



Examining the Level of Maritime Domain Awareness in Lake Victoria-Kenya

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ABSTRACT

Maritime Domain Awareness (MDA) is a prerequisite for effective governance facilitating regulatory enforcement to safeguard against illicit maritime activities. This paper attempts to examine the level of MDA in Lake Victoria, Kenya, focusing on the identification of capacity for monitoring and surveillance. Similarly, information sharing and integration practices, capability to safeguard maritime domain through emergency response or enforcement action are assessed and improvement measures proposed. A mixed methodology was utilized, where secondary sourced from academic publications provided the conceptual background and practice of the MDA. The primary data was collected through surveys, targeting frontline officers from the maritime regulator, Coast Guard, Fisheries Service, Port, Border Police, customs, among other agencies. Additionally, benchmarking of MDA situation at the Kenyan coast (Mombasa RMRCC) and Nigerian coast (NIMASA Deep Blue Project) against MDA situation in Lake Victoria was undertaken. The findings established artisanal fishing, transportation of petroleum products, various cargo, and passengers as the leading maritime activities. The existing MDA system is mainly dependent on human sources (fishers and passengers) who share valuable information with enforcement officers. The main challenges identified include inadequate personnel, equipment and fuel provision. For future improvement, strengthening community and stakeholder collaboration, and enhancing information sharing are suggested.

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1. Introduction.

Lake Victoria is the second-largest freshwater lake in the world and the largest in Africa covering about 68,800 square kilometers, located within the East African Rift Valley system. The Lake is shared amongst Kenya, Uganda, and Tanzania, in the respective portions of 6%, 43%, and 51%; the Lake Victoria Basin is inhabited by a population of over 40 million whose livelihood directly or indirectly depends on the ecosystem (IS-COS, 2022). See Fig 1. below showing the map of Lake Victoria in blue and the wider Lake Victoria Basin in yellow, traversing across five East African countries.

Figure 1: Map Showing Lake Victoria Basin.



Source: Gumisiriza et. al. (2009).

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Organized transportation of cargo and passengers on the Lake was introduced by railway companies early in the 20th century as a connecting link and a natural extension of the railway lines in the Lake region, thus, coordinated lake marine transport in Uganda, Kenya, and Tanzania was managed by these railway companies (Naknyoyi, 2011). The East Africa Railways and Harbours Corporation (EARH), was established by the British authorities in East Africa following the merger of Kenya and Uganda Railways and Harbours, with the Tanganyika Railways; it operated shipping services from 1948 to 1967 after which East African Community (EAC) assumed the operations until its disintegration in 1977. Henceforth, shipping in the Lake was managed by Kenya Railways Corporation, Tanzania Railways Corporation, and Uganda Railways Corporation until 1985 when the three States made bilateral agreements that revived wagon ferry operations between the ports of Jinja, Mwanza, and Kisumu (Naknyoyi, 2011). Over time, shipping declined remarkably due to poor maintenance, poor state of navigation aids, outdated hydrographic charts, limited investment, and inefficiency leaving the once busy inland waterways transport system and crucial regional economic pillar in a state of neglect (Budi et al., 2023).

In recent times, Kenya, Uganda, and Tanzania have initiated revival of activities in Lake Victoria as evidenced by the construction and rehabilitation of MV Uhuru I, and MV Uhuru II, 90- and 100-metre-long wagon ferries for transportation of liquid and dry cargo between the ports in Lake Victoria. Additionally, the establishment of state-owned Kenya Shipyards Limited in Kisumu, the construction of the Kisumu pipeline jetty, the revival of operations of Kisumu Port and key landing sites, the establishment of Kenya Coast Guard Service (KCGS) for enforcement of maritime regulations attests to the revival. On the other hand, Uganda's efforts saw the construction and operationalization of MV Kabaka Mutebi II, a 118metre long and 4700-ton tanker vessel transporting petroleum products from Kisumu Port to the newly constructed 70 million litres capacity storage tanks at Bugiri-Bukasa in Entebbe. The operationalization of eleven ferries and two vessels (MV Kawa and MV Pamba) by Uganda's National Roads Authority and Railway Corporation according to the Northern Corridor Strategic Plan (2022-2026) signifies the revival. Similarly, Tanzania with the largest share of the Lake, constructed and operationalized Ro-Ro/Passenger ferry (MV Mwanza) and passenger and cargo vessel (MV Ukara II) in Mwanza and refurbished another passenger vessel (MV New Victoria) which operated scheduled routes between Mwanza and Bukoba ports via Kemondo Bay Port.

Under the auspices of the EAC, the Lake Victoria Basin Commission (LVBC), supported by African Development Bank (AfDB) was implementing the Multinational Lake Victoria Maritime Communication and Transport project (MLVMCT), to set up a maritime communication network, search and rescue centres, aiming to address safety, efficiency, affordability, and environmental sustainability in the Lake (AfDB, 2016). Besides, Kenya and Uganda had embarked on rehabilitation projects for the meter gauge railway system forming part of the multi-modal transport network to facilitate cargo haulage from Kisumu Port onto the marine vessels for shipping to Port Bell in Uganda, and

onwards to Burundi, Rwanda, Democratic Republic of Congo (DRC). Apart from shipping activities involving conventional vessels, there were thousands of non-SOLAS watercraft operated in the Lake which according to the Africa Development Bank (2016), were estimated to be about 70,000 as of the year 2016, mainly used for artisanal fishing, tourist excursion, and passenger transport linking several islands dotting the Lake.

