2021

Maritime surveillance in the Gulf of Suez : identifying opportunities for future improvements

Esslam Hassan

Dimitrios Dalaklis

IAMU
International Association of Maritime Universities

THE NIPPON FOUNDATION
For Social Innovation

21ST Annual General Assembly

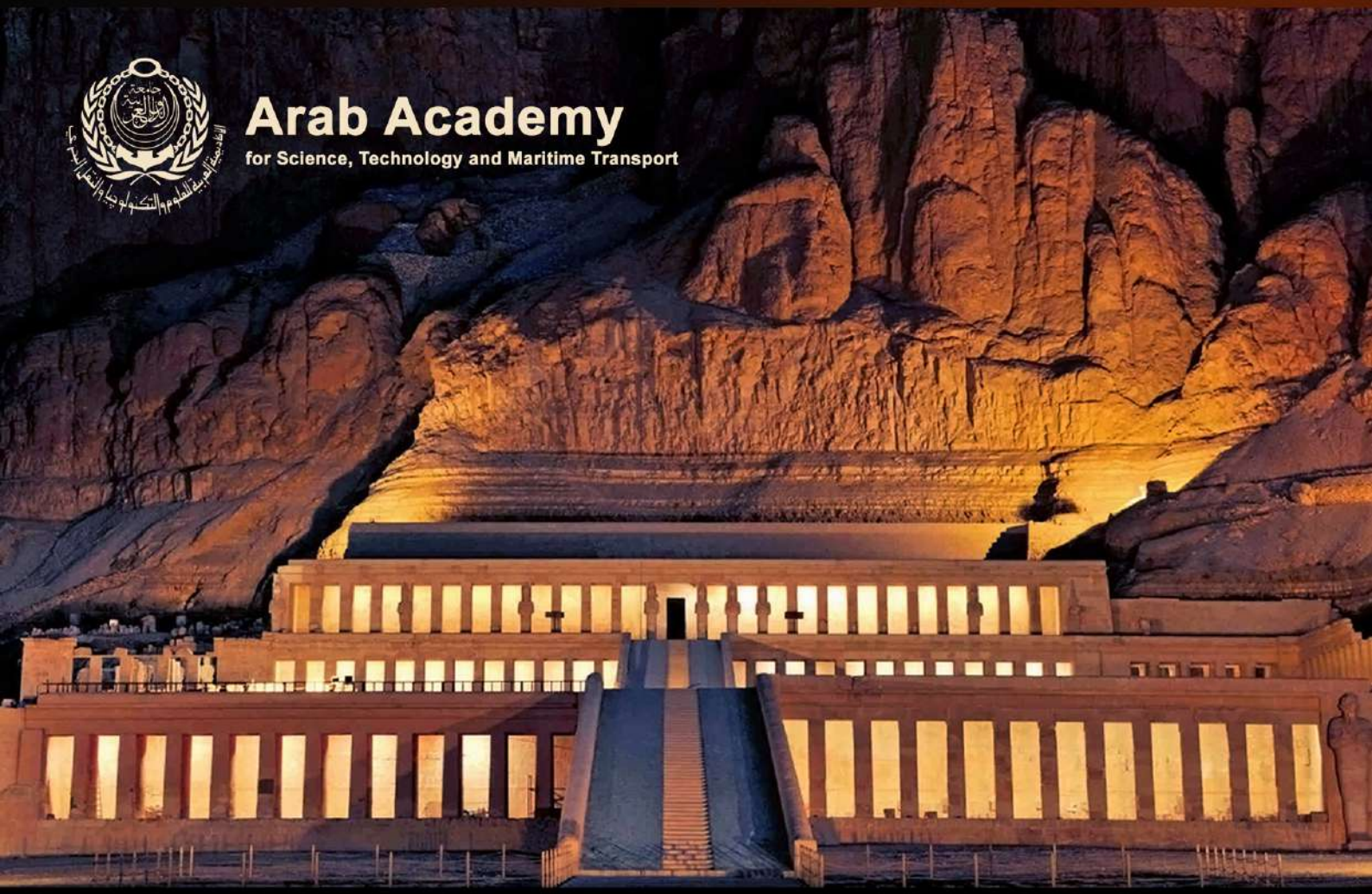
IAMU AGA21

26th-28th October 2021

Alexandria - Egypt

The 21st Annual General Assembly

Proceedings of the International Association of Maritime Universities (IAMU) Conference



Arab Academy
for Science, Technology and Maritime Transport

21ST Annual General Assembly

IAMU AGA21

26TH-28TH October 2021

Proceedings of

The International Association of Maritime Universities (IAMU) Conference

Alexandria, Egypt
26 October 2021

21ST Annual General Assembly

IAMU AGA21

26TH-28TH October 2021

Program Editors
Prof. Yasser Gaber – Capt. Amr Moneer
Arab Academy for Science, Technology and Maritime Transport, Egypt

Chief Program Editor
Prof. Boris Svilicic
University of Rijeka, Faculty of Maritime Studies, Croatia

A publication of the International Association of Maritime Universities
Publisher
Arab Academy for Science, Technology and Maritime Transport
ISSN (Print): 2706-6754
ISSN (Electronic): 2706-6762

Table of Contents

Proceedings

Maritime Surveillance in the Gulf of Suez: Identifying Opportunities for Future Improvements

Esslam Hassan [a], Dimitrios Dalaklis [a]

[a] *World Maritime University, Maritime Safety and Environmental Administration, Malmo-Sweden*

Corresponding author's email: esslamfattah@gmail.com

Abstract

The Gulf of Suez (GOS) is one of the most important waterways in the world. Furthermore, issues like maritime safety, avoidance of accidents and effective conduct of navigation, as well as protection of the marine environment in the GOS are always among the highest priorities of Egyptian legislators. As a result, maritime surveillance in the area under discussion is facilitated by a technologically advanced Vessel Traffic Management System (VTMS) that has been established by the competent authority as a cost-effective measure to reduce and mitigate risks in accordance with international standards and guidelines. The main aim of this paper is to discuss the status of the GOS VTMS and identify relevant opportunities for improvement.

