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The impact of developing navigational aids on improving navigation safety and evaluated the effectiveness of the navigational aids along the Egyptian coast from Alexandria to Damietta

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المستخلص

خلاصة نظرا للنمو الأخير في الموانئ المصرية والذي أدى إلى استقبال أجيال جديدة من السفن وأهمية قناة السويس كممر عالمي للسفن المتجهة شمالا أو جنوبا ، فمن الأهمية بمكان البدء في تطوير وسائل علمية متقدمة لتطوير المساعدات الملاحية على الساحل المصري لرفع مستوى سلامة الملاحة البحرية في هذه المناطق الحساسة. تبحت هذه الورقة في تقييم السفينة عايدة / ٤ للمساعدات الملاحية على ساحل البحر الأبيض المتوسط خلال رحلة من منارة العجمي في الغرب إلى منارة دمياط في الشرق من عام ٢٠١٦ إلى عام ٢٠٢٠. استخدام نظام التعرف الآلي الافتراضي (VAIS) ، وكذلك الممرات والوسائل الملاحية الافتراضية مع تنفيذ مسح لآراء بعض الملاحين أثناء المرور في هذه المواقع المتعلقة بهذه الاختبارات في موانئ الإسكندرية وأبو قير ، ودمياط ، كشفت هذه الورقة عن عدد من النتائج المهمة ، من بينها وجود عيوب خطيرة في كفاءة تشغيل المساعدات الملاحية ، بهدف تقديم أكثر التوصيات العملية لتحسين كفاءة هذه المساعدات من خلال استخدام التكنولوجيا الجديدة مثل VAIS.

Abstract

The recent growth of Egyptian ports, which has resulted in the reception of new generations of ships and the importance of the Suez Canal as a global corridor for ships heading north or south, it is critical to begin developing advanced scientific means to develop navigational aids on the Egyptian coast in order to raise the level of maritime navigation safety in these critical areas. This paper examined evaluation carried out by marine officer on board M/V Aida4 for the navigational aids on the Mediterranean coast during a voyage from Al-Ajami lighthouse in the west to Damietta lighthouse in the east coast of Egypt from 2016 to 2020. This involved the realization of a series of practical experiments involving the use of a Virtual Automatic Identification System (VAIS), as well as virtual navigation lanes and aids. With the implementation of a survey of the opinions of a group of navigators during the passage in these locations related to these tests in the ports of Alexandria, Abu Qir, and Damietta, This paper revealed a number of significant findings, including the existence of serious flaws in the efficiency of navigational aids' operation, with the goal of offering the most practical recommendations for improving the efficiency of this aid through the use of new technology such as VAIS.

1. Introduction

The great growth in the sector of maritime transportation in the Arab Republic of Egypt, particularly in the expansion of seaports and the Suez Canal to accommodate contemporary ships, it is critical to assess the safety of maritime navigation in these areas. The purpose of this research paper is to examine and evaluate the effectiveness of navigational aids, as well as to assess navigational hazards along the navigation route from Alexandria to Port Said, through the continuous passage of navigational aids in these areas, which are represented by a total of six lighthouses, in addition to the buoys for the ports of Alexandria, Abu Qir, and Damietta, along the navigation route, by using the ship Aida /4 throughout four years, totaling 44 passes. As a result, the importance of the research paper became apparent in selecting the best modern technologies after conducting their own tests to determine the most effective means of increasing the efficiency of navigational aids' operation, resulting in an increase in maritime navigation safety.

The current status of navigational aids for the Egyptian coast in the Mediterranean

With the current development of the ports of Alexandria, Abu Qir, and Damietta, as well as the development of the Suez Canal, including the deepening of the canal's navigational route, allowing safe passage for ships with deep draughts up to 66 feet, and the increase in the canal's carrying capacity as a result of the duplication of a large portion of the canal, the Suez Canal's capacity has increased significantly. Ships passing through the Suez Canal, particularly huge ships, as a result, it was necessary to begin enhancing the shipping route along the Egyptian Mediterranean coast, as well

as the ports of Alexandria, Abu Qir and Damietta with advanced navigational to keep up with technological advancements in electronic equipment on board ships.