This paper is a product of the Master of Science dissertation at the World Maritime University (WMU), titled *Sea vision or Sea blindness in Inland Waters: The State of Maritime Domain Awareness in Lake Victoria, Kenya*. The initial research effort involved the collection of primary data which is raw, unprocessed data collected by researchers by way of questionnaires, interviews, or observations (Ajayi, 2023). This was achieved through survey questionnaires being completed by frontline officers mainly working for regulatory and enforcement agencies in Lake Victoria such as Kenya Maritime Authority (KMA), Kenya Coast Guard Service (KCGS), Kenya Fisheries Service (KeFS), Kenya Ports Authority (KPA), Border Police Unit (BPU), Kenya Revenue Authority (KRA) among others.

In the research effort, a survey questionnaire, defined by DeVaus (2002), as cited by (Saunders et al. 2009), as a technique of data collection designed in a way that respondents answer similar questions in a predefined sequence, was used. The questionnaire included both close-ended and open-ended questions to capture numerical data and opinions or views of respondents for purposes of quantitative and qualitative analysis to bring out both apparent and obscure aspects of the research topic. The secondary data, defined by Saunders et. al. (2009) as data in raw or processed form collected by other individuals or entities but preferred for use by a researcher to meet the needs of their studies, in this case, was obtained from academic journals, books, websites of reputable organizations such governmental, intergovernmental and international institutions, internal government reports, publications, and records.

Further, a comparison was made between the state of affairs in Lake Victoria with the MDA system for Kenya's coast as a local benchmark and the MDA system of Nigeria as a regional benchmark. Thus, a comparative questionnaire was administered to the Mombasa Regional Maritime Rescue Coordination Centre (RMRCC), one of the key players in Kenya's coastal maritime domain, and, the Deep Blue Project (C4i Centre) operated by the Nigeria Maritime Administration and Safety Agency (NIMASA). Nigeria's MDA was considered for benchmarking because of the intensive enhancement of monitoring and surveillance capability in recent years in the fight against piracy, armed robbery, and other illicit maritime activities in the Nigerian Exclusive Economic Zone and by extension, the Gulf of Guinea (GoG).

Having presented the background and methodology of this paper in Section One, Section two is discussing the concept of MDA with a focus on its origin and practice in various jurisdictions across the world. Additionally, the interrelated phenomena of sea vision and sea blindness, are covered, illustrating how both are largely determined by the capacity and capability to monitor and surveil activities in the maritime domain. The Fourth section is dedicated to the findings and analysis,

followed by a discussion of the survey results in Section Five, and finally the conclusion and recommendations for improvement of the MDA system, including proposals for future work in Section Six.

2. Activities in Lake Victoria and the Need for Enhancement of MDA.

Apart from the discussed investments in the shipping industry, the Lake is a major economic pillar aiding imports and exports of petroleum products, rice, sugar, crude palm, soda ash, and cotton seed cake (ISCOS, 2022). See Fig. 2 below presenting Kisumu Port Performance and Vessel Statistics from 2017 to 2021 indicating a steady growth in volume of import and export commodities. Kenya Ports Authority (KPA) projections also indicate the potential for a steady growth trajectory of local cargo demand at Kisumu Port estimated at 290,000 tons to 410,000 tons from 2025 to 2035 as a result of port rehabilitation and improved safety thus contributing to the reliability of the transport system in the Lake (Kisumu Small Port, 2024).

Figure 2: Kisumu Port Performance and Statistics from 2017-2021.

	2017	2018	2019	2020	2021
Vessels registered	10	7	41	43	77
Exports (tonnes)	3,431.0	9,945.5	15,195.7	45,550.1	52,064.4
Imports (tonnes)	0.0	1,000.0	2,539.0	670.0	1,950.0
Total throughput	3,431.0	10,945.5	17,734.7	46,220.1	54,014.4

Source: Adopted from ISCOS (2022)/KPA.

The Lakes artisanal fishing is providing food and employment along the value chain with approximated landings of about 97.5 metric tons (MT), in 2022 according to Kenya Economic Survey (2023), showing a decrease from, 118,145MT valued at KES9.44billion in 2016 as compared to 153,051MT in 2015 valued at KES13.2billion (KMFRI, 2018). Conversely, there had been a steady growth in the number of fishers and fishing crafts from 38,000 fishers and 11,515 crafts in 2000 to 43,000 fishers and 14,365 crafts in 2016, figures which could be higher due to time-lapse and increased fishing efforts (KMFRI, 2018).

The growth in shipping activities comes with hazardous conditions that threaten the safety and security of lake users and pose risks to the environment resulting from ship-source pollution operational spillage, deliberate discharge/dumping, or accidents. Besides enhancing the capacity for timely intervention to avert safety risks or investigation of accidents and pollution cases, MDA also enables effective search and rescue response as authorities can easily identify vessels close to the incident location to offer assistance. MDA also facilitates targeted law enforcement operations based on the observed movement of any suspicious vessels. On safety, Naknyoyi (2011) and the African Development Fund (2016) highlighted the frequent fatalities largely attributed to ferry and small watercraft accidents leading to capsizing and drowning. The accidents which involved M/V Bukoba (1996), M/V Kabalega and MV/ Kaawa

(2005) and, MV Nyamageni (2006) resulted in the loss of hundreds of lives, as well as the drowning of 18 school children on 5th August 2010; another 28 persons perished in Entebbe in July 2011 when a passenger ferry capsized as a result of hazardous environmental conditions (Naknyoyi, 2011).

