency was the number of occurrences per unit of boarding (see Appendix E). This risk model has been inspired by the definition given by the IMO (2002) since it proved to be effective in providing good inputs in a decision making process (IMO, 2002). Risk mitigation considered scenarios with a risk index superior or equal to 6, using the formula **(A)**.

$$Risk\ (hazards) = severity * frequency \qquad (1)$$

$$RI\ (hazards) = SI + FI \qquad (A)$$

4.1.2 Security threats

Risks posed by security threats were calculated by multiplying the vulnerability of the asset, the level of threat, the frequency and the severity of an attack. This definition was adapted from the one used in risk assessment in terrorist attacks (Cox, 2008a). The risk was estimated using the formula **(2)**. The vulnerability provided a numerical value for the level of protection of the asset against possible threats. The level of threat gave a value to the nature of threats (see Appendix F). And the severity and the frequency defined the indexes as described for safety hazards (see Appendix E). The risk scenarios where an index was greater than 14, using the formula **(B)**, are the one considered problematic.

$$Risk\ (threats) = vulnerability * threat * severity * frequency \qquad (2)$$

$$RI\ (threats) = VI + TI + SI + FI \qquad (B)$$

4.2 Comparison of Risk assessment methods

Regarding the novelty of the framework applied and the absence of formal study of risks on boarding operations, an additional factor was introduced in the risk quantification method to test the objectivity of the results since the responses depicted

the experience of participants. A value factor was added to the formulas **(1)** and **(2)** to get the formulas **(3)** and **(4)** respectively. The value represented the importance of an asset for the fulfilment of the tasks carried out in these operations or the consequence if the integrity and/or the availability of this asset is compromised, which is defined as operational value index (OVI) for the purpose of this dissertation (see appendix E and F). The reasoning was that if an asset had more value it was likely to get priority in the implementation of RCMs (Bennet, 2018). The identified scenarios were the risks with an index superior or equal to 14 for safety hazards and greater than 21 for security threats, after calculating the indexes with formulas **(C)** and **(D)**. These limits supposed that the loss of the asset could have grave consequences or more.

Risk (hazards) = value * severity * frequency ***(3)***

Risk (threats) = value * vulnerability * threat * severity * frequency ***(4)***

RI (safety) = OVI + SI + FI ***(C)***

RI (threats) = OVI + VI + TI + SI + FI ***(D)***

The hypothesis was as follow:

The value of the asset influences the determination of risk control options

The idea was to test if the addition of the value as a factor in the risk equation changes the RCOs in line with the identified risk scenarios.

4.3 Risk management Likert scale

A value was given to the responses in section 7 (Likert scale), where 5 is the answer “strongly agree” and 1 “strongly disagree”. The average score for a question was the average score of the answers received from participants. A score higher than 4 means that the risk management aspect, which is assessed, is well implemented. Only questions, with an average score of 3 or lower, were considered to require improvements. Naturally, the score of the questions in negative form were reversed. Thus, by targeting the risk management aspects with the lowest average score, this dissertation brought added value in the risk management practices in boarding operations.

CHAPTER V RESEARCH FINDINGS AND DISCUSSION

This dissertation intended to analyse the possible risk scenarios affecting the assets involved in VBSS operations in order to frame risk mitigation measures. As mentioned earlier, the methodology relied on the personal experience and professional judgement of the participants which might have bias depending on their role in these operations. This limitation was overcome by taking into account each opinion as an equal value to others. This chapter summarizes and discusses the data obtained from the targeted organizations in this research. In order to facilitate the analysis, the risk scenarios were codified as follow (see appendix H):

letters for the assets at risk + a letter for the nature of dangers + a number for the dangers itself.

1. Findings

1.1 Risk profile

This section is based on the results of the questionnaire for risk profile. In total, 18 participants provided their inputs (see appendix G). eight out of them held a top management level position. All of them were naval personnel and for ethical reasons their position was not disclosed. They were from different organizations: Navies principally, the Regional maritime security centre of West Africa (CRESMAO), which is one of the two regional security centres defined by the architecture of Yaoundé and the permanent secretary of inter-ministerial committee for the state's action at sea of Côte D'Ivoire (SEPCIM-AEM) in charge of the coordination and the implementation of the SNAEM.

The results suggested that boarding operations have a strategic importance for this country. Indeed, they are a prime mean used for maritime law enforcement to ensure the legal order at sea. Respondent RP1 stated this point when describing the goal of these operations as follow: "to ensure compliance with regulations in the context of public service missions or missions aimed at carrying out checks or interceptions relating to the prerogatives of States in maritime areas under (their) jurisdiction". So, boarding operations could be carried for a multitude of purpose like "the fight against IUU fishing, Narcotics or Piracy" as mentioned by RP2, RP3, RP7 and RP14. VBSS operations also require a variety of assets. Indeed, respondent RP4 rightly argued that "a warship, a small craft (rigid-hulled), qualified personnel (marine

commandos, sailors with boarding skills prerequisites), security equipment (firearms, ammunitions, etc.), safety equipment (lifejackets, gloves, etc.) and logistics (healthcare, food, fuel, etc.)" must be put at contribution to fulfil the tasks. But RP2 and RP16 noticed the need of "specialists" like "fisheries or customs inspectors" in certain cases.

The results acknowledged the hazardous nature of boarding operations. "man overboard" (RP4, RP10, RP14, RP17, RP18), "hostile acts from visited ship's crewmembers" (RP2, RP10, RP13, RP14, RP15, RP18, RP19), "injury" (RP4, RP5, RP13, RP14, RP15), "loss of equipment" (RP8), "sea state" (RP7, RP15, RP16), "engine failure" (RP15), "shooting" (RP12, RP16), "slip" (RP4), "toxic products" (RP4, RP17), "disease-related contamination" (RP4), "ladder accident" (RP12), "hostage-taking" (RP10), "capsizing" (RP10, RP14), "collision" (RP18), "fire" (RP17), "drowning" (RP9, RP14) or "death" (RP9, RP11) were considered inherent dangers to the assets of these operations. Correspondingly, the inputs suggested that capsizing, man overboard, injury, slip and fall, loss of equipment or collision could be more recurrent during the manoeuvres. The results showed also that the risk is permanent thorough the course of operations as 84% of respondents assured, even though, the assets are more exposed to the dangers during the active phase of the boarding and search. RP17 confirmed that risks are higher "on board the small craft, when boarding the vessel and inside compartments and rooms during visits and (searches)". RP15 shared a similar point of view: "during the launching or recovery manoeuvres of the small craft and the men on board and at the bottom of the ladder of the vessel visited". Even if the level of occurrence of accidents or incidents remains low: "rarely" (RP6, RP3, RP9, RP15 and RP18), "once a year" (RP5 and RP13), "negligible" (RP4); their consequences can be serious for the assets. Reporting the worst incident they noticed, RP15 mentioned the loss of a boarding team in undetermined circumstances, RP1, RP3, RP4 and RP5 mentioned the loss of one coxswain's finger, RP13, RP14 and RP17 pointed the capsizing of the small craft with the boarding party on board. This evidenced that assets, which approach the visited ship, are more susceptible to be affected. This observation also confirmed that the participants considered the human health as the value most at risk in VBSS operations (17 respondents) and estimated that the risks are unequally distributed among the assets (13 respondents).

Despite all these circumstances, boarding operations are still being conducted and by all means decisions to accept a level of risk had to be made. The analysis of the responses revealed that assets could be put at risk for different reasons. The success of the mission (RP2), the preservation of human life (RP1, RP7 and RP8), the interdiction of an illegal act (RP16) were some reasons given by the participants. But also if the opportunity was bigger than the risk in situation where there was a reasonable evidence of illegal activities (RP15). Furthermore, the results did not ascertain the existence of a specific tool for risk assessment in boarding operations. Indeed, it was observed that RCMs were used based on the professional judgment and the experience of the personnel involved. However, the codification for this process did not appear in the findings. Respondent RP4 mentioned a periodic risk assessment without reference about the tools used. Likewise, an overview of the observations showed three patterns in the options for risk mitigation. First, intelligence was one of the options suggested. The aim is to share information (RP15) about the suspected vessel (RP12, RP17) and the weather forecast (RP14) in order to assess the threat level (RP18) and also to assess the situation in line with the experience and the readiness of the boarding party (RP10). Second, control should be strengthened through the establishment of standardized procedures (RP1, RP3, RP17) from the lessons learned (RP3) and a thorough mission planning process (RP5, RP8, RP13), which considers interagency cooperation (RP15). And lastly, the provision of equipment (RP14, RP15) and the appropriate training (RP2) ensure the enhancement of the capabilities of the personnel. In addition, the results suggested that contingency planning is taken into account as 14 participants acknowledged the provision of a plan in case of an incident. Further details on the RCOs revealed that the factors influencing their implementation could be mission-related (RP14), the results of their application in drills, a new review of strategy, the availability of finance (RP15), the experience of the personnel (RP18) or the need for update (RP4). Nevertheless, their efficiency differed since respondent RP18 estimated it is as “high level”, while participants RP1, RP2, RP15 and RP17 qualified them as “good”. According to some of them, the performance of the measures is evaluated based on the results of missions and during trainings and drills.

Regarding responsibilities of the top management, the inputs suggested that it plays an important role from the onset to the end of operations. As “operational

authority, it is the bridge between the State's authorities and the force in order to match strategic and operational objectives" (RP4). To do so, the top management ensured the force readiness in every aspect and continuously decided during the course of action. For instance, participant RP14 argued that it has "an upstream job for procurement and training". Later it follows, "through the MOC, the course of ongoing operations to give orders…if necessary" (RP1). It is in charge of decisions related to "procedures and legislation" (RP13), the use of fire weapons and the interagency and international cooperation (RP15). Those decisions are based on lessons learned and communicated through briefings and procedures (RP1, RP15), like "operational directives and rule of engagement" (RP18). Furthermore, the results implied the definition of a threshold for risk levels, however, this level of acceptance was still subjective and not specific for each asset. Respondent RP15 stated the level of acceptance of risks was determined depending on the gravity of risk for the country, the availability of assets, their capabilities and the availability and training of personnel. While participant RP4 estimated that it was an assessment of the vulnerability of personnel, infrastructures and equipment which defined the acceptance level. Similarly, "the impact on the physical integrity of personnel and the condition of equipment" should be considered (RP1). Finally, additional inputs of respondents suggested that the risks related to the heterogeneity of team with different standards of training and qualifications (RP1), the non-domestication of international conventions (RP15) and the psychological and societal impact on personnel (RP4) could be matters of concern as well.