This effort utilizes qualitative primary and secondary data. Primary data was collected by employing in-depth, semi-structured interviews; secondary data was sourced from relevant national legislations, IMO, IALA and UK hydrographic office publications. Thus, the distinctive features of the GOS VTMS along with its degree of compliance with international standards and guidelines have been closely examined for a comprehensive assessment. A conclusion standing out is that GOS' VTMS is a very powerful tool for a more efficient conduct of navigation, with a positive contribution on maritime safety and the protection of the marine environment; however, certain gaps that must be addressed in the near future were identified. A portfolio of the necessary recommendations on how to improve the system's overall performance are also provided.

KEYWORDS: Safety of navigation, Marine environment, Data integration, Vessel Traffic Services, IMO, IALA.

1- Introduction

According to the Merriam-Webster Dictionary, the term ocean describes the body of salt water which covers approximately 71% of the surface of the Earth (Ocean, n.d.). Considering the truly vast areas involved in this discussion, maritime surveillance should be viewed as a very important step towards creating maritime awareness, or simply put "knowing what is happening at sea". Any Maritime Surveillance System

(MSS) must first and foremost comply with the primary function of covering and providing a comprehensive maritime situation picture to control the main areas where maritime activities are being carried out. Coastal states are using Maritime Surveillance (MS) to increase the safety of navigation, protect the marine environment and the State's own interests. MS has been defined by many scholars, International Organizations and Agencies, by using various different perspectives. For example, the Maritime Affairs Directorate of the European Commission is using the following definition: "Maritime Surveillance is the effective understanding of all activities carried out at sea that could impact the security, safety, economy, or environment of the European Union and its' Member States" (European Commission, 2010, p.1). This definition is very similar to the International Maritime Organization's (IMO) definition for Maritime Domain Awareness (MDA), which is defined as "The effective understanding of anything associated with the maritime domain that could impact up on the security, safety, economy, or environment" (IMO, 2010a, p.1).

Egypt, as a member state of IMO, has exercised its sovereignty in the Gulf of Suez (GOS) by establishing measures to ensure the safety of navigation, protect the marine environment and its various economic interests. This paper will discuss the current state of MS and explain the role of VTMS within the GOS. This research effort will explore the cooperation between different entities in order to establish a successful and cost-effective MSS under the scope of national legislations. It will clearly highlight the role of GOS VTMS in increasing the level of situational awareness, which in turn contributes towards the protection of the marine environment and safety of navigation. Finally, it will propose how to improve MS in the GOS specifically and in Egypt in generally, by establishing a national cross-sectoral information-sharing environment.

2- Governmental and non-governmental agencies involved in the Gulf of Suez Maritime Domain surveillance

MS includes the interaction between many maritime agencies that face the challenge of ensuring security, safety, environmentally friendly and clean seas (Chintoan-Uta & Silva, 2017). Commercial vessels are monitored by Maritime Administrations, Fisheries Administrations/Agencies track fishing vessels and the Coast Guard or other law enforcement agencies often undertake monitoring of activities at sea. Each one of these entities/administrations has developed and operate a MSS that compiles and

processes the information in relation to their needs (Tikanmäki, 2017). Data collection for the GOS' VTMS is performed by various different organizations. Governmental and nongovernmental entities are involved in MS in Egypt in general and in the GOS in particular -under the scope of national legislation- in order to enforce the rule of law and fulfill their assigned responsibilities.

2.1 Marine Survey Department (Navy)

The Ministry of Defense, represented by the Navy-Marine Survey Department has the legal basis for application and enforcement under the Law 232/1989 on the safety of ships to provide hydrographic services in Egyptian territorial waters. Its responsibilities are the collection, classification, circulation, and update of all hydrographic data necessary for safe navigation. Also preparation and issuance of both paper and electronic charts; other similar issues include sailing routes, lists of lights, tide schedule and other publications, the production of Marine booklets (publications) and Notices to Mariners to meet the needs of safe navigation.

2.2 Egyptian Authority for Maritime Safety (EAMS)

The legal basis of application and enforcement is Presidential Decree 399\2004 on the establishment of the Egyptian Authority for Maritime Safety and law 232 of 1989 on the safety of ships. EAMS is the maritime administration acting as competent authority of Coastal State/Flag State and also executes Port State Control. EAMS provides navigational aids in Egyptian coastal and territorial waters, promulgate publications and navigational alerts, investigation of marine accidents and monitoring of VTS (Maritime Transport Sector, n.d.).

