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Research Article

ANALYSIS OF NAVTEX MESSAGES PUBLISHED FOR THE MEDITERRANEAN REGION IN TERMS OF SAFE NAVIGATION OF SHIPS

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ABSTRACT

Navigational Telex (NAVTEX) messages have a significant impact on the navigational safety of ships. NAVTEX plays an important role in decreasing the chances of near-misses, groundings, and collisions in the sea by disseminating safety-related information. In this study, it was aimed to present that navigational risk trend in a region could be revealed by analyzing NAVTEX messages. The analysis of NAVTEX messages as a data set will constitute a good data source for ship managers, researchers and seafarers who are navigating on the seas. Since there is no current research on NAVTEX messages in terms of navigational safety focused on Mediterranean Sea in the literature, this study aimed to fill this gap. The NAVTEX messages that pertain to the Mediterranean region were examined in the notice to mariners bulletin published by the Turkish Naval Forces Office of Navigation, Hydrography and Oceanography between 2019 and 2022. The examination was limited to messages broadcast from Antalya station. The study employed the document analysis method. The distribution of the number of messages by year, the annual distribution of messages by topic, and the annual distribution of messages by type were determined as the main research questions. It has been observed that studying the trends of NAVTEX messages can provide significant data about the region. It has been evaluated that this approach will contribute to the decision-making mechanisms of ship managers, particularly seafarers, and can serve as a source of information for rule makers. This study was produced by developing the undergraduate thesis titled "Review of NAVTEX Messages for the Mediterranean Sea Published in Notice to Mariners", which was completed successfully in June 2023.

Keywords: *Maritime Transportation, Ship Management, NAVTEX, Safety, Mediterranean Sea*

1. INTRODUCTION

To ensure safe navigation, ships must have information about the region they are in. Obtaining up-to-date information about weather condition, water depth, and currents, as well as the presence of an element that could adversely affect navigation safety, is crucial. Emergency situations can be managed promptly by being instantly informed of important conditions in the navigation area and the negativities encountered by other ships. It contributes to the safety and security of ship crew and passengers, which in turn increases navigational safety in general.

Safety at sea is ensured through the publication of international standards and regulations. The International Maritime Organization (IMO) is the source of these publications. The aim of these rules is to improve the efficiency of the systems and equipment employed on ships. Communication between shore and ship stations is provided by the Global Maritime Distress Safety System (GMDSS), which is one of these systems. Rapid communication in emergencies and routine communication are possible with the use of GMDSS system, which consists of a series of equipment. The NAVTEX system, which is shortened to Navigational Telex, is a component of the GMDSS system. Emergency messages may also be included in NAVTEX messages that convey important navigational information. NAVTEX messages contain a variety of warnings, including navigation aid status, weather forecast, search and rescue (SAR) activities, environmental information, underwater work, and warnings about fishing vessels. The navigational safety of the ship could be affected by these messages and it may be necessary for the ship to change its route. Ship crew are now able to take early precautions against possible dangers thanks to the NAVTEX messages. Kaptan and Ugurlu (2022) studied how electronic navigation devices contribute to marine accidents. A total of 153 accidents that were published by 9 different accident research institutions were reviewed in the study. It was stated that the error in selecting the station of the NAVTEX device caused a ship collision. Similarly, according to the safety investigation report published by Transport Malta's Marine Safety Investigation Unit (MSIU), NAVTEX operating error was stated among the probable causes in the grounding incident of the oil tanker Hephaestus (Safety4sea, 2023). Therefore, the analysis of NAVTEX messages is important in the context of maritime safety.