Apart from safety matters, the Lake is a shared resource between Kenya, Uganda, and Tanzania with unique maritime security challenges. According to Lagat and Handa (2023), armed robbery and impersonation of law enforcement officers were one of the foremost challenges for fishermen who live in constant fear of attack. The EAC's *Protocol on Peace and Security* (2013), recognized the existence of maritime security threats and outlined joint strategies for their suppression. Further, the 2022 report of the EAC Legislative Assembly Committee on *Assessment of the Measures Instituted by Member States for the Safety and Security of Movement of People and Goods on Lake Victoria and Tanganyika* identified armed robbery, illegal immigration, and illegal fishing as key maritime security threats in the Lake (EALA Assessment Report, 2022). With the ever-existing threat of terrorism within the East Africa region from AlShabab and Allied Democratic Forces (ADF) terror groups the potential threats in the strategic investments on shipping and the associated critical national infrastructure made securing the Lake a priority.

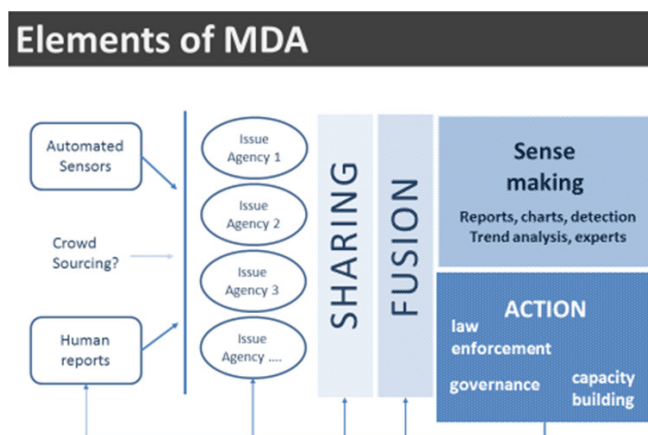
On the other hand, the shipping of millions of litres of petroleum products via the Lake makes the risk of an oil spill possible; continuous ship operational leakages and intentional dumping of harmful waste are also a possibility. In any case, pollution had been identified as a threat to sustainable development in the Lake Victoria Basin attracting recommendations for regional efforts towards pollution prevention (EALA Assessment Report, 2022). Increased shipping activities, car washing, and discharge from local industries were identified as threats worsening the dire environmental conditions in the Lake whose biodiversity was already choking under the effect of climate change, eutrophication, and release of affluence from local industries. As a result, unmitigated pollution from the increased shipping activities would have undesirable consequences on its sustainability.

It is self-explanatory, therefore, that the growth of maritime activities in the Lake comes with a mixture of challenges related to safety, security, and pollution which require effective regulatory enforcement. However, effective enforcement may be undermined without robust mechanism that enables authorities to monitor the maritime activities as suggested by Nimmich and Goward, (2007), and for this case, within Kenya's territory in Lake Victoria as well as from across its maritime border, in the absence of reliable Maritime Domain Awareness (MDA). Dalaklis (2019) therefore, defined MDA as an essential system for monitoring and surveillance empowering littoral states to know what is happening at sea, oceans, and waterways.

The observed growth of shipping in Lake Victoria coupled with a porous maritime border, and numerous unmanned landing sites providing a safe haven for domestic and transnational organized crime makes adequate MDA an imperative for effective regulatory controls with costly consequences if ignored. It is therefore inconceivable for safe, secure, and environmentally

sustainable shipping to thrive without deliberate efforts to enhance the MDA capacity of regulatory and enforcement agencies in the Lake. In order to determine the MDA situation, the research effort first sought to identify the common maritime activities in the Lake, the mechanisms for monitoring and surveillance of such activities; Secondly, the effectiveness of the MDA system was examined taking into account the arrangements for information fusion and sharing as well as capability to deploy maritime assets for emergency response or interdiction of illicit activities and finally the suggestions for improvement of the existing MDA situation were given. For systematic research on the state of MDA, an indicative conceptual model in Fig. 3, incorporating key functional elements of maritime domain awareness developed by Bueger (2016) was adopted for the analysis, discussions and conclusions. A detailed framework of definition relating to the MDA concept is also provided in Section 3.

Figure 3: Elements of MDA.



Source: Bueger, C. (2016).

3. Understanding the Term Maritime Domain Awareness (MDA).

The International Maritime Organization (IMO), a specialized UN agency with the mandate to promote safe, secure, environmentally sound, efficient, and sustainable shipping through cooperation, defined MDA as a system that enables the understanding of events occurring in the maritime domain that may affect the safety and security of shipping, the marine environment and the economy (IMO, 2018). The maritime domain refers to the seas and the oceans of the world on which international shipping takes place. Equally, this definition may apply to inland water bodies such as lakes where shipping much as it is localized is a crucial economic pillar facilitating the exchange of commodities and movement of people within those territories.