2.3 National Telecom Regulatory Authority (NTRA)

The legal basis for application and enforcement is Telecommunications Law 10\2003 Directive that regulates the procedures of maritime communications services. Responsibilities of NTRA include its role as the National Data Provider by registering the data of distress devices of Egyptian ships using COSPAS SARSAT System, issuing radio licenses for Egyptian vessels, registration of Egyptian ships data at ITU (List of Ship Stations), issuing General Operators Certificate (GOC) to radio operators in accordance with STCW 78.

2.4 Telecom Egypt (TE)

The legal basis for application and enforcement was provided under the scope of the Telecommunications Law 10\2003, in addition to license No. 1\2006 issued by the NTRA to TE and the cooperation protocol signed between Telecom Egypt and the

Meteorological Authority. TE has the responsibility to operate coastal radio stations for communication and distress services, broadcast radio navigational alerts and weather forecast services to ships in Egyptian territorial water including the GOS.

3- Traffic features and cost-benefits of maritime surveillance in the Gulf of Suez

The high costs of a high-tech surveillance systems are among the main problems which the Maritime Administration may face; consequently, the lack of an economical and operational criterion is an obstacle to establish and put into operation a well-developed surveillance system. For that reason, costs must be in balance with the benefits which will be achieved by the system and those benefits may be monetary and/or other immaterial valued benefits. Improvements of MS are required because of a wide range of risks, threats and vulnerabilities. The heavy maritime traffic within the Mediterranean Sea, Red Sea as well as Suez Canal is associated with safety, security and environmental challenges for Egypt. According to the World Economic Forum "Global Competitiveness Index (2019)", the global competitiveness of Egypt's liner shipping connectivity and seaport infrastructure rank 18 and 41 respectively among 141 countries and regions (Schwab, 2019).

Ports in Egypt are mainly located around the Gulf of Aqaba, the Mediterranean and the Red Sea. Egypt's Ports have achieved 6.24 billion Egyptian pounds of surplus in 2016. While the annual holding capacity of Alexandria port is 1.613 and Port Said is 3.050 million TEUs, according to Lloyd's List, in 2018 Alexandria port has been ranked 94 and in 2019 port said has been ranked 57 among the top 100 international ports (Lloyd's List, 2018 and 2019). The Suez Canal (SC), is very important link of global maritime transport system by linking the Mediterranean Sea with the Indian Ocean. It connects Europe, Africa and Asia and holds 8% of international trade shipment and 14% of the international seaborne trade in volume (Egypt Economic Development Conference, 2015). SC is one of the pillars of Egypt's economy, its annual revenue being around six billion USD. In 2019 the SC revenue accounted for 2.4% of the Egyptian GDP and the foreign direct investments it attracts account for up to 8% of the total volume (Egyptian Center for Economic Studies, 2020).

3.1 Gulf of Suez Waterway features and status of safety incidents

Gulf of Suez is a waterway that lies at the north of the Red Sea (Fig. 1). The area of interest (AOI) which encompasses the entire Gulf is approximately 175nm. The GOS is a narrow waterway in most areas being only 10-15nm wide and at the widest being

about 25nm (Jica, 2008). In general, one of the main features of the GOS is the intensity of traffic, oil wells, prohibited areas and a large number of non-SOLAS vessels. Any accident in this confined waterway will lead to economic losses expressed in delays of ships, loss in property, life and environmental damage.

Oil rigs and fishing vessels operations are frequent. Numerous oil rigs and platforms are the main hazards to navigation in the GOS on both shores of the Gulf; some marked by lights (and in some cases by racons as well). Also mariners are warned that some of these structures are temporary and that they should not rely on the charted positions; due caution is required when navigating in their vicinity and entry into certain areas containing oil fields is prohibited (UK Hydrographic Office, 2019).

Professors Dalaklis, Siousiouras and Nikitakos (2009) also stated that although maritime accidents occurred in the past and could continue in the future, utmost effort must be made to ensure safe and efficient shipping operations. In order to evaluate these statements and identify the risk in the GOS area, further investigation in trends of maritime incidents has been carried out.