1.2 Risk estimation

This section presents the results of the questionnaire for risk assessment described in section 3.1.2 of the methodology. The responses were introduced in risk matrices to convert them in numerical values as explained in Chapter IV section 4. The calculations were done with the MICROSOFT EXCEL software (see appendix I). The results of 28 participants were computed to obtain the results (see appendix G). Among them, 86% were directly involved in boarding at sea and the remaining held positions in supporting infrastructure on shore. Figure 11 also describes the distribution of participants by years of experience in boarding operations.

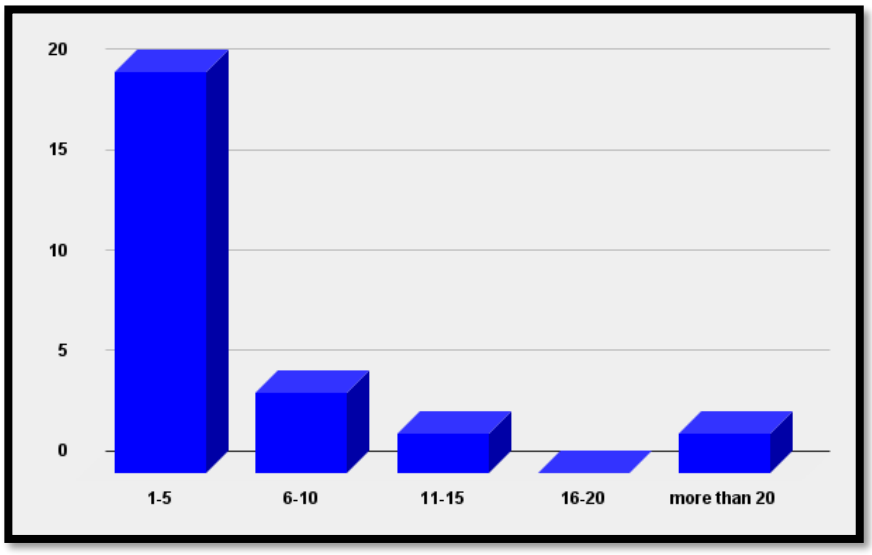

Figure 9: Repartition of participants per years of experience (questionnaire for risk assessment)

1.2.1 Safety hazards

The complexity of boarding operations renders them subject to several types of dangers. From navigational risks to occupational health and safety issues, the actors involved are stressed. The results suggested a wide range of safety hazards are unequally distributed among the assets. Using the formula **(A)**, table 1 shows the safety hazards whose index was greater than or equal to 6. On an average one asset was affected by six hazards. It appeared that the boarding team members were the most at risk with twelve scenarios and the service weapons and the communication equipment the least with two scenarios. Likewise, the small craft's crewmembers experienced a higher risk level compared to the vessel's crew members, even if in principle they are part on the unique crew of the vessel. The equipment and naval platforms used were relatively less impacted by the hazards where the small craft, with five risk scenarios was the first.

Assets	Risk scenarios	Total
BT	BTH1, BTH2, BTH5, BTH6, BTH7, BTH9, BTH10, BTH11, BTH12, BTH16, BTH17, BTH18	12
VC	VCH1, VCH2, VCH5, VCH7, VCH9, VCH11, VCH12	07
SC	SCH1, SCH2, SCH5, SCH6, SCH9, SCH10, SCH11, SCH12	08
V	VH7, VH9, VH14, VH17	04
S	SH7, SH9, SH13, SH14, SH17	05
W	WH5, WH17	02
C	CH5, CH17	02
		40

Table 1: Risk scenarios for safety hazards

A closer look at the hazards revealed that their consequences on assets can be differentiated. Using a colour code, the hazards, highlighted in red, may induce death or total loss of the equipment while those in yellow represented direct life threatening or severe damage situations for the assets. Presented in this perspective, most assets appeared to experience high-consequence risks. Therefore, consideration must be placed on every asset to develop measures to reduce those risks.

1.2.2 Security threats

The assessment for security threats reflected the results of the estimation of risk based on the formula **(B)**. Table 2 shows the security threats which risk index exceeded the limit defined of 14. The overview of risk scenarios demonstrated that boarding team members and small craft's crewmembers, which could be in direct contact with a potential adversary, were more likely to be targeted. Although, the scenarios appeared to be few, the nature of the potential adversaries and their motivation could make them complex and catastrophic. So, in all scenarios human life was jeopardized as shows by the colour code (red and yellow). Hence, a particular attention was also required in addressing security threats to avoid them or to minimize their impact.

Assets	Risk scenarios	Total
BT	BTT1, BTT2, BTT3, BTT4	04
VC	VCT1, VCT3	02
SC	SCT1, SCT2, SCT3	03
V	*None*	00
S	ST1, ST3	02
W	*None*	00
C	CT3	01
		12

Table 2: Risk scenarios for security threats

According to the results, industrial fishing vessels and commercial vessels were most likely the ones to be boarded whereas ferries and offshore vessels had the least interest (See figure 10).

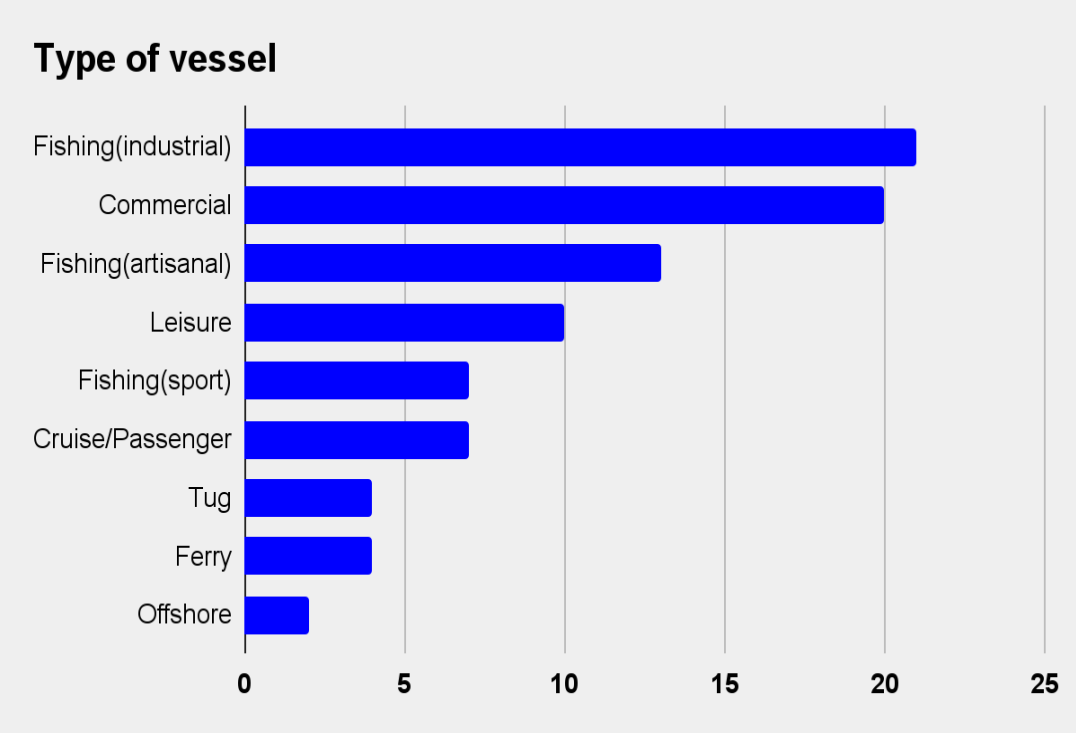

Figure 10: Most common type of vessel visited

Looking at figure 11, the findings also showed that drug traffickers and pirates represented the most probable potential adversaries in VBSS operations. Fishermen and terrorists were also identified as potential attackers in a lower extent. Passengers and offshore workers were not of many concern.

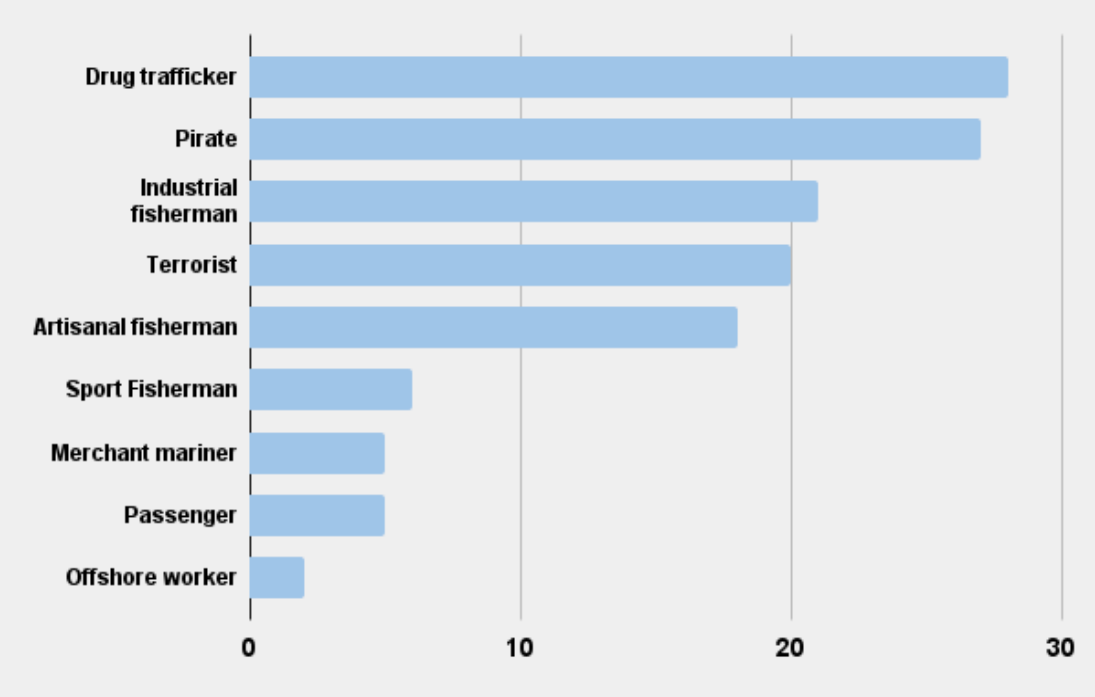

Figure 11: Nature of potential adversaries

1.3 Risk management and risk communication

The results of theme 7 of the questionnaire for risk assessment are presented in this section. Table 3 showcases the average score for each question on a Likert scale (see 4.3 of the methodology). An average score of 3 or lower needed attention and consideration (in yellow) (see appendix J).