MDA therefore is a system composed of short- and long-range electronic sensors and human capacity for surveillance and monitoring, verification, analysis and fusion of information, including information sharing and capability for launching interdiction or emergency response. Some of the commonly

used sensors include AIS, coastal radar, LRIT, VMS, synthetic aperture radar, aerial surveillance using drones, ship/boat patrols and human intelligence sources. The optimal level of awareness enables authorities to “see and sense” the various events in the maritime sphere, thus gaining the *sea vision* necessary for protecting national interest for maritime safety, security and environment (Lim and Jau, 2007).

Alternatively, the absence of an adequate level of awareness creates a phenomenon known as *sea blindness*. Abdallah and Pappoe (2022), attributed sea blindness to the focus on land-based security threats at the expense of equally pressing security threats in the maritime space. Safe Seas (2018), associated sea blindness to the tendency for less consideration of the political priorities for maritime matters over other matters. As such, it can be understood that this situation can lead to inadequate resources and institutional incapacity hence crippling sound governance of maritime affairs and creates a conducive environment for illicit activities such as piracy, armed robbery, IUU fishing, human trafficking and waste dumping among many others. For an example, Mboce and McCabe (2020), also concurred and attributed the emergence of illicit maritime activities such as piracy, Illegal Unreported Unregulated (IUU) fishing, and drug smuggling within Kenya’s maritime domain to sea blindness. This according to Charo (2021), impacted not only the global economy but also Kenya’s economy citing the example of the significant reduction in cruise liner visits from 35 in 2008 to zero by 2012.

Tracing the origin of MDA concept, Hicks and Matricks (2018), explained that the modern MDA idea emerged after the September, 2011 terrorist attack in the US and the rapid growth in information technology that followed. The signing of Homeland Security Presidential Directive- 13(HSPD-13)/National Security Directive-41(NSPD-41) in 2004 by President (at the time) George Bush and the development of National Maritime Domain Awareness Plan (NMDAP) contained in the National Strategy for Maritime Security (NSMS) was meant to bolster homeland and global security informed by the possibility of another terror attack. Thus, the directive, the plans and strategies laid down a framework for cooperation within federal, state and local structures of government as well as the private sector (National Strategy for Maritime Security, 2005). Having been conceptualized in the US, the MDA concept was adopted in several other jurisdictions as an important enabler of sound maritime governance.

It is therefore not a coincidence that European Union (EU) and NATO had provided a definitional approach towards MDA. For example, NATO conceptualized the same term as Maritime Situational Awareness; Hicks and Matricks (2018), considered it as more or less reflective of the US concept as it also focused on the activities happening in the maritime environment being both of military or civilian interest. Dalaklis (2019), therefore, summarized NATO’s conceptualization as the grasp of military and civilian activities and situation within the maritime space that are of concern to NATO’s strategy and operations.

It is also interesting to note that the EU had implemented a series of projects by leveraging cross-border and cross-sectoral cooperation to achieve what it referred to as situation aware-

ness, interoperability, sharing best practices, eliminating duplicity, and enhancing cooperation, all which were key for achieving common operation picture in maritime surveillance for the discharge of a variety of functions of key authorities (Tikanmaki and Ruoslahti, 2017). Some the EU MDA projects in the recent past include Common Information Sharing Environment (CISE) namely; Policy oriented marine Environmental Research in the Southern European Seas (PERSEUS), Cooperation Project Maritime Surveillance (CoopP), Maritime Integrated Surveillance Awareness (MARISA), Maritime Surveillance (MARSUR) and EUCISE20.

Steering the discussion towards the focus of this research effort, in the case of the African maritime domain, the emergence and spike in piracy cases both in the Gulf of Guinea (GoG) and the Western Indian Ocean (WIO) influenced the efforts to enhance MDA. The efforts of IMO, EU and other international partners necessitated the adoption of the Djibouti Code of Conduct (DCoC) in 2009 and the Yaoundé Code of Conduct in 2013 to consolidate regional cooperation and secure the maritime domain for regional economic growth (EU Maritime Security Factsheet: The Gulf of Guinea, 2021). Specific MDA support to the GoG from UK, US and the EU towards improving MDA capacity included Skylight, SOLATRA, MSSIS Seavision and YARIS (Okafor-Yarwood et al., 2024). These efforts focused on enhancing awareness of maritime domain, maritime risks, standardization of safety regulations, and improved port efficiency and emergency response according to Aboh and Ahmed (2018). It is noteworthy that Kenya's MDA efforts, though modest, existed even before the upsurge of piracy attacks evident by the installation and operation of maritime surveillance radar systems along the coastline and maritime patrols by naval assets.

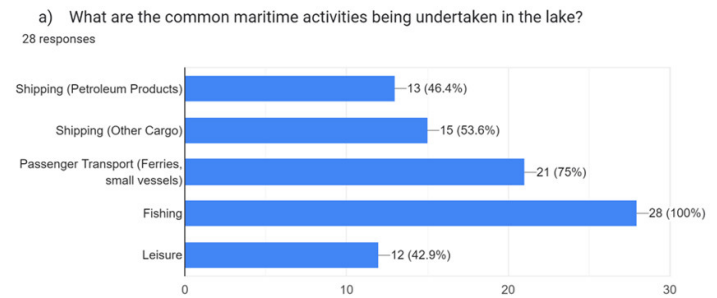
Despite these prior efforts, Mboce and McCabe (2020), confirmed that the support from partners such as the EU (EU NAVFOR) and the US, provided Kenya's Mombasa ISC (RMRCC) with access to Seavision, IORIS, *Mercury* and MSSIS Sea-vision systems with capabilities for real-time information sharing and web based AIS monitoring platforms which combined with AIS Base Station and LRIT substantially enhanced MDA in the region. As such, MDA in WIO has overtime been reinforced with the establishment of Regional Maritime Information Fusion Centre (RMIFC) based in Madagascar and Regional Centre for Operational Coordination (RCOC) based in the Seychelles, set up with the support of the European Union to enhance maritime security in the Eastern and Southern Africa-Indian Ocean region (Agarwala, 2020). Having appreciated the conceptual background, origin and practice of MDA in other jurisdictions, as well as its role as a cornerstone of effective maritime governance, the next segment of this paper focused on the analysis and discussion of the findings of the research survey, while exploring answers to the key questions examining MDA in Kenya's inland water territory in Lake Victoria.