1.1 Navigational aids in the port of Alexandria

By the use of Aida IV, the racon and the light of the Ras El-Tin and Ajami lighthouses and the navigational aids in the navigational passage, as well as the Differential Global Positioning System (DGPS) station in El-Max, were followed up in the port of Alexandria through a periodic follow-up over four years from 2016 to 2020. The racon signal appeared as stated in Table (2), "34" times out of a total of "44" passes of the Ras El-Tin lighthouse over a four-year period. The light appeared "26" times out of a total of "44" occasions, representing a percentage of 59.1 percent, which is an unsatisfactory percentage. It is well observed that the Ajami lighthouse's racon's signals only "15" times out of a total of "44" times pass by at a rate of 34.1 percent, as stated in Table (2), and the appearance of illumination 22 times out of a total of 44 times passes by at a rate of 50 percent, which is a very small percentage in relation to the importance of the lighthouse in terms of approving ships approaching the anchorage area or entering the port of Alexandria or Dekheila, as shown in Table (1), as well as the difficulty of determining the signal of the racon of the Ajami lighthouse when approaching the port of Alexandria through the radar screen of the ship Aida IV except at very limited angles, as shown in Figure (1), which leads to the inability of ship's masters to fix their ships' position by using this lighthouse. This implies that the lighthouse is unable to guide ships in this high-traffic area, and it is noticeable that by ships, when passing by the Al-Ajami lighthouse, the lighthouse is located near a significant number of coastal buildings, which

has an impact on the racon's efficiency and the lighthouse's brightness. By observing El-Max DGPS station's technical condition, it was observed that the station has been malfunctioning since the beginning of 2018, affecting the accuracy of ship's locations in this area, as well as the interference observed on the Global Positioning System (GPS) by the use of the ship Aida IV during its voyages from 2016 to 2020, as well as the navigational warning No. 013 of 2019, issued by the US Department of Maritime Affairs (US. MARAD), on September 24, 2019, which indicated that (GPS) satellite systems are being interfered with in several areas in the eastern Mediterranean, posing a threat to navigational safety and the marine environment in this vital region. (US MARAD, 2019)

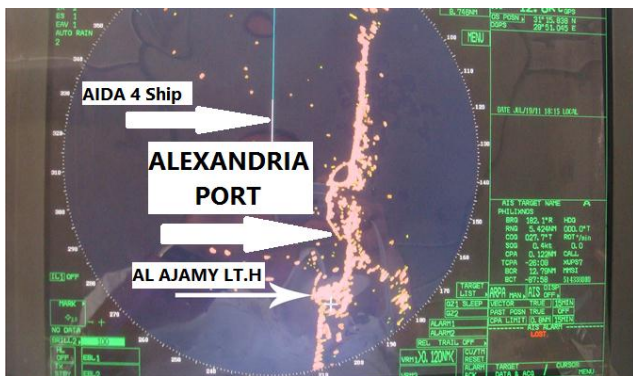


Figure (1): The weak signal of the racon of the Ajami lighthouse on the radar screen.

Source: Photograph from the ship's radar Aida IV while at sea (7/2019).

By monitoring the navigation route of the port of Alexandria, it was noticed the absence of a number of shipping route buoys in the locations designated for them on multiple occasions over the course of four years, from 2016 to 2020, as a result of the impact of bad weather at various times of the year, which affects the safety of navigation for ships while entering or leaving Alexandria's harbor.

1.2 Navigational aids in Abu Qir area

The technical condition of the navigational aids and navigational routes for the area of Abu Qir and Idku ports has been monitored continuously from 2016 to 2020. The navigational aids are represented by Nelson Island Lighthouse and Rashid Lighthouse, as a result of ongoing development in Abu Qir port and the establishment of a massive container handling station with a capacity of 2 million containers, it was noticed that the Nelson Island lighthouse's racon signal was observed 6 times out of a total of 44 passes over the course of 4 years, at a rate of only 13.6 percent, as presented in Table (2), as well as the appearance of lighting for 8 times out of a total of 44 passes at rate of only 18.2 percent, which is a very low percentage in relation to the lighthouse's importance, as presented in Table (1). Rashid lighthouse's racon signal appeared 29 times out of a total of 44 passes with 65.9% as presented in table (2).

As shown in Figure (1), the lighting is only 10 times out of a total of 44 passes with 22.7 percent, which is an unacceptable percentage as it affects the safety of navigation in this important shipping and economic area on the Egyptian coast for ships approaching and entering ports or passing through the shipping route (Alexandria-Port Said). Figure (2) depicts Aida IV ship's radar photo while sailing through the Abu Qir area, where there are no electronic navigational aids to guide ships in this densely trafficked area.