Items	Questions	Score
Top management	Q28	3.3
	Q29	3.4
Procedures	Q31	2.4
	Q33	3.3
Risk awareness	Q27	3.7
	Q32	3.4
Organizational culture	Q26	2.8
	Q30	3.3
	Q34	2.3

Table 3: Average score for risk management

- Top management:

The average score for the question related to the role of the top management in risk management showed that the perception of the role in decision making was understood and recognized. This observation confirmed the importance of its implication in the risk analysis process.

- Procedures

The results suggested that contingency procedures have been established to deal with unexpected events, however the utilization of a risk assessment tool was not a common practice for the targeted organization. This inconsistency in procedures needed improvement.

- Risk awareness

For the theme, the observations clearly showed that the actors involved in boarding operations had a knowledge about the risks.

- Organizational culture

The findings for this aspect implied that on an average the behaviours drifted towards risk which was accepted in the organization.

1.4 Comparison of methods

Assuming that the value of an asset could influence the scenarios chosen for the implementation of RCMs, the section presents the findings for the estimation of risk with the additional factor defined as OVI. The hypothesis was to ascertain if the introduction of this factor in the equation would influence the identified risk scenarios and subsequently the implementation of RCOs.

- Safety hazards

Table 4 presents the different risk scenarios based on the two formulas **(A)** and **(C)**. The results showed that there were more risk scenarios in the second method than the first. Two assets out of the seven had additional risk scenarios. Those scenarios were highlighted in yellow. The small craft had a reduction of one scenario highlighted in green. In total, eight additional risk scenarios required consideration, bringing the number to 48 in the second method.

Assets	Risk scenarios 1		Risk scenarios 2	Total
BT	BTH1, BTH2, BTH5, BTH6, BTH7, BTH9, BTH10, BTH11, BTH12, BTH16, BTH17, BTH18	12	BTH1, BTH2, BTH3, BTH4, BTH5, BTH6, BTH7, BTH8, BTH9, BTH10, BTH11, BTH12, BTH14, BTH16, BTH17, BTH18	16
VC	VCH1, VCH2, VCH5, VCH7, VCH9, VCH11, VCH12	07	VCH1, VCH2, VCH5, VCH7, VCH9, VCH11, VCH12	07
SC	SCH1, SCH2, SCH5, SCH6, SCH9, SCH10, SCH11, SCH12	08	SCH2, SCH5, SCH6, SCH9, SCH10, SCH11, SCH12	07
V	VH7, VH9, VH14, VH17	04	VH7, VH9, VH14, VH17	04
S	SH7, SH9, SH13, SH14, SH17	05	SH5, SH7, SH8, SH9, SH10, SH11, SH13, SH14, SH16, SH17	10
W	WH5, WH17	02	WH5, WH17	02
C	CH5, CH17	02	CH5, H17	02
TOTAL		**40**		**48**

Table 4: Difference of risk scenarios for safety hazards

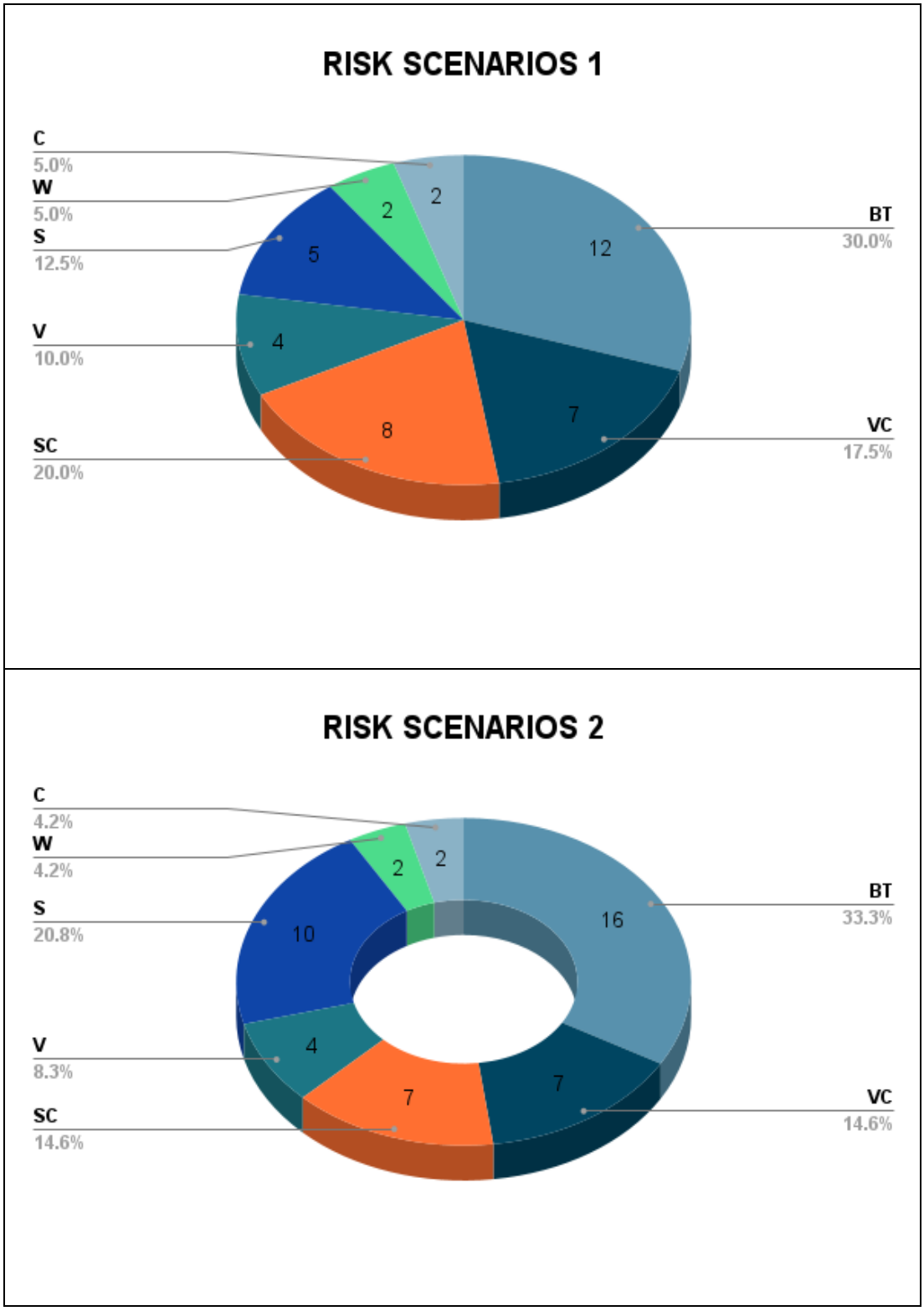

Figure 12 : Comparison of risk estimation methods for safety hazards

By comparing the distribution of risk scenarios among assets for the two methods (see figure 12), it appeared that the share of each asset stayed approximatively the same, with the exception of the small craft, which scenarios increased of 50%. But based on its nature, SH10, SH11 and SH16 could not really impact it in reality. As the methods used were not meant for a categorical ranking of the risk scenarios, the observation led to estimate that the OVI had not much influence in their determination.

- Security threats

Table 5 presents the different risk scenarios based on the two formulas **(B)** and **(D)**. A quick overview of the findings attested that five more risk scenarios should be considered for mitigation with the second method. Compared to the first, this was an increase of almost 50% scenarios. However, the results were not sufficient to confirm that the OVI could influence RCOs. Indeed, VT1 and VT3 could be linked to VCT1 and VCT3 respectively when implementing RCMs. The same applied to ST2 and SCT2.

Assets	Risk scenarios 1		Risk scenarios 2	Total
BT	BTT1, BTT2, BTT3, BTT4	04	BTT1, BTT2, BTT3, BTT4	04
VC	VCT1, VCT3	02	VCT1, VCT2, VCT3	03
SC	SCT1, SCT2, SCT3	03	SCT1, SCT2, SCT3, SCT4	04
V	*None*	00	VT1, VT3	02
S	ST1, ST3	02	ST1, ST2, ST3	03
W	*None*	00		00
C	CT3	01	CT3	01
	TOTAL	**12**		**17**

Table 5: Difference of risk scenarios for security threats

2. Discussions

This section intends to discuss and to explore the main findings in order to identify measures to mitigate the risks in VBSS operations.