4. Findings and Analysis.

This section analyses the findings on the key elements of MDA examined in the survey whose questionnaires were intended for 50 potential respondents (out of which 28 responses

were received) as well as feedback from two MDA centers out of the three initially identified for the benchmarking. To establish the real state of MDA system that supports the maritime regulatory enforcement in Lake Victoria-Kenya, the study first sought to identify the main maritime activities which common regulatory violations are associated with, that required an effective MDA system in order to achieve satisfactory maritime governance. All the respondents unanimously agreed that fishing was a leading activity, 75% of them chose passenger transport, 53% chose shipping of general cargo, 46% chose shipping of petroleum products, while 42% chose leisure activities as the least common in the Lake as depicted by Fig.4 below.

Figure 4: Main Maritime Activities in Lake Victoria, Kenya.

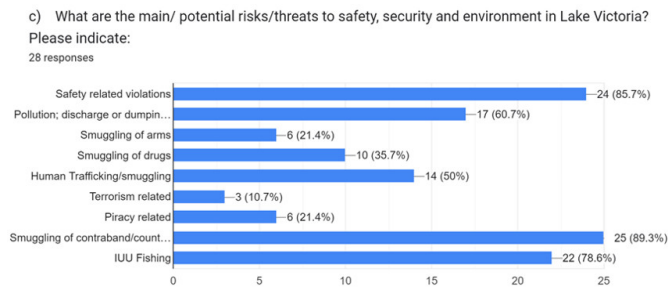


Source: Survey Results.

These results confirmed the assertions made in the background of this paper on the growth of shipping of petroleum products, other cargo, and passenger transport, in the Lake in recent times even though artisanal fishing remained the most popular activity being the main source of livelihood for the Lakeside communities. Of the said activities, all the respondents confirmed with varying degrees that there existed risks / threats to safety, security, and environment associated with the common maritime activities. The main/potential violation in their own experience was related to smuggling according to 89% of the respondents followed closely by safety violations at 85%, IUU fishing at 78%, pollution through discharge and dumping at 60%, human trafficking/smuggling 50%, drug smuggling 35%, arms smuggling 21%, armed robbery (piracy related) 21% and terrorism 10%. Some respondents specifically mentioned armed robbery, collision incidents involving conventional ships and small boats, and maritime boundary disputes. Fig.5 below represented main/potential risks/threats to safety, security and the environment and reflects the findings of the secondary sources of information presented under the problem statement of this research.

Having shared their views on the main maritime activities and the associated threats and risks, the views of the respondents were sought to identify the existing sensors or mechanisms for monitoring and surveillance. From the results (Fig.6), an overwhelming majority of respondents agreed that ship/boat patrol is the most common means of surveillance employed by the agencies at 96% followed by human intelligence (HUMINT) at 74% and ship/vessel databases at a distant third attracting 33% concurrence among respondents. Under 11% of respon-

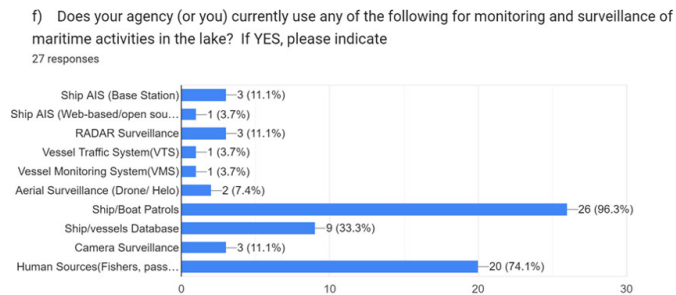
Figure 5: Threats and Risks to Safety, Security, and Environment in Lake Victoria, Kenya.



Source: Survey Results.

dents reported the use of electronic sensors for monitoring and surveillance. Additional information provided by one participant suggested intelligence sharing with security agents in the neighboring countries to combat illicit activities in the Lake. This reflected an MDA system anchored on human sources as opposed to modern technology.

Figure 6: Monitoring and Surveillance Systems.



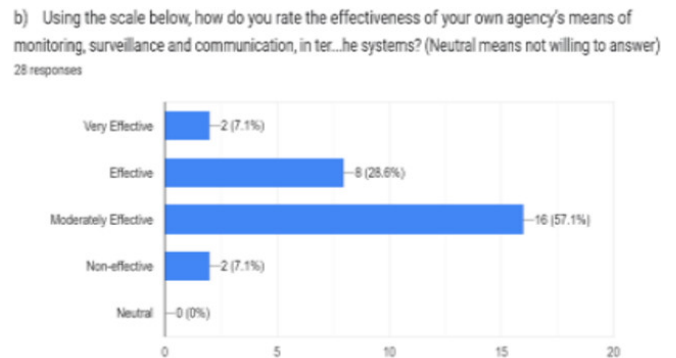
Source: Survey Results.