As a result of the large number of fishing vessels fishing by trawl nets at night in the shipping route (Alexandria-Port Said), as well as in the shipping routes for entering the ports of Abu Qir and Edkou, with no commitment fishing vessels to the areas designated for fishing outside the shipping route nor its navigational lights, as shown in

Figure (2), for the radar of the ship Aida IV while sailing in the Abu Qir area, which harmed the safety of navigation of passing ships.

As a result of all of the foregoing, an urgent and pressing need has arisen to find practical and expedient solutions to raise the technical level of navigational aids in this important shipping and economic area, including the development of advanced technological means to track fishing vessels present in large numbers while sailing in the Abu Qir area, as this is one of the factors that seriously affect safety of navigation.

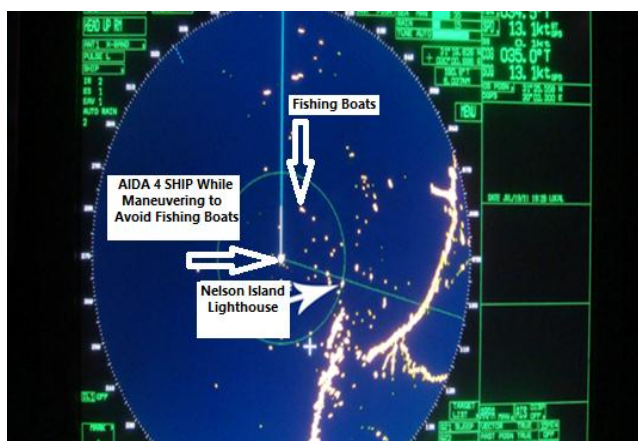


Figure (2): The poor efficiency of the navigational aids operation in Abu Qir Bay.

Source: Photograph from the ship's radar Aida IV during sailing (01/2020).

1.3 Navigational aids in the navigation route (Borollos - Damietta)

The shipping route from Burullus to Damietta is considered one of the most important shipping routes on the Egyptian coast. Due to the high density of ships, oil platforms, and fishing vessels in this area, the careful monitoring of the racoon and lighting of the Burullus and Damietta lighthouses, as shown in table (1) and (2), it was observed that the appearance of the Burullus lighthouse racoon for 22 times at a rate of 50

percent, as well as its lighting for 25 times at a rate of 56.8 percent, is considered an unacceptable percentage for such an important navigational area. The Damietta lighthouse racoon, as well, appeared 14 times at a rate of 31.8 percent, and lighting was detected 19 times at a rate of 43.2 percent, which is considered a very low percentage that jeopardizes the safety of ships in this area. In this important area, there are navigational hazards in addition to the large number of fishing vessels fishing in the shipping route from Damietta to El Burullus without complying with the areas designated for fishing outside the shipping route or with the lights of fishing vessels, which were shown on the Electronic Chart Display and Information System after connecting it to the radar of the ship Aida IV during sailing to avoid colliding with large numbers of fishing vessels, and in turn impacted the maritime safety of navigation in this important shipping and economic area.

In light of the foregoing, an urgent and pressing need has emerged to find unconventional and rapid solutions to raise the technical level of navigational aids at the lowest possible cost and in the shortest possible time, with the best possible results, as well as to find advanced technological means to monitor fishing vessels present in large numbers while sailing from Alexandria to Damietta.

To improve navigational aids in accordance with global advancements, practical experiments were carried out with the VAIS to ensure the system's suitability for the nature of the Egyptian coast. This is the first experiment of its kind in the Arab Republic of Egypt's Mediterranean Sea.

Table (1): The status of the illumination of the navigational aids for the Egyptian coast in the Mediterranean Sea during 44 passes

ROSETTA L.T.H		NELSON ISLAND L.T.H		AL AJAMY L.T.H		RAS AT TIN L.T.H	
UNLIT	LIT	UNLIT	LIT	UNLIT	LIT	UNLIT	LIT
34	10	36	8	22	22	18	26
77.3%	22.7%	81.8%	18.2%	50%	50%	40.9%	59.1%
DAMIETTA L.T.H		AL BURULLUS L.T.H					
UNLIT	LIT	UNLIT	LIT				
25	19	19	25				
56.8%	43.2%	43.2%	56.8%				

Source: Reports of the Egyptian Authority for Maritime Safety 2016-2020).