2.1 Risk scenarios

2.1.1 Similarities with pilot boarding operations

Boarding operations require a party to board another vessel in order to carry out specific tasks related to law enforcement. In the maritime industry, pilots are also expected to board a vessel but for different purposes. However, the embarkation and disembarkation on a ship is a common point with VBSS operations. Interviewee INT1 acknowledged similarities between pilot boarding operations and VBSS operations regarding the embarkation and the disembarkation stages. By doing the parallel with pilot boarding manoeuvres, occupational health and safety issues, revealed by the findings, could be better understood and addressed. Indeed, occupational health and safety deals more with day-to-day exposures to hazards due to normal operations (Ng & Hassim, 2015). Many safety hazards identified by the assessment felt in this category. As presented in the findings, the period between the small craft is waterborne to the boarding itself with a pilot ladder appeared to be risky. One crucial moment was the moment where the personnel was on the ladder (see figure 13). In this manoeuvre, Interviewee INT1 viewed the risks higher during the disembarkation because the evaluation of the situation is biased since the pilot could only appreciate it only after climbing down the ladder and at this point he had to leave the ship whatever the environmental conditions might be. After more than 5000 ships serviced, interviewee INT1 estimated that the level of occurrence of major accidents was rare since no fatalities were recorded and only three accidents of this type came to his knowledge in Côte d'Ivoire: a pilot fallen in water, a crushed toe and a crushed ankle. The most common incidents remained missed step on the pilot ladder, shocks on articulations or injuries. However, these figures might change since minor incidents are not always reported. Finally, participant INT1 noticed than the psychological impact due the permanent risk factor or after an accident pushed some pilots to leave the corporation.

Figure 13: Embarkation of Boarding team (US Navy, 2021)

2.1.2 Links between risk scenarios

The conceptual framework, used for assessing the risks in this dissertation, grabbed scenarios which were most likely to affect the assets involved. However, the assets do not play a role in isolation of each other in reality. There are close links of interdependency between them to create a synergy of action. In this perspective, risks affecting one asset could have an impact on another. By the same token, developing RCMs for on asset could transfer risks to other assets. But, the method of assessment could not highlight those relationships using numerical values (Cox, 2009b). Thus, identifying those possible interconnections between risks scenarios was important to consider for the development of RCMs. These links could be a direct relationship or a direct or indirect consequence. For instance, a pilot ladder accident (BTH6) might

end with a boarding team member falling overboard (BTH5), consequently his equipment would fall as well (WH5 and CH5). Another example was the small craft and its crew which was targeted by a self-propelled explosive (ST3 and SCT3), the attack could indirectly ignite fire in the craft (SH7). Similarly, if fire threatened the vessel (VH7), its crew found itself in danger (VCH7). A complex case was a collision of the small craft (SH13) which might lead to a technical failure (SH17) but also to capsizing (SH14), then its crew ended in water (SCH5) and probably the boarding team could fall overboard with their equipment (BTH5, WH5 and CH5), if they were on board at that moment. Figure 14 shows some of the links between the risk scenarios. Therefore, addressing those risks required the consideration of these factors and stressed again the importance to protect all assets.

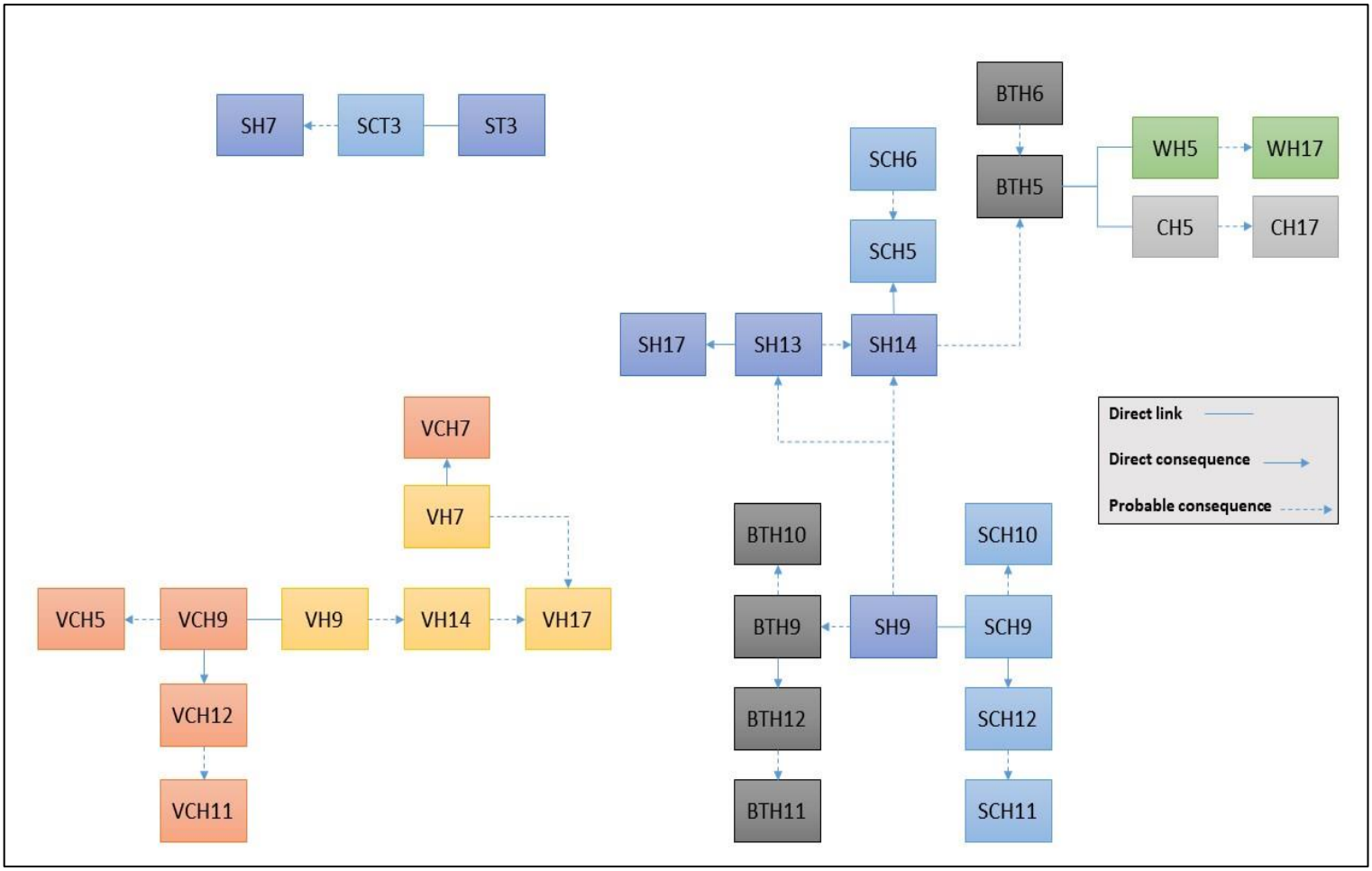

Figure 14: Links between risk scenarios (Author)

2.2 Methods of assessment

This dissertation used a novel research framework to analyse risks in naval operations. First, the results suggested that the qualitative and the quantitative methods of assessment led to similar results with two different samples. This observation confirmed that professional judgement and personal experience can be valuable in assessing risk in VBSS operations. The comparison of quantitative methods, based on the assumption that the operational value of one asset can influence the determination of RCOs, suggested that this factor did not impact significantly the scenarios and should not induce major changes in the implementation of RCOs. And lastly, the inclusion of respondents from the Nigeria Navy and the Senegal Navy highlighted the existence of common patterns which meant most issues were not specific to Côte D'Ivoire Navy only.

2.3 Risk management and risk communication

2.3.1 Training and equipment

The results suggested that the provision of equipment and the conduct of the right training were paramount to enable risk reduction in VBSS operations. Indeed, equipment serve as barriers to protect personnel from the consequences of probable accidents. They represent also a risk reduction factor in case personnel are targeted by hostile acts. NATO (2005) provided a comprehensive set of equipment which should be at the disposal of boarding party to ensure the safety of operations. Interviewee INT1 pointed lifejacket, helmet, shin guard and visual identification signs as requirement for a pilot. Also, participant INT2 added that a proper maintenance of all equipment should be a prerequisite for an optimal level of protection. For Interviewee INT3, a clear maintenance policy was also required. Concerning boarding arrangements, interviewee INT1 argued that ship owners should devote more resources to preserve their quality in accordance with requirements of the IMO (2011). However, fishing vessels can hardly fulfil those requirements because of poor maintenance, in addition to low freeboards which makes boarding operations more hazardous (Five associations, 2021). This point retained attention since fishing vessels were the type of vessels mostly visited (see figure 10).

Then, training comes to reinforce the capabilities by ensuring the right use of equipment and giving a clear understanding of the procedures and the challenges associated with these operations. It appears as a good channel to communicate about risks. As figure 9 showed, with the assumption that they all received training before, nearly three-quarters (20 participants) of the respondents in the questionnaire for risk assessment, which had less than five years of experience, gave a fair evaluation of the risks associated in boarding operations. Interviewee INT2 supported it by stating that good training can also complement the lack of clear procedures. Participant INT3 shared the same opinion but added the necessity of follow-up training. Nevertheless, this is not enough to ascertain that more years of practice and experience would not be more beneficial. This observation joined the point of view of INT1 who estimated that risk assessment was not part of the formal training of pilots but through the on-the-job learning process risk awareness was achieved.

2.3.2 Consideration for the nature of threats

The findings suggested that assets in VBSS operations are vulnerable to several threats. The successful completion of a risk scenario can have severe consequence. As stated in the literature review by Cox (2008a), using equations to assess risk in security obliterates the ability and the unpredictability of intelligent threats. Indeed, numerical value did not sufficiently describe planning, learning and adaptive re-planning of intelligent attackers. To overcome this problem, the probable attacker's responses to risk management recommendations should be considered in the defence preparation. Always in the idea of Cox (2008a), the aim was to optimize defences assuming that attackers would optimize their attacks accordingly. Addressing risks posed by those threats meant gathering information about them but also preventing them to obtain useful information. Referring back to figure 12, the identified potential adversaries usually wait for a window of opportunity in order to execute their plan. Dalaklis (2019) argued that motive coupled with opportunity were the two important element for the manifestation of threats. Therefore, reducing opportunities for those threats was required. To do so, law enforcement authorities relied on intelligence. As explained by Guilfoyle (2017), intelligence gathering is important for intercepting those threats.