In seeking to understand the effectiveness of the MDA systems in terms of the capacity for monitoring, surveillance and information sharing, the respondent's opinion of their own agency's capacity was sought. Common practice in MDA systems involves each agency operating its own monitoring and surveillance system or collaborating through a Joint Operation Centers which when integrated forms a single National Maritime Information Sharing Centre (NMISC) as the strategic hub for information fusion, verification, analysis and dissemination for action. Being an agency-based monitoring and surveillance, the respondents gave feedback (Fig.7), where 57% expressed moderate confidence in the systems of their own agencies, 29% believed it was effective and 7% believed it was very effective, while another 7% believed it was non-effective.

Similarly, in Fig.8 on interagency collaboration and information sharing a similar pattern was observed where about 61% believed it was somewhat effective while 29% confirmed the effectiveness, 3% believed it was very effective, and 7% rated interagency collaboration and information sharing as non-effective. These outcomes points to a satisfactory level of confidence in the existing system as the verdict of over 90% of respondents

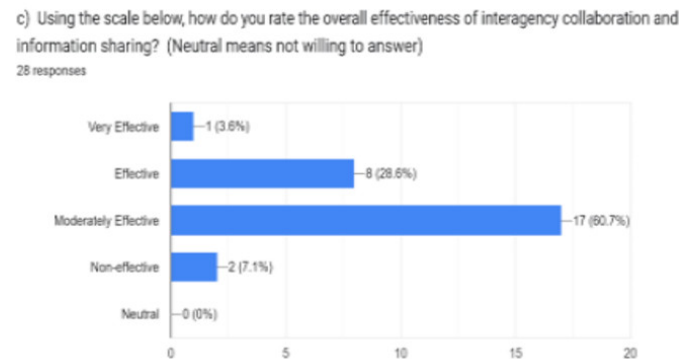
suggested effectiveness while only 7% believed the systems were non-effective. Despite the expression of confidence in their own agency's capacity for monitoring, surveillance, and communication as well as interagency collaboration and information sharing, the respondents cited challenges concerning resource availability and communication protocols which obviously would have impacted the general effectiveness of the MDA.

Figure 7: MDA System Effectiveness.



Source: Survey Results.

Figure 8: Effectiveness of Interagency collaboration & information sharing.

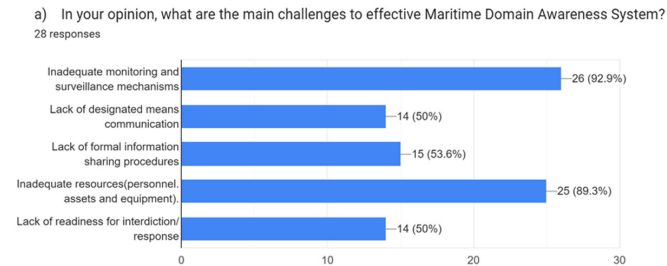


Source: Survey Results.

Also examined in the survey were the main challenges to effective MDA (Fig.9) focusing on surveillance and monitoring systems; training, communication and information sharing; resources and response capability whereby over 90% of respondents identified inadequate monitoring and surveillance mechanisms as the foremost challenge followed by inadequate resources (personnel, equipment and assets) at 89%. About half of respondents believed lack of formal information sharing procedures, lack of readiness to respond, lack of designated means of communication posed a challenge in each case. Inadequate monitoring and surveillance mechanisms and lack of sufficient personnel, equipment, boats, operational facilitation such as fuel, were therefore, the most outstanding challenges. Justifiably, this may could have been as a result of the

reliance on maritime patrols and human sources of information which ordinarily required personnel, serviceable boats and sufficient fuel, hence need for complementary electronic sensor for surveillance and monitoring. Additional information provided pointed to weak regulatory framework; poor infrastructure; corruption among government officers; lack of cooperation from local communities; lengthy communication protocols and lack of training.

Figure 9: Challenges to effective MDA.



Source: Survey Results.

As part of the survey, participants were also asked for potential areas of improvement. Their suggestions can be summarised as follows: i) Capacity building through provision of additional personnel, equipment, training, boats for patrols and sufficient fuel provision; ii) Installation of surveillance systems such as radars, use of AIS, aerial surveillance, VHF/MF/HF and satellite communication systems and establishment of multi-agency/ joint operation centre for information fusion, analysis and dissemination for awareness, enforcement action or emergency response; iii) Enhanced information sharing among agencies and with EAC member states formalised through standard operating procedures; iv) Community and stakeholder engagement through collaboration and partnerships in maritime governance; v) Enhanced presence of regulatory enforcement officers through establishment of additional stations with resources for patrols, enforcement, search and rescue and community outreach; vi) Establishment of mechanisms for oversight of activities of regulatory enforcement officers for accountability and improvement.