This study examined NAVTEX messages that were published in one of the seas surrounding Turkey, with the idea that examining the content of NAVTEX messages within a specific region may provide insight into navigational safety in that region. It is aimed to reveal some information about the topics on which messages are published most, what the type of messages are and the annual change in the number of messages. The results will assist in making suggestions to enhance safety based on the information obtained. The Mediterranean Sea was selected as the area of study. The Mediterranean Sea has always been the location of many activities, such as maritime trade and fishing. The Black Sea countries have their sea exit route through the Mediterranean, which opens to the Suez Canal. Due to the constant use of commercial ships, there is a high volume of maritime traffic in the area. The geographical features and

geopolitical position make it one of the most important sea areas in the world. Furthermore, the Eastern Mediterranean's dynamism has been enhanced by research and work on energy resources. It is crucial for ships sailing in the region to have knowledge about the region to ensure their safety. (Kedikli & Çalağan, 2017).

This study examined the NAVTEX warnings in the notice to mariners published by the Turkish Naval Forces Office of Navigation Hydrography and Oceanography, that pertain to the Mediterranean region. Only the messages broadcast from Antalya station were analyzed. Other countries' announcements regarding this region were excluded. The data for the years 2019-2022 was analyzed. The data was categorized under the standard message type classes of NAVTEX. By contributing to the safe operation of ships, it aims to increase safety in the maritime sector by providing useful information to ships sailing in the Mediterranean. In this study, it was aimed to present that navigational risk trend in the region could be revealed by analyzing NAVTEX messages. It was assessed that using big data analysis approach to review NAVTEX messages would increase navigational safety.

This is the first study that examines the NAVTEX warnings for the Mediterranean Sea included in notice to mariners published by the Turkish Naval Forces Office of Navigation Hydrography and Oceanography in terms of navigational safety. It will be a great resource for literature. The significance of NAVTEX messages in safeguarding maritime operations and preventing accidents at sea cannot be underestimated. Thus, this study is significant due to its potential to inspire future research. The next section of the study contained information about NAVTEX and references to studies in the literature. Section 3 outlines the methodology. This section provides an explanation of data classification, research questions, and data analysis method. In Section 4, the study's findings are presented. The study results' and advantages are discussed in Section 5.

2. NAVTEX

Maritime safety information (MSI) encompasses numerous navigational and meteorological warnings, as well as urgent safety-related messages that need to be distributed to ships in different areas of navigation (Zanic Mikulicic, 2018). Narrow Band Direct Printing Telegraphy also sends MSIs, which are received by the NAVTEX receiver. NAVTEX uses 518 kHz frequency on which coast stations transmit information and the range of about 250 to 400 nautical miles is intended to prevent mutual interference and transmissions (Korc, 2011). On a time-sharing basis, the transmission is transmitted in English. The message types that the NAVTEX device receives are explained in IMO MSC.1/Circ.1403 as illustrated in Table 1.

Table 1. Characters and types of NAVTEX messages (IMO MSC.1/Circ.1403)

Identification character	Type
A	Navigational warnings
B	Meteorological warnings
C	Ice reports
D	Search and rescue information, acts of piracy warnings, tsunamis and other natural phenomena
E	Meteorological forecasts
F	Pilot and VTS service messages
G	AIS service messages (non-navigational aid)
H	LORAN messages
I	Currently not used
J	GNSS messages regarding PRN status
K	Other electronic navigational aid system messages
L	Other navigational warnings
M, N, O, P, Q, R, S, T, U	Currently not used
V, W, X, Y	Special services allocation by the IMO NAVTEX coordinating Panel
Z	No message

NAVTEX and maritime safety are covered in various studies in the literature. An application was developed by Lee and Lee (2013) that displays NAVTEX messages on Android mobile devices. Korcz (2016) analyzed the operational and technical capabilities of marine communication systems to guarantee maritime safety and security. The author concluded that the combination of NAVTEX and the SafetyNET service via the Inmarsat EGC service is a highly reliable method of disseminating warnings. The study pointed out that implementing new technology is the only way to achieve navigational safety and security. Yao et al. (2017) proposed a design for the exciter of the weather fax chart and NAVTEX message. Liu et al. (2018) investigated a classification system that uses the Bayes Theorem for MSIs. From 2011 to 2016, thousands of NAVTEX messages were collected by the authors and they compared naive Bayes classifiers with different event models. They concluded that the method proposed to use Naive Bayes theory to classify MSI is feasible and can result in a good classification effect. Borisova et al. (2020) examined the improvement of the telecommunication support of navigational safety systems in the Arctic. One of the conclusions that the authors reached is that the deployment of NAVTEX automated systems and high-frequency coastal equipment should be included in the construction of marine rescue coordination centers.