2.3.3 Procedures

Boarding operations seemed to be procedural according to the findings, as described also in the literature. Even if the course of action is defined, uncertainties remain during different phases especially the boarding and search. Procedures contribute to risk mitigation by giving inputs or outputs for the process of operations. Interviewee INT3 argued that some initiatives were implemented but were functioning in isolation. For instance, all interviewees recognized the effectiveness of the protocols implemented by their organization to cope with the COVID-19 pandemic but acknowledged the reduction of operational capabilities they created in other aspects like human resources unavailability, limited time on duty, decrease of number of inspections. In figure 14, the environmental conditions could impact the small craft (SH9) and this could be the beginning of cascading events inducing risks to many assets. So, the definition of clear guidance to balance the inherent limitations of the platforms and equipment with weather conditions was a point to consider. Participant INT1 considered effectively the sea state as a contributing factor to accidents. Moreover, procedures play a role in the training of personnel. Indeed, certification of teams should include procedures to evaluate their training and medical fitness but also to ensure their continued proficiency. This point seemed to be important in specific case where teams are mixed with people from different organizations. Interviewees INT2 and INT3 also stressed the implementation of standard operating procedures (SOPs) which need to be approved by the top management in order to reduce the flexibility of personnel at sea who may not have the authority to support decisions particularly when risks are higher. Finally, as mentioned by NATO (2005), procedures for communication should be well established. In fact, reduction of risk could be achieved if information flows among all stakeholders. Every actor should give and receive inputs, like intelligence, environmental conditions, condition of the visited vessel, mission objectives, for the safety of operations.

2.3.4 Development of systematic risk assessment tools

The findings revealed that risk awareness was at an acceptable level. But the process of assessment for decision making was not clearly defined or was left to the appreciation of every stakeholder. The consequence was the introduction of subjectivity in the evaluation process. In this regard, one actor could have limited

overview of the situation. As interviewee INT2 mentioned less experienced personnel had a knowledge about dangers related to their equipment and their specific role but lack of overall risk awareness. This observation called for a systematic risk assessment process. In order to be effective, first, this process should involve all levels of responsibility in VBSS operations. Second, the process should ensure dissemination of relevant information through the chain of command. Finally, the process should be duly documented and recorded. The end result should be the standardization of the risk assessment procedures.

2.3.5 Organizational culture

The results showed a level of risk taking among actors in boarding operations. Interviewee INT2 explained it by stating that even if resources at disposal were not optimal, taking risks beyond capabilities was necessary for the protection of waters. Besides, military organizations are hierarchical in nature so the willingness of the top management or high command may be to overlook some risks in order to gain opportunities. A way to overcome this issue is sensitization and professionalism. Sensitization could increase the risk awareness while professionalism could incite people to work always within the limits of their capabilities. Furthermore, mitigation measures needed to get support from decision makers. Hence, the definition of key performance indicators (KPIs) was also a point for consideration. However, participants INT2 noticed difficulties to obtain statistical data to back up arguments. Interviewee INT1 pointed difficulties in convincing top management to make financial resources available. Similarly, he estimated that external factors, like the drive for profit in the maritime industry, push ship owners to reduce investments in necessary arrangements for boarding at sea. In any case risk assessment was important, as interviewee INT2 concluded: “risk assessment is linked to (our) capacity to fulfil the mission” because it helps getting the “so what”. For this reason, the development of “safety culture” was a prerequisite because “safety is a key element of success for all” (interviewee INT3).

CHAPTER VI CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the work in this dissertation and intends to propose recommendations according to the findings and discussions.

1. Conclusions

This dissertation endeavoured to apply risk analysis principles to frame measures which could mitigate effectively risks in VBSS operations in Côte D'Ivoire. The aim was to set the pathway for a safer environment for the assets contributing to the success of these operations. To meet this objective, this dissertation followed a conceptual research framework based on existing risk analysis frameworks. The first step was to identify the dangers, related to safety and security, and to estimate the risk level in order to develop risk scenarios. To do so, qualitative and quantitative methods of assessment, using surveys and questionnaires, were framed to evaluate principally the likelihood and the consequence of those dangers. The determination of factors influencing RCOs and the channels used for risk communication were the next two steps. The inputs were collected from personnel in the chain of command of boarding operations and they reflected their professional judgment and personal experience.

The findings demonstrated that VBSS operations hold a strategic role in conducting law enforcement at sea in Côte D'Ivoire. Despite the permanent risk factors, the level of occurrence of incidents can be considered marginal. However, the consequence of those incidents can be severe for assets involved. While human health is the value most at risk, risks are unequally distributed among assets. Additionally, there are direct or indirect links between risks scenarios which complicate the situation. Furthermore, the nature of threats and their motive make the outcome of an event more complex and severe. Also, the value of an asset does not influence the development of risk mitigation measures. Therefore, managing those risks requires a comprehensive approach which target specific areas for improvement.

The results also acknowledged that a level of risk acceptance is considered but the criteria are not clearly defined. The absence of a risk assessment tool may be a reason. As a consequence, personal experience guides the definition of RCMs, making them subjective and incomplete. In this aspect, those RCMs have variable

performance in bringing risks ALARP. For risk mitigation, efficient information sharing, capacity building through procedures, equipment and training and improving organizational behaviours are the recommended options. However, their effectiveness depends on the support and approval of the top management in the chain of command.

Finally, the observations showed that the methodology used can be suitable to analyse risks in VBSS operations as the outputs of different methods are convergent. According to Yoe (2019), risk assessments "… do not always produce the truth and they never produce decisions" (p. 103), they only provide information to risk managers. Hence, information in this dissertation obtained from experts' opinion in the field of study can be relevant for decision makers in Côte D'Ivoire Navy.

2. Recommendations

After analysis and discussions, the areas which needed improvement or attention led to the formulation of the following recommendations. These recommendations do not stand alone but function as a systems approach of physical and administrative barriers with four pillars, Training, Equipment, Organizational culture, and Procedures, which could be integrated to a safety management system (SMS) (Dalaklis, 2017b). Figure 15 summarizes the recommended options.

2.1.1 Prior to operations

- Training

No matter the role played in boarding operations, a high level of proficiency and specific skills are required. Côte D'Ivoire Navy should ensure that the personnel conducting these operations receive the adequate education and training. This training should also emphasize topics like risk awareness and risk assessment. A partnership with the corporation of pilots in the port of Abidjan should be beneficial for experience sharing especially for the best practices in embarkation and disembarkation.

- Equipment

Equipment represent one of the barriers preventing an accident or reducing its consequence. The personnel in these operations should wear the appropriate personal protective equipment (PPE) adapted to the marine environment but also to

the level of threats. Certainly, the procurement of those equipment should be made in collaboration with the users to ensure their suitability to the operational requirements. A particular attention should be devoted to the maintenance programme of those equipment to ensure they are always functioning at the optimal level of protection.

- Procedures

Another important point to consider is the development and the renewal of SOPs. To be effective, these procedures ought to be approved by the high command in Côte D'Ivoire Navy. The process of intelligence gathering and dissemination should involve every relevant actor and should be supported by clear communication procedures which come to enable the flow of information among all stakeholders. Information concerning weather forecasts, condition of vessels, level of threats, level of proficiency of the personnel must be collected and shared. Furthermore, the processes for qualification of personnel and vetting of equipment should be standardized in order to avoid disparities. Moreover, the top management in the navy should consider establishing rules of engagement (ROE). Those ROE must define as clearly as possible, for instance, the conditions for using weapons, the self-defence principles, the classification of threats and the prerogatives of each decision maker. Usually, procedures, like Go and No Go checklists, could be a starting point. Côte D'Ivoire Navy should also set up clear procedures for incident reporting. Finally, the inputs and outputs of those procedures are expected to be properly documented and archived by a designated authority.

- Organizational culture

As a military organization, risk has become an accepted parameter in Côte D'Ivoire navy operations. Côte D'Ivoire Navy should emphasize sensitization and professionalism to reduce complacency. Indeed, a new narrative about risks needs to be conveyed among the stakeholders. Risk should not be the norm and safety must always prevail. During planning, training, and briefings, risks should be discussed and measures to mitigate them must be identified. But also, at the decision making level, the need for a right balance between the necessity of the mission, the limitations of assets and the prerogatives of decision makers should be understood.

2.1.2 During operations

- Equipment

During operations, the personnel should continuously monitor the state of their equipment to ensure their effectiveness has not been compromised at any point of time.

- Procedures

As discussed, boarding operations can have uncontrollable factors like people behaviours, weather or conditions of vessel encountered. Those factors can create uncertainties in the process of managing risks. So, risk necessitates to be evaluated on-scene too. To do so, the OSC should rely on a clear and consistent process. Côte D'Ivoire Navy should consider to implement a model similar to the GAR tool developed by the USCG. This process should be systematically documented and reported to the MOC for top management's decision if necessary. Nothing should also prevent the BO to repeat this procedure for his own specific tasks. In addition, the personnel deployed at sea should possess a comprehensive contingency plan to respond to emergencies and unexpected events.

- Organizational culture

From an organizational standpoint, reporting any incident or near miss should become the norm and attention should be devoted to encourage this culture.

2.1.3 After operations

Following operations, all relevant data and information should be analysed and the feedback recorded. It will provide inputs for improvement of planning and for statistical studies. At the end, the normalisation of this process will facilitate the measurement of KPIs and the implementation of corrective measures.