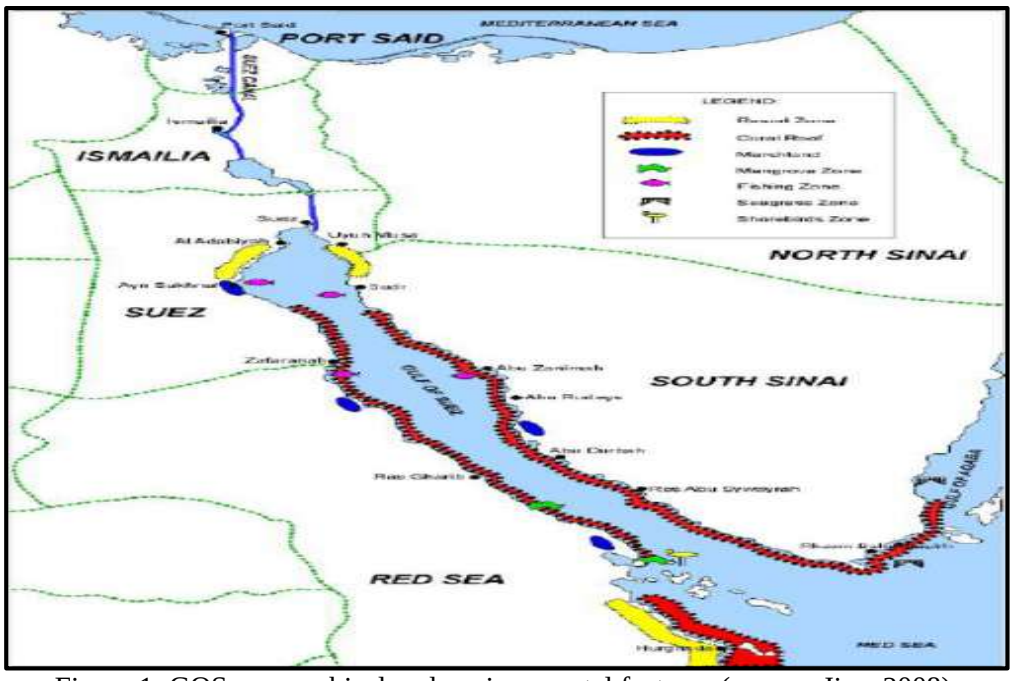


Figure 1: GOS geographical and environmental features (source: Jica, 2008)

In 1990, the total number of incidents/casualties in the GOS accounted for 7, while in 1997 this number increased to 16 accidents. Between 1990 and 1997 the total number of incidents reached 88 with different types of indicative types being oil pollution, collision and grounding (Abelhafez, 1998). In 2014, a collision between a fishing boat and a Kuwaiti flagged container ship resulted into 25 fatalities in the GOS (Ahram

Online, 2014). Moreover, GOS is the region associated with most risk of pollution in the Red Sea, particularly oil pollution (Ghalwash & Elkawam, 2004). Consequently, Traffic Separation Scheme (TSS), Aids to Navigation (AtoN) and Vessel Traffic Service (VTS) are risk control options that have been established by competent authorities. The requirements and standards of these risk control options have been mandated in the international regulations such as UNCLOS, SOLAS in addition to recommended guidelines issued by IMO and IALA.

3.2 Rules for ships navigating in the Gulf of Suez

For safe navigation within the GOS, special rules were issued by EAMS; these measures have been endorsed by IMO and included in part F of "SHIP'S ROUTEING MANUAL". All ships should take into account throughout their passage in the GOS the following: All ships must have their radar in operational mode day and night across the passage between Shaker Island and Suez Port as assistance to achieve maximum compatibility with the lane and avoid collision risks. Ships transiting the GOS are required to watch-keeping broadcasts of traffic information in the GOS and inform "SUZ" if any aids to navigation are out of position or malfunctioning (IMO, 2019).

3.3 Traffic separation scheme (TSS)

Maritime traffic rules are typically limited to national legislations and confined by the IMO-approved routing scheme which is implemented as a TSS. At the northern end of the GOS vessels enter and leave the Suez Canal. In the central area of the GOS, there is intense marine oil field related activity and in the south of the GOS there is an increase in the recreational traffic due to expanding tourism related to the coral reefs. Five areas have been identified as critical traffic management areas in the GOS (UK Hydrographic Office, 2019).

3.4 Aids to Navigation in the Gulf of Suez

Egypt as a coastal state has the obligations/ rights as stipulated in SOLAS V/13 and III code paragraph 48.8 to implement AtoN with regard to the traffic density and risk degree in accordance with IALA guidelines and maritime buoyage system. According to national legislations, EAMS has the legal basis of application and enforcement to the establishment and maintenance responsibilities of AtoN in Egyptian waters. GOS AtoN are including lights, racons, light beacons and light floats that are established throughout the GOS to aid safe navigation of the TSS and safe entrance and approach to ports and major oil terminals (IALA, 2013a).

Lighthouses, buoys, shapes and marks are the main components of AtoN. The operational status of these components are monitored by EAMS engineers via a designated GSM and satellite monitoring system in order to maintain their proper function. Type, number and range of AtoN operating in the GOS are (Table 3):

Table 1: Aids to Navigation in the GOS

Navigation Aids	**Number**	**Range in NM**
Light Houses	7	Between 15-22 NM
Beacons	11	Between 7-18 NM
Safe water buoy	5	Between 9-12 NM
Isolated danger buoy	2	9 NM

To understand the current situation of AtoN in the GOS, an overview has been carried out via the secondary source of data in "Admiralty LIST OF LIGHTS AND FOG SIGNALS NP77 volume D". This publication is weekly updated from the notice to mariners. Any information regarding faults or changes to the aids to navigation is broadcast by Serapeum Radio. But on the other hand, seafarers are warned that AtoN in the GOS are unreliable and may be unlit, or off-position; navigation must be conducted with great caution (IMO, 2019)

3.5 VTMS as total maritime surveillance and its role as a cost-effective safety tool

IMO member states are required to take all essential measures to reduce the probabilities of risks in addition to reducing consequences in critical waterways such as collisions and groundings. VTMS is a tool for risk reduction established by EAMS as a competent authority in accordance with SOLAS V/12, III code para 48.7 (IMO, 2013) and IMO Resolution A.857(20) (IMO, 1997). The objective of the GOS VTMS is to provide safe and efficient operation of the GOS ports and waterways through real-time monitoring and analysis of vessel movements, types of cargo with an accent on hazardous cargo, environmental conditions and other vital information needed (EAMS, 2020). Although the GOS VTMS is a high-tech with a high-cost surveillance system, it improves the performance of ports and GOS waterway and thus facilitates commerce and significantly contributes into the development of Egypt's economy. Zhang, Pedersen, & Villavicencio (2019) study, stated that reducing the frequency of ship grounding and collision is the ultimate cost-effective control option. Thus, it is

obvious that GOS VTMS is playing a crucial role as a cost-effective safety tool. If an accident has already taken place and immediate action is needed, consequences reduction measures are established in the GOS represented by Maritime Rescue Sub Centers (MRCSC) in Hurghada and Ismailia (ICAO, 2018).