It is observed in the literature that the studies on NAVTEX messages specific to the Mediterranean region (Oral, 2021; Şen and Açıkgöz, 2022; Ogurlu and Ozsaglam, 2022) are generally linked to politics. As there is no current research on NAVTEX messages in terms of navigational safety focused on Mediterranean Sea in the literature this study will be the first to be published on this subject.

3. METHOD

The research was conducted using a document analysis method. The process of document analysis involves examining and evaluating materials in electronic or printed media (Bowen, 2009). The document analysis process is depicted in Kiral (2020)'s study as shown in Figure 1.

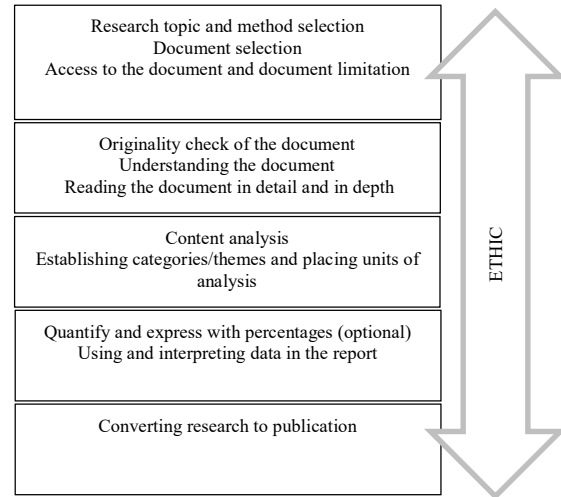


Fig. 1. Document analysis process Kiral (2020)

The process begins with choosing the subject and accessing the document, and continues with a detailed examination of the document, as shown in Figure 1. Afterward, the data obtained through content analysis is analyzed and published. Ethics appears to be the fundamental element of this process.

NAVTEX messages published in the Mediterranean Sea were examined within the scope of the research. The research focused solely on Türkiye's published messages, while other countries' announcements regarding this region were excluded. The information under the heading "NAVTEX message" in the Notices to Mariners Bulletin published regularly on the website of the Turkish Naval Forces Office of Navigation, Hydrography and Oceanography was used. Weekly publication is the norm for this bulletin. The validity and reliability of the research is enhanced by the use of an institutional report. According to Baltacı (2019), the degree to which the researcher solves the problem objectively is known as validity, and reliability is related to the repeatability of the results. It is considered that this study is valid and reliable because the information in the notice to mariners is presented in an understandable, clear and organized manner and the data used within the scope of the research is not modified.

Detailed information about the data analysis stages is presented under the headings of Section 3.1 Data Classification, Section 3.2 Research Questions, and Section 3.3 Data Analysis.

3.1. Data Classification

The following categories were determined to examine the data through content analysis.

- Notice number (week/year)
- Message number
- Serial number
- Continuing/Discontinued identification
- Station code
- Message type
- Message topic
- Message content
- Position information

Codes are used to categorize some of these categories within themselves. The explanations under the category headings below provide detailed information about classification. An Excel file was used to process the data for the years 2019-2022.

3.1.1. Notice number

The notice number provides us with information about the week and year in which the message was published. The messages for the first week of the year are numbered 01. The messages for the final week of the year are numbered 52. The week number is followed by the year information.

3.1.2. Message number

Each message published by the Turkish Naval Forces Office of Navigation, Hydrography and Oceanography has a distinct message number assigned to it. The processing of messages is prevented from any confusion by this method. The archiving process is also made easier by it.