Table (2): The status of a raccoon of the navigational aid for the Egyptian coast in the Mediterranean, while during 44 passes

NELSON ISLAND L.T.H		AL AJAMY L.T.H		RAS AT TIN L.T.H	
Working	Not Working	Working	Not Working	Working	Not Working
6	38	15	29	34	10
13.6%	86.4%	34.1%	65.9%	77.3%	22.7%
DAMIETTA L.T.H		AL BURULLUS L.T.H		ROSETTA L.T.H	
Working	Not Working	Working	Not Working	Working	Not Working
14	30	22	22	29	15
31.8%	68.2%	50%	50%	65.9%	34.1%

Source: Reports of the Egyptian Authority for Maritime Safety 2016-2020).

2. Practical experiments carried out in the Mediterranean

After a detailed monitoring was carried out to check the efficiency of the operation of the navigational aids in the port of Alexandria, Abu Qir area, and the navigation route from Burullus to the port of Damietta, it became clear that there is a significant deficiency in the efficiency of the operation of most of the navigational aids due to

several factors, including, but not limited to, the age of racons and searchlights, as well as the direct impact of the buildings located behind the Ajami lighthouse, which reduces the chances of a racon signal appearing on ships' radar.

2.1 The practical experiment that was carried out in the port of Alexandria

The virtual AIS (AtoN) were installed at Al-Agamy Lighthouse and the GREAT PASS BEACON in the navigation route at the entrance to the port of Alexandria as part of the practical experiment. In January 2020, this experiment was carried out on the ship Aida IV with the help of the Virtual AIS AtoN. The experiment was conducted in inclement weather in order to acquire results in inclement weather, and meteorological data were taken, which revealed that the wind speed was 19 knots, the wave height was 2.5 to 3 meters, and the atmospheric pressure was 1005 millibar.

The experiment began when the ship Aida IV was moored in the port of Alexandria, and a virtual navigation route was established with six virtual buoys numbered A1 through A6, as well as a virtual position for Beacon GREAT PASS BEACON, as illustrated in Figure (3).

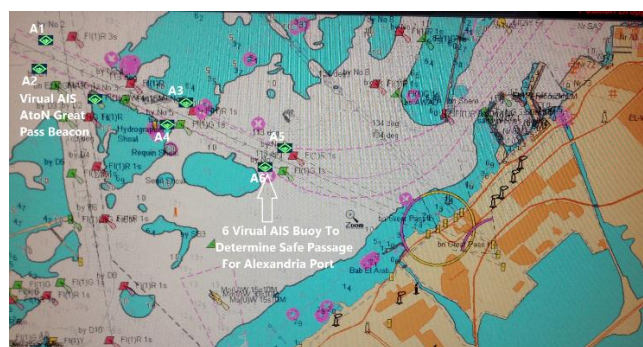


Figure (3): The ship Aida IV during the implementation of the practical experiment in the port of Alexandria.

Source: Photo by Transas ECDIS of Aida IV (1/2020)

The ships entering or departing the port of Alexandria, as well as ships approaching the port anchorage area, were watched for a 12-hour period by the ship Aida IV while it was berthed in Alexandria port to observe how they reacted when using the virtual navigation route by use of RADAR, ECDIS, and AIS. In addition, they used GREAT PASS BEACON to fix their ship's positions.

During the implementation of the practical experiment, a survey was conducted on 17 ships using a VHF device, asking a series of questions as given in Table (3) during entry and exit from the port of Alexandria. The survey's outcome was confirmed after receiving the responses and analyzing them using the percentage computation. The survey found that 16 ships out of a total of 17 ships used the virtual navigation route with ease of identifying the GREAT PASS BEACON through RADAR, AIS, and ECDIS, ensuring that the ships benefit from all of the capabilities of virtual navigational aids, namely (identifying the type of the buoy, its name, the accuracy of its location, bearing and distance from the navigational aid, as well as the reception of weather information, and navigational warnings emphasizing the use of the Maritime Mobile Service Identity (MMSI) number for easy messaging with navigational aids in emergency situations. One ship (5.9%) stated the inability to view the virtual navigational route on the RADAR, however virtual navigational aids were observed through the AIS, and ECDIS.

The ship Aida IV departed from the port of Alexandria after the survey was completed, and the virtual navigation route for the port of Alexandria was used, and the GREAT PASS BEACON was easily identified through the RADAR and ECDIS as shown in Figure (4) with

the ship's positions was fixed while leaving the port of Alexandria and sailing through the shipping route (Alexandria - Port Said).



Figure (4): The ship Aida IV during the implementation of the practical experiment in the port of Alexandria.