3.6 Compliance with international regulations

The VTS is a shore-based maritime traffic management system established by the competent authority to assist the bridge team (IALA, 2016). In other words, VTS is classified as a socio-technical system established to manage and control maritime traffic in port approach as well as coastal areas and congested waterways that represent navigation difficulties for the bridge team (Praetorius, 2014). Cutting a long way short, the GOS VTMS provides comprehensive information on maritime traffic for ships. According to IALA, the VTS consists of three main services including TOS, INS, and NAS, which are all explained next (IALA, 2016).

Information services (INS) is a service where a Vessel Traffic Service Operator (VTSO) provides when necessary all vessels in the region with necessary safety-related information (Dalaklis et al., 2009). The information varies from hydro-meteorological to the location information, intent and identity of other ships in the area (Costa et al., 2018). Very briefly, INS seek to ensure that all parties are familiar with the current situation of the area to help them in building situational awareness. Basically, this service is standard and provided by VTS centers.

Traffic Organization Service (TOS) is a traffic management service inside the VTS coverage area (Siousiouras & Dalaklis, 2009). It regulates traffic to prevent hazardous situations such as problems related to conflicting travel routes and space allocation that may lead to crowding or grounding or in the worst case collisions (Blokus-Roszkowska & Smolarek, 2014). It works by allowing maneuvers, preventing entrance into specific areas, set the speed limits and grant permits. It ensures the safety and efficiency of traffic flow within the coverage area of VTS.

Navigational Assistance Service (NAS) is explained by Professors Dalaklis, Siousiouras and Nikitakos (2009) as the provision of maritime assistance services provided to ships have problems and/or difficulties in navigating safely on its own and seeks the benefits of VTS assistance. The lack of onboard navigation equipment or other internal/external problems may lead the decision-maker onboard ships to request the service (Van Westrenen & Praetorius, 2014). By actively providing the ship's crew

with information about other ships' positions, currents, obstacles, and factors to consider when navigating in a limited area, the goal of the VTSO providing NAS is to assist in making navigational tactical decisions onboard ships. (Siousiouras & Dalaklis, 2009; IMO, 1997). After providing the advice, the VTSO monitors the outcomes through the decision support system. The service is almost rendered exclusively at the request of the ship and the instructions provided must be results-oriented, which means that execution details are left to the shipmaster.

The GOS VTMS meets the functional objectives outlined in the guidelines for VTS, which include collecting and recording pre-arrival and pre-departure information about all vessels in the surveillance area as well as target acquisition and continuous tracking of ships in the AOI to enable; detection, supervision and control of inbound and outbound traffic, monitoring vessel traffic within the surveillance area and coordinate traffic, search and rescue activities and all subsidiary services, provide information to ongoing ships to enable safe and expeditious navigation, provision of pollution control tools, store ship information for statistical analysis and provide evidence in case of an accident or incident. Thus, in accordance with IALA and IMO Resolution A.857(20), established GOS VTMS services comply with all requirements.

4- GOS VTMS contribution to increased situational awareness on board ships and onshore

Although there are several debates relating to the definition of SA, this research effort is utilizing the definition provided by Brödje et al. (2010), which stated that SA is the concept used to describe how people are formulating their mental picture in a dynamic environment. Also, it considered the SA definition in the VTS domain provided by Endsley (1995; as cited in Wiersma & Mastenbroek, 1998, p. 36) which stipulates that "Situation awareness is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future". As per this definition, when discussing SA as a perception of elements in the VTS domain, there are two approaches to be explained. The first is the SA of VTS operators which is strongly related to their personnel abilities such as competency and professionalism and equipment such as sensors, work stations and data processing available in the VTS center. The second is the SA of the shipboard crew, which mainly depend on instruments available onboard such as radars, AIS and VHF information provided by the shore side from the operators of VTS.

4.1 Multi-sensors data fusion and its role in situation awareness and decision making

A study carried by Dalaklis et al., (2009), along with the work of de Vries, (2015) showed that decision making is based on the collected information and communication initiated between the bridge team and shore operators. Brödje et al., (2010) research findings showed that VTSOs are using VHF, radar and AIS as a primary source for information; VTSOs are making decisions based on data fusion from different sensors therefore, information is crucial in the VTS operation. The type of information used by VTSOs as well as how, when and why it is used is crucial to understand the cognitive status of the operators. From the ships' crew perspective, a better understanding can be achieved by looking at the range of services, including TOS, INS, and NAS provided by the VTMS (IALA, 2016; Dalaklis et al., 2009). It is obvious that increasing SA of the ship's crew is created by providing comprehensive information on maritime traffic. This result can be supported by the findings of Blokus-Roszkowska & Smolarek (2014); Van Westrenen & Praetorius (2014); Costa et al., (2018) and Wiersma (2010). Information communication between the ship's bridge and VTS Center, in addition to data fusion of multiple sensors from different remote sites enables the VTSO to configure and construct a holistic traffic image in the waterway and supporting the decision-making process. However, there are several limitation and shortcomings of AIS; VTSOs are mainly depending on radar sensors for detection and tracking and the data are overlaid on AIS data then displayed on the main electronic geographical map to allow the operator to confirm the vessel's position and identifying the vessel by receiving ship's particular such as MMSI, ETA, destination, type of cargo and other static and dynamic data. GOS VTMS operators are mainly depending on radar sensors network located along the coast of the GOS as well as VHF communication, while AIS is considered to be a secondary source of information. This finding is in line with the study carried by Brödje et al., (2010), which stated that radar readings are the most important visual data and AIS is not usually used for navigation and detection.