5. Discussions.

This section discussed the research outcomes with special attention on the main maritime activities and associated risks/threats and, the efficacy of the existing MDA system. Fishing was identified as the main maritime activity in Lake Victoria Kenya, confirming the suggestion that artisanal fishing was a primary means of subsistence for the majority of the population living along the Lake going by the massive number of fishing crafts, approximated to 15, 369 (Regional Assessment Report of Transnational Organized Crime, 2023). Despite this, shipping activities involving transport of petroleum products and other cargo as well as passenger ferry operations were identified to be among the leading maritime activities in the Lake, confirming the remarkable growth of shipping activities as a result

of the restoration of port facilities, refurbishment of ships and establishment of shipyards in Kisumu, Mwanza and Entebbe and, construction of oil jetty and storage facilities in Kisumu and Entebbe, thus signaling positive economic prospects for the region.

At the same time, the identified maritime activities were also associated with safety violation, pollution through dumping, discharge and armed robbery according to the respondents. Also featuring prominently in the responses were IUU fishing, and smuggling of contrabands, counterfeits, humans, drugs, and weapons, all which had an effect on security, stability and economic sustainability in the region. Moreover, the Lake was prone to transnational criminal activities which took advantage of weak regulatory measures for small water crafts, porous maritime boundaries, and numerous unregulated landing sites. These revelations, therefore, highlighted the potential risks / threats which required the development of appropriate remedial action by concerned authorities.

Key to managing the identified risks is the monitoring and surveillance by way of electronic sensors, human sources and open-source data or information and vessel register which bring to the knowledge of the concerned entities, the activities happening in the maritime domain of interest. Based on respondents' feedback, the research identified human sources of intelligence as the main means of monitoring and surveillance utilizing ship/boat patrols, information from fishers and passengers, vessel registry, and other databases. Instrumental to this is the co-management framework of governance of the fisheries sector in Kenya through collaboration between the Beach Management Units (BMU) and concerned Ministries, Department and Agencies positioned fishers as key source of intelligence due to their presence along and across the Lake.

Whereas the temptation to fashion MDA as the acquisition and operation of sophisticated electronic sensors was common, the cost implication in the procurement of such like systems, their installation, maintenance, subscription, and training was in most cases beyond the reach of most countries. Consequently, resource scarce jurisdictions relied on human sources of information, augmented with databases and web based open sources for marine traffic monitoring systems, especially where the MDA imperative had to be achieved regardless of resource limitations. For this reason, Jamie and Ian (2024), recommended prioritization of the less alluring basic needs but most meaningful and impactful such as the facilitation of patrol teams with serviceable vessels, and sufficient fuel provisions, over sophisticated systems for surveillance. Notably, when asked about their opinion of the effectiveness of some key elements of the MDA system, about 90% of the respondents expressed confidence in their effectiveness but equally pointed out challenges with other important MDA elements discussed which may have been informed by the need to keep confidentiality.

Having analyzed and discussed the findings of the research, a decision was made for a comparison of the MDA system under the Mombasa RMRCC, Deep Blue Project (DBP) and the MDA system in Lake Victoria Kenya based on the feedback from the two MDA centres and the respondents operating in the Lake. The comparison revealed that the maritime domain under

the Area of Responsibility (AOB) of both DBP and RMRCC experienced almost similar threats and risks to Lake Victoria except for the case of DBP which experienced additional peculiar challenges with illegal bunkering and illegal ship-to-ship transfer.

Notably, DBP operated an integrated MDA system with more sophisticated electronic sensors, air, land, and maritime assets and personnel as well as a centralized Command Control Computer Communication and Information Sharing (C4i). On the other hand, the RMRCC had the basic monitoring and surveillance systems but thanks to its designation as a Piracy Information Sharing Centre, it was granted access to Mercury and MSSIS Seavision by the international partners supporting counter-piracy initiatives in the region, while the Lake Victoria MDA system largely relied on human sources of information. In addition to sensors, DBP had a range of designated communication systems followed by RMRCC while the medium of communication for Lake Victoria are mostly telephone and WhatsApp.

Whereas DBP operated under presidential directive for multi-agency collaboration in information sharing and coordination with the C4i Centre as the hub for information integration and maritime interdiction tasking, the RMRCC operated under SAR Convention, regional and national SAR plans of operation, Djibouti Code of Conduct (Jeddah Amendment 2017) and domestically within the whole-of-government approach to regulatory enforcement. In the three cases under comparison, all the respondents concurred that continuous training by way of familiarization or refresher training in the operation of electronic sensors or on other functional elements of MDA was important for improving competencies of personnel.

However, on the challenges to an effective MDA system, the main difference cited by DBP was the issue of interagency competition resulting to agencies encroaching into each other mandates. On the issue of challenges, the respondents in the three cases acknowledged the inadequacy of resources in terms of equipment, personnel, monitoring and surveillance capability, absence of designated means of communication, information sharing, and inadequate capability for timely emergency response and enforcement action could impact effective MDA, except for Lake Victoria where corruption was cited as a unique additional challenge. Finally, the proposals offered for improvement of the MDA system in Lake Victoria centred on the measures to address the resources shortages for equipment, personnel, streamlining of information sharing procedures, and enhancing community and stakeholder collaborations. The RMRCC proposal was similar to that of Lake Victoria agencies emphasizing enhancement of stakeholder and community engagement to improve information sharing. For an effective MDA, DBP emphasizes monitoring and surveillance infrastructure, adequate training and equipment, clarity of roles, and responsibilities, and designation of clear channels of communication.

Conclusions and Recommendations.