Source: Photograph from the ship's radar Aida IV during sailing (1/2020).

2.2 The practical experiment that was implemented in the Abu Qir area

It was planned to begin implementing the experiment in the Abu Qir area, using the ship Aida IV as it sailed away from the port of Alexandria. The Virtual AIS AtoN device was programmed with the positions of six buoys for the Abu Qir port navigation route, as well as a virtual position for the Nelson Island lighthouse, as shown in Figure (5) and transmission has started. At a distance of 18 nautical miles, virtual positions in Abu Qir port were observed by Aida IV RADAR, ECDIS, and AIS. During the practical experiment, a survey of 12 ships in the Abu Qir area was conducted by asking a series of questions, as shown in Table (3). Following the responses from the ships' captains, the experiment demonstrated the ease of identifying the virtual navigational aids of the Nelson Island lighthouse, as well as the ease of identifying the safe navigation route for port of Abu Qir near navigational hazards, and the survey result in this experiment was 100% of the number of ships.

A large number of ship captains emphasized the importance of researching the benefits of providing a variety of navigational aids along the coast with the VAIS, particularly in the port areas of Eddko, Abu Qir, Alexandria, and Damietta.

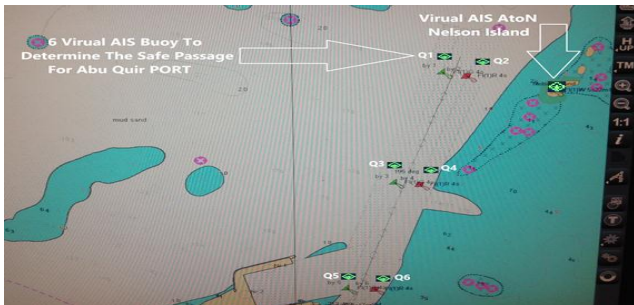


Figure (5): The ship Aida IV during the implementation of the practical experiment at Abu Qir port.

Source: Photo by Transas ECDIS while sailing, Aida IV (1/2020)

height of 2.5–3 meters). The experiment was carried out in this bad weather to assess the system's capabilities in various weather conditions.

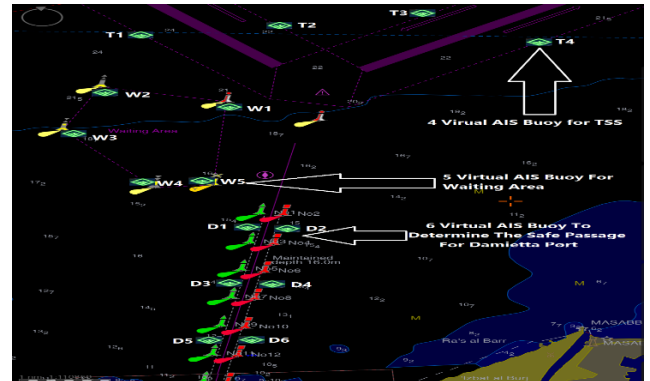


Figure (6): The ship Aida IV during the implementation of the practical experiment in the port of Damietta.

Source: Photo by Transas ECDIS, Aida IV (1/2020)

2.3 The practical experiment that was implemented in the area from Damietta to Al-Burullus

After completing the Suez Canal passage in January 2020, plans were made to begin implementing the experiment in the Damietta port area, using the ship Aida IV while sailing. The Virtual AIS AtoN device has been programmed with 15 virtual locations 5 for waiting area buoys, 6 for the navigational route to enter the port, and 4 for TSS areas), and transmission has begun. The virtual buoys appeared on the Aida IV ship's navigational equipment while the ship was sailing in Traffic Separation System (Port Said-Damietta) at a distance of 17 nautical miles, as shown in figure (6). Because of the nature of the bad weather in January, this month was chosen. During the experiment, the weather was monitored, and the forecast data was (wind speed of 17–21 knots, sea condition of 4-5 Befourt, atmospheric pressure of 1007 mbar, and wave

During the implementation of the practical experiment, a survey was carried out by asking a number of questions as shown in Table (3), by communicating via VHF as well as sending messages via the AIS device using the MMSI numbers of 13 ships navigating the TSS area in front of Damietta. When conducting a survey, it was noticed that the captains and officers of these ships responded quickly due to the importance of advanced navigational aids in guiding ships in this region, which has a high density of ships but is not equipped with modern navigational aids. Following the response from duty officers, the experience revealed that it was easy to identify the virtual navigation aids through (RADAR, ECDIS, and AIS) for 12 ships, at a rate of 92.3 percent, and 1 skipper for a fishing ship, at a rate of 7.7 percent, indicated that they were unable to follow the virtual navigation aids. Because Egyptian fishing vessels do not have an AIS onboard.