5- Results and Recommendation

Primary data was collected through in-depth interviews with targeted sampling techniques for VTS competent authority officials as well as highly experienced users of the GOS such as masters and chief officers in addition to service providers. The data was obtained from the interview transcript and then analyzed by Coding (or

sometimes an activity that is referred as indexing). The coded data describes data that has been repeated several times by the interviewee or who himself explicitly stated that it is important. The researchers conceptualized the data by describing the connection between the labeled categorized data, presenting the results and then proposed a solution under the scope of international best practices.

5.1 Towards integrated Maritime Surveillance

Maritime surveillance and monitoring data within and around Egyptian waters is gathered by a number of agencies for a range of different purposes including promoting safe navigation, environment protection, managing fisheries, and monitoring borders and migration control. Each of these maritime stakeholders are working independently and each entity follows a sectoral approach to MS and the absence of a multidisciplinary approach. Each agency has its own organizational culture, bureaucracy and legal basis for the application and enforcement under national legislation. Since different authorities have a variety of competencies, and thus, different information is needed to be collected which is very specific to those competencies where only some of this information within these systems will be useful to other users. That is why separate or single-sector systems were needed. Changes in the scope and focus of MS over recent years have been accompanied by technological developments that allow large amounts of data to be obtained, processed and exchanged in real-time. Therefore, it is necessary to establish a national cross-sectoral information sharing environment. Although there are several separate systems are running, the existing surveillance systems have to be consolidated and move to a higher degree of integration of MS information.

In fact, to make data integration and aggregation is a difficult process due to differences in data formats and technical systems specifications as well. This technical obstacle can be removed by following the best practices already implemented by European member states. Since 2010 integrating the MS approach has been adopted by European Member states expressed in Common Information Sharing Environment (CISE) (European Commission, 2010).

This paper examined the GOS VTMS as a case study in order to verify its compliance with international instruments regarding the role of VTMS as a Maritime Surveillance System. Although international guidelines are not obligatory, IMO urged member states to follow them in order to apply these guidelines as a global standard.

Hence, with the above-identified benchmark, it is possible to discuss how to fill the gaps to ultimately improve the current state of affairs. The VTMS is made of different authorities that are carrying out various MS tasks. Sharing (on a need to know basis) information between VTMS and coastal stations will create a better understanding of maritime traffic/activities within Egyptian waters. Also it can increase the coverage area of the GOS VTMS, which in turn will enable the operator to early detect critical situations providing adequate time to initiate proper actions, well before a potential threat is manifested.

5.1.1 Policy harmonization

Integrated policies and establishing a cost-effective national cross-sectoral information sharing environment will improve the efficiency of Maritime Surveillance System by covering existing information gaps, while avoiding duplication of data. This can be achieved through integrated policies that are based on harmonization of laws, regulations and standard operating procedures (SOPs) with the aim to avoid contradictions and gaps. A cost-effective decentralized interconnection of several information layers, could also improve the efficiency of Maritime Surveillance System under examination by effectively dealing with information gaps that exist throughout Egypt waters, while avoiding duplication of data. MS integration aims to create an added value through additional relevant surveillance cross-sectoral data which will enhance the existing sectoral maritime awareness image among users of the Egyptian maritime domain (Fig. 5).

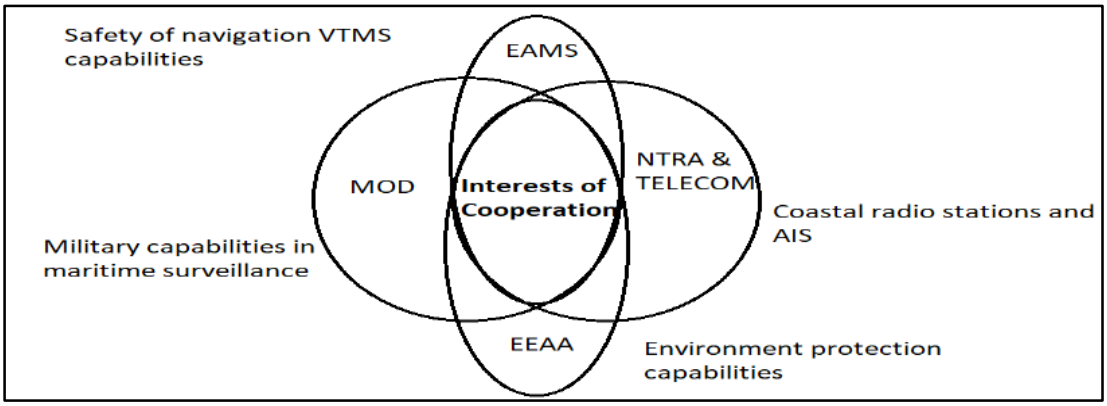


Figure 2: A need to know information sharing among MD stakeholders.