This research effort identified artisanal fishing as the leading activity in Lake Victoria, Kenya, followed by the shipping of petroleum products, general cargo, and passenger transport

by catamaran ferries and small water crafts. It also revealed that there are risks / threats such as safety violations, pollution through dumping and discharge, armed robbery, IUU fishing, and smuggling of contraband, counterfeits, humans, drugs, and weapons were identified. It was also concluded that an effective maritime regulation and enforcement regime ought to be supported by an MDA that enables proactive regulatory controls through tracking, targeting and interdiction of suspicious activities, facilitates prevention and contributes to effective response in relation to emergencies like search and rescue, oil spill and for investigation of collision and waste dumping.

In an attempt to establish the effectiveness of the MDA system comprising the spectrum of key elements under focus, it must be noted that although the respondents expressed confidence in the effectiveness of the existing system, they still pinpointed inadequate resources such as fuel, personnel and equipment as the main challenge experienced. This was most as a result of reluctance to disclose their own agency's shortcomings perhaps for confidentiality purposes. In summary, it was concluded that the MDA system was very heavily dependent on human sources of intelligence obtained through boat patrols by enforcement officers, fishermen and passengers as opposed to electronic sensors such as AIS, radar, VMS, SAR, VTS for monitoring and surveillance of maritime activities in the Lake. Consequently, proposed initiatives for enhancement of the MDA would benefit a lot by the improvement of community and stakeholder collaborations for enhanced information sharing, verification, and enforcement controls.

In view of the above conclusions, future work for the improvement of the MDA system in the Lake Victoria is needed. Given that the MDA system is dependent on human sources of information more than electronic sensors, initiatives that would foster cooperation and trust among maritime regulatory and enforcement agencies as well as between the agencies and stakeholders involved in fishing, cargo and passenger transport are recommended. This is to promote positive image, attitudes and perception to enable collaboration in information exchange and inspire self-regulation that enhances compliance for safety, security and pollution prevention in the Lake. As such, joint training and regulatory control programs, stakeholder sensitization, accountability, and integrity measures for frontline officers is encouraged to eliminate corruption and inspire confidence.

Cognizant of the evident growth of shipping activities promoted by the investment in Blue Economy projects and as a remedy for the identified inadequacy of the most basic necessities for effective regulation and enforcement such as consumables (fuel), personnel and equipment, it is recommended for the enhancement of enforcement capability through deployment of additional enforcement officers with necessary assets, equipment and provisions so as to increase their presence, improve capacity to conduct enforcement operations and to boost morale. The establishment of coastguard stations along the Lake and the envisaged SAR centres with boats, personnel and equipment under the MLVMCT project is expected to contribute towards a better working environment for the concerned stakeholders.

Notably, the Security Laws (Amendment) Act 2014 created provisions for the establishment of multi-agency Joint Opera-

tion Centres (JOC) at the gazetted maritime ports of entry/exit. This was intended to position JOC as the hub for collection, analysis and dissemination of information among agencies to improve information sharing, monitoring, surveillance and detection of illicit maritime activities. It was noted that the establishment of JOC in Kisumu was in process, therefore, it is recommended for fast-tracking of establishment of the Centre and introduction of mandatory AIS requirements or mandatory reporting (in national laws) for conventional vessels entering or leaving Kenya's territory in the Lake to facilitate monitoring and tracking.

Further, it is proposed for JOC to be equipped with a computer system and reliable internet connectivity for monitoring and tracking of ships through web based, open sourced AIS network such as MSSIS Seavision to complement the dependency on human sources of information. Moreover, to enhance capacity for information exchange and overall awareness, it is proposed for JOC to set up mechanisms for information collection and fusion, from human sources, print, electronic and social media, weather forecasts and disseminate such information periodically in form of weekly or monthly reports to selected stakeholders to enhance maritime domain awareness.

On the other hand, achieving a satisfactory level of compliance for the huge number of small water crafts had been a challenge for a long-time rendering monitoring and surveillance elusive. Due to their design and propulsion systems, the implementation of a suitable program for electronic tracking (using transponders) became an uphill task given the lack of a reliable source of energy and cost implications for craft owners. Despite this, it was noted that South Africa implemented a tracking system for non-SOLAS vessels where a modified satellite aided Class B AIS was installed on the vessels to aid tracking (Gülcan and Erginer, 2023 Pg.15). Similar low-cost technology devices for tracking of non-SOLAS vessels had also been implemented by India, aided by its satellite system to facilitate search and rescue response and boost maritime domain awareness.

While these projects seemed beyond reach presently, future research to explore the viability of low-cost technology for tracking of Kenya's small crafts for search and rescue, maritime security and general maritime domain awareness is proposed given their massive numbers, general lack of compliance and the risks/threats they pose as vessels of choice for illicit maritime activities. Also, there is a need to enhance registration and regular update of the registry (database) of the said small non-SOLAS vessels for ease of identification and verification. Finally, the Lake is a major inland waterbody and key resource shared by Kenya, Uganda and Tanzania which together have pursued regional approach in addressing maritime safety, search and rescue and security challenges in the Lake through initiatives such as MLVMCT Project. It is, therefore, proposed that a future study should assess the state of maritime domain awareness for Uganda and Tanzania which account for almost 94% of the Lake, to gain a comprehensive understanding of the collective MDA capability and capacity to support regional objectives for regulation and enforcement against maritime risks/threats.

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