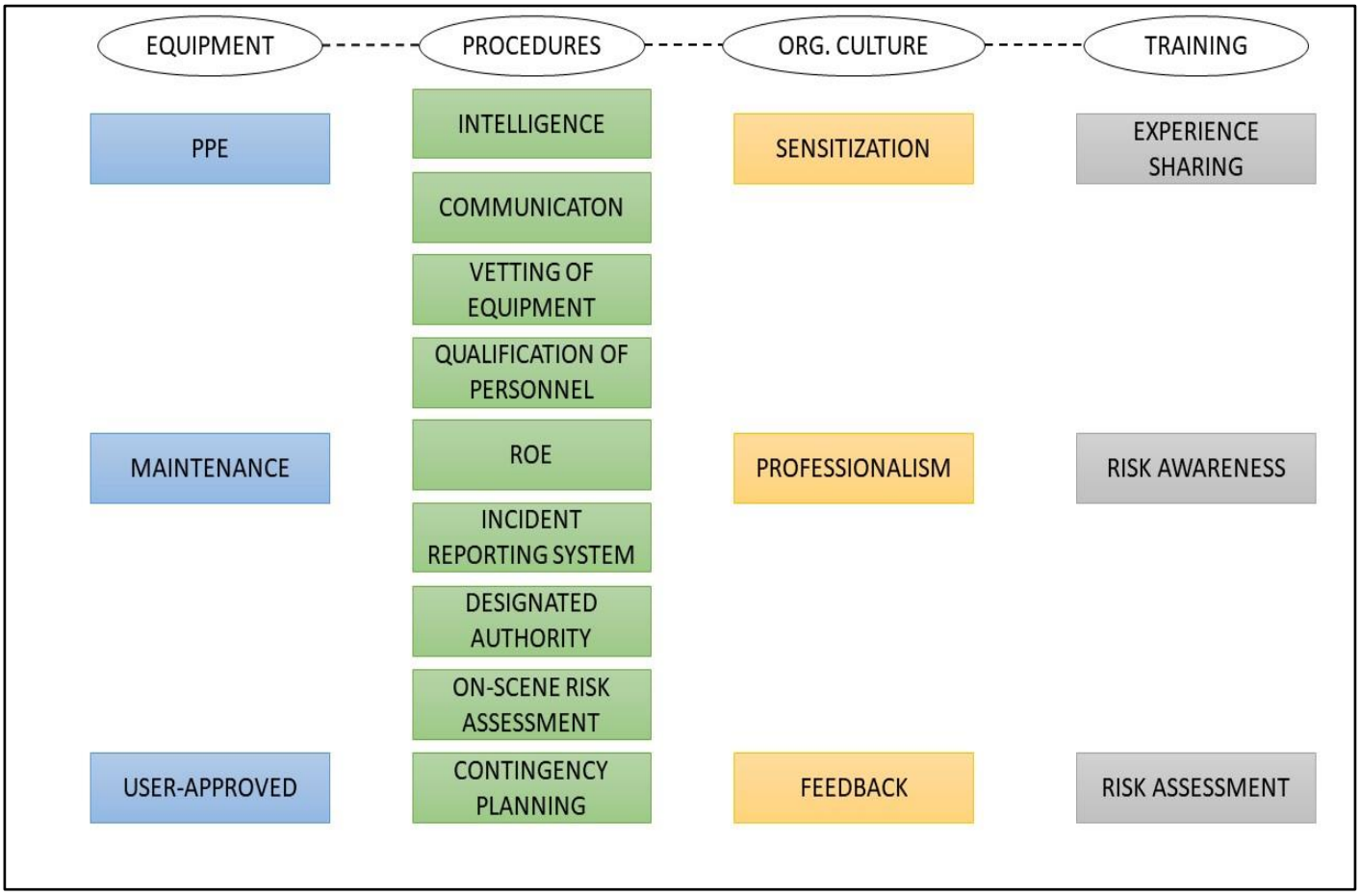

Figure 15: Recommendations for Risk control options (Author)

3. Contribution to knowledge

This dissertation proved that experts' judgement for the estimation of probability of high-severity rare incidents can produce relevant information for decision makers. Furthermore, it showed that the combination of a qualitative and a quantitative risk assessment model could bridge the gap and have valuable outputs. In addition, this research contributed to risk analysis studies in the maritime field in the sense that it framed a methodology applicable to naval operations not only in Côte D'Ivoire but also in countries of the GoG.

4. Recommendations for future research

At this point, further studies could integrate statistical models to calibrate the risk scenarios highlighted and reduce the reliance on experts' opinion. However, the low number of incidents may require records over a long period of time or a large sample of law enforcement organizations. The psychological and societal impacts due to permanent risk factors and serious injuries could be investigated further to evaluate their effects on the dynamic of operations.

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Appendix A

Risk profile. Yoe (2019)

- Latest statement of the problem
- Description of the hazard or opportunity involved
- How assets are exposed to the hazard
- Frequency, distribution, and levels of occurrence of the hazard
- Identification of possible risks from the available scientific literature
- Nature of values at risk (human health, economic, cultural, etc.)
- Distribution of the risk and benefits from the risky activity
- High level or preliminary assessment or prioritization of the risks
- Characteristics of available risk management options
- Current risk management practices relevant to the issue
- Public perceptions of the potential risks
- Information about possible risk management (control) measures
- Preliminary identification of important scientific data gaps that may prevent or limit a risk assessment
- International implications of risk management
- Risk management objectives
- Decision to pursue a risk assessment
- Questions to be answered by risk assessment

Appendix B

QUESTIONS FOR RISK PROFILE

Generalities

1. In which type of naval operations is it necessary to conduct to do a boarding?

2. What are the assets engaged in Visit board search and seizure operations?

3. What are the inherent dangers of these types of operations?

4. How many ships are necessary to conduct these operations?

None/1/2/3/more than 3

5. How many personnel is necessary to carry out the tasks?

1-10/11-20/21-30/31-50/51-100/more than 100

6. How many small craft is necessary to carry out the tasks?

None/1/2/3/more than 3

Description of risks

7. How are assets exposed to the hazards?

8. How many boarding do you conduct in a year?

1-10/11-20/21-30/31-50/51-100/more than 100

9. How often do you have an incident or accident during these operations?

10. Is the danger always present?

11. Which hazards are most likely to be recurrent?

12. What are the values put at risk in these operations?

Human health/cultural/geostrategic/environment/political/other (specify)

13. How do you describe the worst incident you had in these operations?

14. Are the risks equally distributed among the assets?

15. Which assets are most likely to be affected?

Management of risks

16. What can be a good reason to put your assets at risk?

17. Which tool do you use to assess risks in your organization?

18. How do you differentiate the safety hazards from the security threats?

19. What are the main characteristics of your risk control options?

20. How are risks in these operations currently mitigated in your organization?

21. Do you have a contingency plan for an incident in these operations?

22. How do you measure the effectiveness of the risk management practices?

23. What is the role of the top management in Visit board search and seizure operations?

24. How risks are taken into account in the decision making?

25. What are the requirements which influence the implementation of risk control measures?

26. How do you determine the level of risk acceptance?

27. In your opinion, what is the value of risk assessment in these operations?

no value added/relevant/no opinion

For your organization particularly? *no value added/relevant/no opinion*

28. Can you provide two questions in relation to risk you think this study should answer?

Appendix C

QUESTIONS FOR RISK ASSESSMENT

This study intends to analyse risks in Visit board search and seizure Operations in Côte D'Ivoire Navy to find out an "acceptable in terms of risk" method to use, as well as to further develop the Risk Control Measures which could be used to mitigate these risks effectively.

For the purpose of the research, it will be considered only the risks incurred by the assets directly involved in the conduct of those operations (**humans, vessels and equipment**)

GUIDELINES

PLEASE READ CAREFULLY THE INSTRUCTIONS BELOW:

- If you do not know a "clear" answer to a question or if the question does not apply, please do not provide input.
- Please note that operations refer to Visit Board Search and Seizure operations (unless otherwise specified in the relevant instructions).
- Please note that all questions refer to the components directly involved in Visit board search and seizure Operations (unless otherwise stated).
- Always answer the questions having in mind YOUR role in the operations.
- Please DO NOT use abbreviations or acronyms
- The potential sensitivity of some questions has been acknowledged. Confidentiality of the respondents is ensured. Individual answers are/will be not identified in any circumstances.
- This questionnaire requires approximately 30 minutes/up to an hour to be completed.

SECTION 1: IDENTIFICATION OF HAZARDS

1. Which of the following risks do you think apply to Visit board search and seizure operations (can affect humans, vessels or equipment)?