As a consequence, better situational awareness will be achieved which in turn can positively impact on issues like maritime safety and security, prevention of marine pollution, as well as more effective fisheries management and borders control. In other

words, an improved sharing of information could also bring costs down, since the cost-effectiveness of Maritime Surveillance System will be optimized.

6- Conclusion

This research effort heavily focused on emphasizing the importance and role of maritime surveillance in the GOS to enhance the safety of navigation and protect the marine environment. Data collected/analyzed indicated that several governmental and non-governmental agencies are involved in the surveillance of Egypt's maritime domain. Also, it was explained that Egypt has exercised its sovereignty and deployed certain tools available such as the GOS Traffic Separation Scheme (TSS), Aids to navigation and Vessel Traffic Management System that were all established by the competent authorities under the scope of national legislations and in compliance with the relevant international instruments.

Due to the extensive existence of oil wells, offshore Rigs and heavy traffic of non-SOLAS and SOLAS ships transiting the waterway, GOS is one of the hot spots of oil pollution in the Middle East region. Consequently, GOS VTMS is a cost-effective risk reduction and mitigation safety tool, established in a very important and quite narrow waterway. This research effort discussed how exchanging and updating information between VTS Centers and vessels is playing a dominant role in improving SA for the shipboard crew as well as the onshore VTSOs in a complex dynamic traffic image. Consequently, the improved SA is leading to construct a holistic traffic image which in turn will facilitate the safety of navigation and protect the environment. The research results also indicated that there are a number of gaps, in comparison with international regulations and guidelines. The lack of a multidisciplinary approach for maritime surveillance is one of the main gaps. This is mainly happening when governmental and non-governmental agencies are working independently and each entity follows a sectoral approach to maritime surveillance. It is recommended to establish a cross-sectoral information-sharing environment, at the national level. This can be achieved through integrated policies that will the competent authorities to avoid contradictions and gaps, mainly in relation to their standard operating procedures and the way the sharing of information is taking place.

References

Abelhafez, M. (1998). *The role of VTS in the safety of navigation and environment protection in the Gulf of Suez*, World Maritime University.

Ahram Online, (2014). *Death toll rises to 25 in Sunday's Gulf of Suez ship collision* http://english.ahram.org.eg/NewsContent/1/0/118328/Egypt/Death-toll-rises-to--in-Sundays-Gulf-of-Suez-ship-.aspx

Al-dhubhani, R., Al Shehri, W., Mehmood, R., Katib, I., Algarni, A., & Altowaijri, S. (2017). Smarter border security: A technology perspective. *1st International Symposium on Land and Maritime Border Security and Safety*, Saudi Arabia, 131-143.

BLOKUS-ROSZKOWSKA, A., & SMOLAREK, L. (2014). Influence of maritime traffic organization at waterwaysâ€™ crossings on the safety level of navigation. *Logistyka*, (3), 553-562.

Brödje, A., Lützhöft, M., & Dahlman, J. (2010). The whats, whens, whys and hows of VTS operator use of sensor information. *International Conference on Human Performance at Sea, Glasgow. University of Strathclyde, Glasgow,* 161-172.

Chintoan-Uta, M., & Silva, J. R. (2017). Global maritime domain awareness: A sustainable development perspective. *WMU Journal of Maritime Affairs*, *16*(1), 37-52.

Costa, N. A., Lundh, M., & MacKinnon, S. N. (2018). Non-technical communication factors at the vessel traffic services*. Cognition, Technology & Work, 20*(1), 63-72. https://doi.org/10.1007/s10111-017-0448-9

Dalaklis, D., Nikitakos, N., & Siousiouras, P. (2009). Enforcing safety and security in the eastern mediterranean: The greek effort to implement vessel traffic services. *The International Hydrographic Review*, 35-34. http://www.academia.edu/11718069/Enforcing_Safety_and_security_in_the_Eastern_Med_The_Greek_effort_to_implement_Vessel_traffic_services.

De Vries, L. (2015). Success factors for navigational assistance: A complementary ship-shore perspective. *Proceedings of the Human Factors and Ergonomics Society Europe*, 175-186.

Dewina, R. and Yamauchi, F., 2009. Human capital, mobility, and income dynamics: Evidence from Indonesia. *Japan International Cooperation Agency, Tokyo, and International Food Policy Research Institute, Washington, DC Photocopy.*

Directions, S. (2020). *Red Sea and Persian Gulf publication 172.* National geospatial-intelligence agency Springfield.

EAMS, (2020). *Rules of navigation to vessels traffic service: Gulf of Suez and the Red Sea V.T.S users' guide*. Egyptian authority for maritime safety.

Egypt Economic Development Conference. (2015). *Why invest in Egypt?* 1-13. https://www.uschamber.com/sites/default/files/why_invest_in_egypt_-_eedc.pdf

EMDB, (2019). *Maritime transport sector achievement 2019*. ministry of transport. http://www.emdb.gov.eg/multimedia/docs/Achievements2019_E.pdf

EMSA, (2007). *Promoting best practices*. European Maritime Safety Agency. http://www.emsa.europa.eu/who-are-we/admin-board/rules-of-procedure/188-

workshops/1108-promoting-best-practices-among-eu-vts-centres-the-finnish-experience-and-the-helsinki-vts83.html

European Commission. (2010). Integrating Maritime Surveillance: Common Information Sharing Environment (CISE). *Communication from the Commission to the Council and the European Parliament*. https://doi.org/10.2771/64104

Frame, J. D. (2003). *Managing risk in organizations: A guide for managers* John Wiley & Sons.