After completing the experiment in the Damietta area, preparations were made to begin implementing the experiment in the Burullus area by setting two locations on the Virtual AIS AtoN device (Baltim East GaSFIELD and Baltim South GaSFIELD), and the transmission was started. As illustrated in Figure (7), at a distance of 17 miles, during the practical experiment, a survey was conducted as well, by calling nine ships and asking a series of questions as shown in Table (3). The experiment's survey found that only 2 vessels (22.2 percent) identified and benefited from virtual navigational aids, while 7 fishing vessels (77.8 percent) reported not knowing the system due to the absence of an AIS onboard. As shown in Figure (7), a large number of fishing vessels may be observed, with their non-compliance with international fishing rules that forbid approaching shipping routes, as well as not adhering to fishing vessel lights or shapes, which affect the safety of navigation and the marine environment in this area where a large number of gas platforms are located.



Figure (7): The ship Aida IV during the implementation of the practical experiment in the navigational passage Damietta - Burullus. Source: Photo by Transas ECDIS, Aida IV (1/2020)

Table No. (3): Questionnaire on using AIS AtoN to evaluate work efficiency of navigation aids in Alexandria, Abu Quir and Damietta Ports

1	Are you familiar with the Virtual AIS Aton?
2	Did you see the symbol indicating the virtual AIS Aton in Alexandria Port through ECDIS, RADAR and AIS?
3	Did you see the symbol indicating the virtual AIS Aton in Abu Quir Port Through ECDIS, RADAR and AIS?
4	Did you see the symbol indicating the virtual AIS Aton in Damietta Port and Baltim Gas Fields in Al Burullus through ECDIS, RADAR and AIS?
5	Have you been relying on virtual AIS Aton in Alexandria, Abu Quir and Damietta Ports?

3. Results

The research paper revealed a number of significant findings, including:

- There is a severe deficiency in the efficiency of the operation of navigational aids in Alexandria, Abu Qir, and the navigational route from Abu Qir to Damietta, which is represented by lighting and racons, as it was indicated that the average efficiency of the operation of all navigational aids' racons is 45.5 percent, and the operation of all navigational aids' lights is 41.7 percent, and subsequently for all navigational aids is 43.6

percent, posing a serious threat to ship safety and thus having a direct impact on the safety of navigation and the marine environment in these critical areas of the Egyptian coast.

- The lack of electronic navigational aids to assist ships in entering Abu Qir port or Idku port or passing through the Alexandria-Port Said shipping route, resulting in a low level of maritime safety in the Abu Qir area, taking into consideration that this area is regarded as one of the most important navigational and economic areas on Egypt's coast.
- As a series of practical experiments were carried out in Alexandria Port, Abu Qir Port, and the shipping route from Damietta to Burullus using the AIS AtoN, the experiments demonstrated that the system was unaffected by the nature of the Egyptian coast, the prevailing bad weather, or the high density of ships. In addition to the ease of identification and recognition of it by ship captains by using ECDIS, RADAR, and AIS.
- The survey of the practical experiments that were carried out in January 2020 in Alexandria, Abu Qir, Burullus, and Damietta using Virtual AIS AtoN revealed the ease of use by 42 out of a total of 51 ships, equal to 82.4 percent, for virtual aids and routes, as well as the inability of 9 fishing vessels, equal to 17.6 percent, to identify the system due to a lack of AIS on board the Egyptian fishing vessels.

4. Recommendations

- Due to the racon's inefficiency with these lighthouses, Ras El-Tin, Al-Ajami, Nelson Island, Rashid, Burullus, and Damietta

lighthouses need to be equipped with a Virtual AIS AtoN system to supplement the racon.

- The Virtual AIS AtoN is to be utilized in navigation routes for the ports of Alexandria, Dekheila, Abu Qir, Adku, and Damietta.
- The installation of a GREAT PASS BEACON with Virtual AIS Aton near the port of Alexandria's entrance is vital since the beacon is vital for directing ships into both the Alexandria and Dekheila ports.
- The use of the Virtual AIS Aton system during the port's passage, which assists shipmasters in selecting a safe navigation route, especially in foggy conditions.

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