Biological hazards	Navigational risks	Occupational safety and health	Security matters	Fire risk	Chemical hazards	Others (specify)

2. To which level do you estimate the risks during the following stages of these operations?

	Very low	Low	Medium	High	Very high	Extremely high
Pre-boarding activities (approach, interception, query)						
Boarding activities (active boarding, search, takedown)						
Post-boarding						

activities (seizure, diverting)						

SECTION 2: LIKELYHOOD OF HAZARDS

- For the **questions 3 to 9**, please consider the marking system below:

Frequent	Likely to occur once in 3 boardings
Reasonably probable	Likely to occur once in 10 boardings
Remote	Likely to occur once in 100 boardings
Very remote	Likely to occur once in 10 000 boardings

3. To which extent **boarding team member** involved in these operations are exposed to the following hazards?

4. To which extent **vessel** involved in these operations are exposed to the following hazards?

5. To which extent **small craft** involved in these operations are exposed to the following hazards?

6. To which extent **equipment (communication)** involved in these operations are exposed to the following hazards?

7. To which extent equipment (service weapons) involved in these operations are exposed to the following hazards?

8. To which extent **small craft's crew member** involved in these operations are exposed to the following hazards?

9. To which extent **vessel's crew member** involved in these operations are exposed to the following hazards?

	Very remote	Remote	Reasonably probable	Frequent
Harmful substances (dangerous cargo, biohazards, chemicals)				
illness (Covid 19)				
Burns				
Electric shock				
Falling overboard				
Pilot ladder accident				
Fire				
Submerged objects				
Weather (Storms, Sea state, lighting)				
Injury (fall, slip, trip)				
Fatigue				
Stress				
Other ship (Collision)				
Capsizing				

Grounding				
Fire weapons				
Sharp objects (cut)				
Bladed weapons/ blunt weapons				
Explosives				
Technical failure				
Confined spaces				
Self-propelled explosive (missile, torpedo, rocket)				
Others (specify)				

SECTION 3: NATURE OF SECURITY THREATS

10. Which one of the following can be a potential adversary? (check 5 responses)

Seafarer/Fisherman (industrial)/Fisherman (artisanal)/Drug trafficker/Seasonal fisherman/Terrorist/Pirate/Passenger/Oil rig worker/Other

11. Which types of ships are most likely to be boarded? (Check 4 responses)

Merchant vessel (container, tanker, bulk carrier)/Fishing boat (artisanal)/Fishing vessel (industrial)/Pleasure boat/Fishing boat (leisure fishing)/tug boat/Cruise or Passenger ship/Ferry/Offshore vessel/Other (specify)

12. Are these threats present or thought to be present? (**Existence**) (use Y/N table below)

13. Do the adversaries have to **capability** to carry out attacks using: (use Y/N table below)

14. What attacks has the potential adversary committed in the past? (**history**) (use Y/N table below)

	Yes	No
Handgun		
Blunt weapon		
Bladed weapon		
Missile/ torpedo		
Machine gun		
Rifle		
Rocket propeller		
Artillery		
Explosives		

15. Do you know if an adversary is performing surveillance on the key assets? (**targeting**)

	Yes	No
Boarding team member		
Vessel's crew member		
Small craft's crew member		
Communication equipment		
Small craft		
Navy vessel		
Service weapon		

16. What does the potential adversary hope to achieve? (**intention**)

SECTION 4: ASSET VALUE

17. How do you evaluate the **value** of the following assets? (consequence of damage or loss on the fulfilment of the mission)

Please consider the marking system below:

Very high	Exceptionally grave consequences
High	Grave consequences
Medium high	Serious consequences
Medium	Moderate to serious consequences
Medium low	Moderate consequences
Low	Minor consequences
Very low	Negligible consequences

	Very low	Low	Medium low	Medium	Medium high	High	Very high
Boarding team member							
Navy vessel's crew member							
Small craft's crew member							
Communication equipment							
Small craft							
Navy vessel							
Service weapon							

SECTION 5: IMPACT ON HUMANS AND EQUIPEMENT

- For the **questions 18 to 20**, please consider the marking system below:

Severity	**Effects on humans**
Negligible	Single or minor injuries
Significant	Multiple or severe injuries
Critical	Single fatality or multiple severe injuries
Catastrophic	Multiple fatalities

18. How do you evaluate the effects of the following hazards on **Boarding team member**?

19. How do you evaluate the effects of the following hazards on **vessel's crew member**?

20. How do you evaluate the severity of the following hazards on **Small craft's crew member**?

	Negligible	Significant	Critical	Catastrophic
Harmful substances (dangerous cargo, biohazards, chemicals)				
illness (Covid 19)				

Burns				
Electric shock				
Falling overboard				
Pilot ladder accident				
Fire				
Submerged objects				
Weather (Storms, Sea state, lighting)				
Injury (fall, slip, trip)				
Fatigue				
Stress				
Other ship (Collision)				
Capsizing				
Grounding				
Fire weapons				
Sharp objects (cut)				
Bladed weapons/ blunt weapons				
Explosives				
Technical failure				
Confined spaces				
Self-propelled explosive (missile, torpedo, rocket)				
Others (specify)				

- For the **questions 21 to 24**, please consider the marking system below:

Severity	**Effects on equipment**
Negligible	No significant damage
Significant	Minor damage (able to function partially)
Critical	Severe damage (not able to function at all)
Catastrophic	Destruction or total loss

21. How do you evaluate the effects of the following hazards on **Vessel**?
22. How do you evaluate the effects of the following hazards on **Small Craft**?
23. How do you evaluate the effects of the following hazards on **Equipment (communication)**?
24. How do you evaluate the effects of the following hazards on **Equipment (service weapons)**?

	Negligible	Significant	Critical	Catastrophic
Harmful substances (dangerous cargo, biohazards, chemicals)				

illness (Covid 19)				
Burns				
Electric shock				
Falling overboard				
Pilot ladder operation				
Fire				
Submerged objects				
Weather (Storms, Sea state, lighting)				
Injury (fall, slip, trip)				
Fatigue				
Stress				
Other ship (Collision)				
Capsizing				
Grounding				
Fire weapons				
Sharp objects (cut)				
Bladed weapons/ blunt weapons				
Explosives				
Technical failure				
Confined spaces				
Self-propelled explosive (missile, torpedo, rocket)				
Others (specify)				

SECTION 6: VULNERABILITY

25. How much do you estimate the **level of protection** of the following assets:

	Boarding team member	Vessel's crew member	Small craft's crew member	Vessel	Small craft	Service weapon	Communication equipment
Vulnerable to bladed weapons or blunt weapons							
Vulnerable to small arms fire (handgun)							
Vulnerable to light anti-armour weapons (rifle)							
Vulnerable to medium anti-armour weapons fire							

(machine gun, explosives)							
Vulnerable to heavy anti-armour fire or specialized weapons (rocket propeller, naval artillery)							
Invulnerable to all but the most extreme targeting measures (Missile, torpedo)							

SECTION 7: RISK MANAGEMENT

Questions	strongly disagree	Disagree	No opinion (neutral)	agree	strongly agree
26- the current practices in my organization can mitigate the risks mentioned					
27- the risks in these operations are known by every actors					
28- the top management in your organization consider the risks in the decision making					
29- the top management plays an important role in risk management					
30- risk assessment is a common practice in your organization					
31- your organization has developed a risk assessment tool for these operations					
32- risk assessment is part of my training					
33- I know what to do in case of an incident occurred					
34- Taking risk is necessary to fulfil the mission					

SECTION 8: ADDITIONAL INFORMATION

35. What is your current position in your organization?

36. What is your experience in Visit board search and seizure Operations? (position held in the past or training)

37. How many years of experience do you have in these operations?

00/1-5/6-10/11-15/16-20/more than 20

38. Excluding the questions in this questionnaire, can you please provide more information on the risks in these operations?

Appendix D

QUESTIONS INTERVIEW

This study intends to analyze risks in Visit board search and seizure Operations in Côte D'Ivoire Navy to find out an "acceptable in terms of risk" method to use, as well as to further develop the Risk Control Measures which could be used to mitigate these risks effectively.

For the purpose of the research, it will be considered only the risks incurred by the assets directly involved in the conduct of those operations (humans, vessels and equipment)

1. Can you describe how a person embarks and disembarks a ship?
2. How often do you have incidents or accidents in your job (affecting your own resources)?
3. What are the most recurring incidents?
4. What can the worst accident of your career look like?
5. What factors have contributed to such a scenario?
6. Do you think that you have an adequate level of protection against the risks associated with this maneuver?
7. What specific measures could improve this level of protection?
8. What protective measures have you taken during the COVID19 pandemic?
9. What other measures can be implemented to reduce the consequences of an accident?
10. Has your organization performed a risk assessment in these operations?
11. What can be done to improve risk management for this kind of maneuver?
12. How important is risk assessment in your training?
13. What can be the challenges related to the development of a risk assessment tool for boarding operations?
14. How many years of experience do you have in this corporation?
15. Can you give a figure for the number of maneuvres you have performed in your career?

Appendix E

- **Value** (Asset criticality (Bennet, 2018))

Operational value index		
OVI	Value	Definition (damage or loss)
10	Very high	Exceptionally grave consequences
9	High	Grave consequences
7	Medium high	Serious consequences
6	Medium	Moderate to serious consequences
4	Medium low	Moderate consequences
3	Low	Minor consequences
1	Very low	Negligible consequences

- **Severity** (IMO, 2002)

SI	Severity	Effects on human	Effects on ship or equipment
1	Negligible	Single or minor injuries	No significant damage
2	Significant	Multiple or severe injuries	Minor damage (able to function partially)
3	Critical	Single fatality or multiple severe injuries	Severe damage (not able to function at all)
4	Catastrophic	Multiple fatalities	Destruction or total loss

- **Frequency** (IMO, 2002)

FI	Frequency	Definition
7	Frequent	Likely to occur once in 3 boardings
5	Reasonably probable	Likely to occur once in 10 boardings
3	Remote	Likely to occur once in 100 boardings
1	Very remote	Likely to occur once in 10 000 boardings

Appendix F

- **Value index** (Asset criticality (Bennet, 2018))

Operational value index		
OVI	Value	Definition (damage or loss)
10	Very high	Exceptionally grave consequences
9	High	Grave consequences
7	Medium high	Serious consequences
6	Medium	Moderate to serious consequences
4	Medium low	Moderate consequences
3	Low	Minor consequences
1	Very low	Negligible consequences

- **Threat level** (the commonwealth of Kentucky office of Homeland security) (Bennet, 2018)

Threat index						
TI	Threat level	Existence	Capability	History	Intention	Targeting
5	Severe	X	X	X	X	X
4	High	X	X	X	X	O
3	Yellow	X	X	X	O	
2	Blue	X	X	O		
1	Green	X	O			

X = factor must be present; O = factor may or may not be present

- **Vulnerability** (CARVER target analysis tool) (Bennet, 2018)

Vulnerability index	
VI	Definition
10	Vulnerable to bladed weapons or blunt weapons
9	Vulnerable to small arms fire (handgun)
7	Vulnerable to light anti-armor weapons (rifle)
5	Vulnerable to medium anti-armor weapons fire (machine gun, explosives)
3	Vulnerable to heavy anti-armor fire or specialized weapons (rocket propeller, naval artillery)
1	Invulnerable to all but the most extreme targeting measures (Missile, torpedo)