Ghalwash, G., & Elkawam, M. (2004). Updated oil spill risk assessment for the gulf of suez. *WIT Transactions on Ecology and the Environment, 77.*

Hollnagel, E. (2016). *Barriers and accident prevention*. Routledge

IALA. (2013*). IALA Guideline 1081 provision of virtual aids to navigation*: International Association of marine Aids to navigation and Lighthouse Authorities.

IALA. (2013a). *Maritime buoyage system and other aids to navigation*: International Association of marine Aids to navigation and Lighthouse Authorities.

IALA. (2016). *VTS manual (6th ed.)*: International Association of marine Aids to navigation and Lighthouse Authorities.

ICAO. (2018). *Egyptian search and rescue*. https://www.icao.int/MID/Documents/2018/ACAC-ICAO%20Civ-Mil%20WS/18-%20Session%203.1-2.pdf#search=JRCC%20CAIRO

IMO. (1997). *Guidelines for vessel traffic services* (Res.A.857(20)): International Maritime Organization.

IMO. (2010a). *Amendments to the International Aeronautical and Maritime Search and Rescue (IAMSAR) manual*. MSC.1/Circ.1367 24 May 2010: International Maritime Organization. http://www.imo.org/blast/blastDataHelper.asp?data_id=29093&filename=1367.pdf

IMO. (2010). *Seafarers` Training, Certification and Watchkeeping (STCW) Code*, 2010: International Maritime Organization.

IMO. (2013). *Imo instruments implementation code (iii code).* Resolution A.1070(28). Adopted on 4 December 2013. https://docs.imo.org/

IMO. (2017). *Guidelines and criteria for ship reporting systems* (Res.MSC.189(79)): International Maritime Organization. http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Maritime-Safety-Committee-%28MSC%29/Documents/MSC.433%2898%29.pdf

IMO. (2019). *Ships' routeing* (2019. ed.): International Maritime Organization.

JICA, (2008). *State of oil pollution and management in Suez gulf region.* regional environmental management improvement project (REMIP), Japan international cooperation agency http://www.eeaa.gov.eg/remip/index_files/WG2/080723%20State%20of%20Oil%20Pollution%20and%20Management.pdf

Lloyd's List (2018). *One Hundred Ports 2018*. https://lloydslist.maritimeintelligence.informa.com/one-hundred-container-ports-2018

Lloyd's List (2019). *One Hundred Ports 2019*. https://lloydslist.maritimeintelligence.informa.com/one-hundred-container-ports-2019/

Maritime Transport Sector. (n.d.a). *Specialized ports*. http://www.emdb.gov.eg/en/sections/11/1-11-Specialized-Ports

Maritime Transport Sector. (n.d.). *The Egyptian port's capacity*. http://www.mts.gov.eg/en/content/275/1-83-The-Egyptian-PortsCapacity

Ocean. (n.d.). In Merriam-webster Online Dictionary. https://www.merriam-webster.com/dictionary/ocean.

Praetorius, G. (2014). *Vessel Traffic Service (VTS): A Maritime Information Service Or Traffic Control System?: Understanding Everyday Performance and Resilience in a Socio-Technical System Under Change* [Chalmers University of Technology]. https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1084991&dswid=-5632

Schwab, k. (2019). *Insight Report.* http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

Siousiouras, P., & Dalaklis, D. (2009*). The Greek Effort to Implement Vessel Traffic Services in the Aegean Sea*. https://wmu. academia. edu/DimitriosDalaklis.

Suez Canal. (2020). *SCA navigation statistics: Monthly number and net ton by ship type,* Suez Canal Authority. https://www.suezcanal.gov.eg/English/Navigation/Pages/NavigationStatistics.aspx

The Egyptian Center for Economic Studies. (2020). *Egypt's economic profile and statistics 2020 edition*. http://www.eces.org.eg/PublicationsDetails?Lang=EN&C=5&T=1&ID=1178&Egypt%27s-Economic-Profile-and-Statistics---2020Tikanmäki, I. (2017). Common information sharing on maritime domain: A Qualitative study on European Maritime Authorities' Cooperation. *Knowledge Engineering and Knowledge Management,* 3, 283–290. https://doi.org/10.5220/0006582502830290

UK Hydrographic office. (2019). *Admiralty list of radio signals pilot services, vessel traffic services and port operations NP286(8) VOLUME 6*. UK Hydrographic office

UNCLOS, (1982*). United Nations Convention on the Law of the Sea chapter XXI, 1994*. United Nations https://treaties.un.org/Pages/ViewDetailsIII.aspx?src=TREATY&mtdsg_no=XI-6&chapter=21&Temp=mtdsg3&clang=_en#EndDec

Van Westrenen, F., & Praetorius, G. (2014). Maritime traffic management: A need for central coordination? *Cognition, Technology & Work, 16*(1), 59-70. https://doi.org/10.1007/s10111-012-0244-5

Wiersma, E., & Mastenbroek, N. (1998). Measurement of vessel traffic service operator performance. *Ai & Society, 12*, 78-86.

Zhang, S., Pedersen, P. T., & Villavicencio, R. (2019). *Probability and mechanics of ship collision and grounding* Butterworth-Heinemann.

Zhao, J., & Hu, Y. (2018). Features of Egypt's water transportation and China's participation in Egypt's port construction. *International Relations and Diplomacy*, *6*(9), 469-475.