Appendix G

List of participants: Questionnaire for risk profile

Participants	Organization
RP1	Côte D'Ivoire Navy
RP2	
RP3	
RP4	
RP5	
RP6	
RP7	
RP8	
RP9	
RP10	
RP11	
RP12	
RP13	
RP14	
RP15	SEPCIM-AEM (Côte D'Ivoire)
RP16	CRESMAO
RP17	Senegal Navy
RP18	Nigeria Navy

List of participants: Questionnaire for risk assessment

Participants	Position	Organization
RA1	Commanding officer	Côte D'Ivoire Navy
RA2	Commanding officer	
RA3	Commanding officer	
RA4	Executive officer	
RA5	Executive officer	
RA6	Executive officer	
RA7	Executive officer	
RA8	Executive officer	
RA9	Staff officer	
RA10	Boarding officer	
RA11	Boarding officer	
RA12	Boarding team member	
RA13	Boarding team member	
RA14	Boarding team member	
RA15	Boarding team member	
RA16	Boarding team member	
RA17	Boarding team member	
RA18	Boarding team member	
RA19	Boarding team member	
RA20	Boarding team member	
RA21	Boarding team member	
RA22	Small craft's crew	
RA23	MOC officer	
RA24	MOC chief	Senegal Navy
RA25	Commanding officer	
RA26	Commanding officer	
RA27	Commanding officer	
RA28	Staff officer	Nigeria Navy

List of participants: Interview

Participants	Position	Organization
INT1	Port pilot	Port of Abidjan
INT2	Commanding officer	Côte D'Ivoire Navy
INT3	Chief of Operations bureau	

Appendix H

ASSETS	
Boarding team member	BT
Vessel's crew	VC
Small craft's crew	SC
Vessel	V
Small craft	S
Communication equipment	C
Service weapon	W

HAZARDS	
Harmful substances (dangerous cargo, biohazards, chemicals)	H1
illness (Covid 19)	H2
Burns	H3
Electric shock	H4
Falling overboard	H5
Pilot ladder operation	H6
Fire	H7
Submerged objects	H8
Weather (Storms, Sea state, lighting)	H9
Injury (fall, slip, trip)	H10
Fatigue	H11
Stress	H12
Other ship (Collision)	H13
Capsizing	H14
Grounding	H15
Sharp objects (cut)	H16
Technical failure	H17
Confined spaces	H18
Others (specify)	H19

THREATS	
Fire weapons	T1
Bladed weapons/ blunt weapons	T2
Explosives	T3
Self-propelled explosive (missile, torpedo, rocket)	T4
Others (specify)	T5

Appendix I

BT					
	RI 1	RI 2		RI 1	R 2
H1	7	15.60714286	T1	18.82417582	27.43131868
H2	7.75	16.35714286	T2	18.21703297	26.82417582
H3	5.69047619	14.29761905	T3	18.82417582	25.43131868
H4	5.973544974	14.58068783	T4	14.07020757	22.67735043
H5	6.944444444	15.5515873	T5		
H6	7	15.60714286			
H7	6.178571429	14.78571429			
H8	5.611111111	14.21825397			
H9	6.714285714	15.32142857			
H10	6.714285714	15.32142857			
H11	6.857142857	15.46428571			
H12	6.5	15.10714286			
H13	5.25	13.85714286			
H14	5.857142857	14.46428571			
H15	4.857142857	13.46428571			
H16	6.678571429	15.28571429			
H17	6.25	14.85714286			
H18	6.321428571	14.92857143			
H19		8.607142857			

VC					
	RI 1	RI 2		RI 1	RI 2
H1	6	14	T1	14.50328042	22.50328042
H2	6.285714286	14.28571429	T2	13.61571429	21.61571429
H3	5.666666667	13.66666667	T3	14.25857143	22.25857143
H4	5.357142857	13.35714286	T4	11.85513228	19.85513228
H5	6.056878307	14.05687831	T5		
H6	5.642857143	13.64285714			
H7	6.192307692	14.19230769			
H8	4.857142857	12.85714286			
H9	6.464285714	14.46428571			
H10	5.571428571	13.57142857			
H11	6.392857143	14.39285714			
H12	6.321428571	14.32142857			
H13	5.357142857	13.35714286			
H14	5.535714286	13.53571429			
H15	4.645502646	12.64550265			
H16	5.582010582	13.58201058			
H17	5.857142857	13.85714286			
H18	5.142857143	13.14285714			
H19		8			

SC					
	RI 1	RI 2		RI 1	RI 2
H1	6.037037037	13.89417989	T1	16.34656085	24.2037037
H2	6.5	14.35714286	T2	15.88624339	23.74338624
H3	5.653439153	13.51058201	T3	16.13624339	23.99338624
H4	5.481481481	13.33862434	T4	13.3505291	21.20767196
H5	6.928571429	14.78571429	T5		
H6	6.464285714	14.32142857			
H7	5.974867725	13.83201058			
H8	5.285714286	13.14285714			
H9	6.785714286	14.64285714			
H10	6.607142857	14.46428571			
H11	7.071428571	14.92857143			
H12	7	14.85714286			
H13	5.456349206	13.31349206			
H14	5.892857143	13.75			
H15	4.55026455	12.40740741			
H16	5.878306878	13.73544974			
H17	5.617724868	13.47486772			
H18	5.174603175	13.03174603			
H19		7.857142857			

V					
	RI 1	RI 2		RI 1	RI 2
H1	5.142857143	13.21428571	T1	13.36857143	21.44
H2	5.892857143	13.96428571	T2	12.58285714	20.65428571
H3	4.964285714	13.0357142 9	T3	13.72571429	21.79714286
H4	5.392857143	13.46428571	T4	11.72571429	19.79714286
H5	5.21978022	13.29120879	T5		
H6	5.428571429	13.5			
H7	6.642857143	14.71428571			
H8	5.37037037	13.44179894			
H9	6.928571429	15			
H10	5.357142857	13.42857143			
H11	5.785714286	13.85714286			
H12	5.392857143	13.46428571			
H13	5.892857143	13.96428571			
H14	6	14.07142857			
H15	5.571428571	13.64285714			
H16	5.5	13.57142857			
H17	7.214285714	15.28571429			
H18	5.349206349	13.42063492			
H19		8.071428571			

S					
	RI 1	RI 2		RI 1	RI 2
H1	5	13.28571429	T1	14.69510582	22.98082011
H2	5.285714286	13.57142857	T2	13.99669312	22.28240741
H3	4.936507937	13.22222222	T3	14.59722222	22.88293651
H4	5.367724868	13.65343915	T4	12.56547619	20.85119048
H5	5.773809524	14.05952381	T5		
H6	5.607142857	13.89285714			
H7	6	14.28571429			
H8	5.732804233	14.01851852			
H9	7.214285714	15.5			
H10	5.857142857	14.14285714			
H11	5.821428571	14.10714286			
H12	5.321428571	13.60714286			
H13	6	14.28571429			
H14	6.071428571	14.35714286			
H15	4.802910053	13.08862434			
H16	5.75	14.03571429			
H17	6.504273504	14.78998779			
H18	4.671957672	12.95767196			
H19		8.285714286			

W					
	RI 1	RI 2		RI 1	RI 2
H1	3.902116402	11.93783069	T1	12.16239316	20.19810745
H2	3.720899471	11.75661376	T2	11.11111111	19.1468254
H3	3.82010582	11.85582011	T3	12.90425315	20.93996744
H4	4.431318681	12.46703297	T4	10.59340659	18.62912088
H5	6.607142857	14.64285714	T5		
H6	4.554945055	12.59065934			
H7	5.321428571	13.35714286			
H8	4.03968254	12.07539683			
H9	4.338624339	12.37433862			
H10	4.341269841	12.37698413			
H11	4.129984127	12.16269841			
H12	4.088624339	12.12433862			
H13	4.146825397	12.18253968			
H14	4.726190476	12.76190476			
H15	3.663817664	11.69953195			
H16	3.91025641	11.9459707			
H17	6.035714286	14.07142857			
H18	4.011904762	12.04761905			
H19		8.035714286			

C					
	RI 1	RI 2		RI 1	RI 2
H1	3.642857143	11.17857143	T1	13.07738095	20.61309524
H2	4.142857143	11.67857143	T2	12.70568783	20.24140212
H3	3.854497354	11.39021164	T3	14.25595238	21.79166667
H4	5.5	13.03571429	T4	11.89880952	19.43452381
H5	6.506157635	14.04187192	T5		
H6	4.312169312	11.8478836			
H7	4.857142857	12.39285714			
H8	4.142857143	11.67857143			
H9	5.962962963	13.49867725			
H10	3.753968254	11.28968254			
H11	3.871693122	11.40740741			
H12	4.126984127	11.66269841			
H13	3.597883598	11.13359788			
H14	4.386243386	11.92195767			
H15	3.642857143	11.17857143			
H16	3.678571429	11.21428571			
H17	7.357142857	14.89285714			
H18	4.037037037	11.57275132			
H19		7.535714286			

Appendix J

	trongly disagree	disagree	neutral	agree	strongly agree	otal respondents	score	
	1	2	3	4	5			
Q26	5	7	6	9	1	28	2.785714286	2.8
Q27	3	2	3	13	7	28	3.678571429	3.7
Q28	4	3	6	10	5	28	3.321428571	3.3
Q29 (R)	7	5	10	3	3	28	3.357142857	3.4
Q30	3	5	6	10	4	28	3.25	3.3
Q31	7	8	5	7	0	27	2.444444444	2.4
Q32 (R)	6	8	7	5	2	28	3.392857143	3.4
Q33	5	2	5	11	5	28	3.321428571	3.3
Q34 (R)	3	0	6	11	8	28	2.25	2.3