3.1.3. Serial number

The serial number of a message can be used to determine the year the message was published by the Turkish Naval Forces Office of Navigation, Hydrography and Oceanography.

3.1.4. Continuing/Discontinued Series Identification

NAVTEX messages are divided into two categories: continuing and discontinued. A continuing series is defined as messages that have been published and are valid at later dates. Discontinued series are messages that are published once and do not remain valid at later dates. The analysis phase in this study was organized by assigning codes "1" to continuing series and "2" to discontinued series during the data processing phase.

3.1.5. Station Code

NAVTEX messages are broadcasted by Coastal Radio Stations (CRS). Stations in Istanbul, Antalya, Samsun, and Izmir in Türkiye produce these broadcasts.

This study will only examine NAVTEX messages that were published for the Mediterranean Sea. The

messages broadcast from Antalya station were analyzed for this reason. Istanbul station was coded as "1", Samsun station was coded as "2", Izmir station was coded as "3", and Antalya station was coded as "4" during the data extraction process.

3.1.6. Message type

To define the message type, 6 separate classes have been determined in accordance with NAVTEX standards. The data was recorded by assigning a code to each class.

- The code for navigational warnings (A) is '1'. Announcements about significant malfunctions in navigation aids, marine accidents, fires, suspicious objects, underwater work, wrecks, and shallows are included under this message type.
- The code for meteorological warnings (B) is '2'. The purpose of these warnings is to provide information about meteorological events.
- The code for ice warnings (C) is '3'. There are no warnings of this nature in the region. To avoid disrupting the NAVTEX message category order, this category was also numbered and added to the analysis process.
- The code for Search and Rescue Activities and Piracy (D) is '4'. The purpose of this broadcast is to inform ships about search and rescue activities. This class also includes announcements to alert other ships in case of a piracy activity.
- The code for the weather forecast (E) is '5'. This class includes weather forecast reports.
- The code for pilotage (F) is '6'. This class contains information about pilotage messages made by ports.

3.1.7. Message topic

According to the content of the message, to better comprehend the topic on which it was published and present it in numerical results, 7 message topic classes were established. Below is a list of the classes and their assigned codes.

Aids to navigation messages are encoded with '1'.

The code for messages about shipwrecks and floating objects is '2'.

Messages that pertain to underwater work and scientific research are encoded with '3'.

Military activities and drills are coded with '4'.

Messages about piracy are coded with '5'.

The code for messages about mines is '6'.

The code for other messages is '0'.

3.1.8. Message content

The purpose of this category is to examine the content of NAVTEX messages. The codes under the message topic heading were assigned after reading the contents.

3.1.9. Position information

The purpose of creating this category was to comprehend the latitude and longitude of the warning subject to the message.

3.2. Research questions

The research's objective was to uncover answers to the following questions.

Question 1: What is the distribution of the number of messages by years?

Question 2: What is the annual distribution of messages based on their topics?

Question 3: What is the annual distribution of messages based on their type?

3.3. Data analysis

The Excel screenshot in Figure 2 demonstrates the classification of data.

To find answers to the research questions mentioned in section 3.2, the data arranged in the format exemplified in Figure 2 was analyzed. There was a total of 718 data entries made for the years 2019-2022.

	A	B	C	D	E	F	G	H	I
1	Notice no	Message no	Serial No	Continuing/Discontinued	Station	Message type	Message topic	Message Content	Position
2	41/2022	962	2022	2	4	1	1	MMK METALLURGY pier light located at 36 47.08 N, 036 12.07 E is temporarily off. Notice to mariners.	36 47.08N, 036 12.07 E
3	41/2022	998	2022	2	4	1	1	BABA BURNU light at location 36 50.77 N, 030 45.48 E is temporarily off. Notice to mariners.	36 50.77 N, 030 45.48 E

Fig. 2. Example screenshot for data classification in Excel file

4. FINDINGS

Figure 3 presents the distribution of the number of messages by year as the answer to research question number 1.

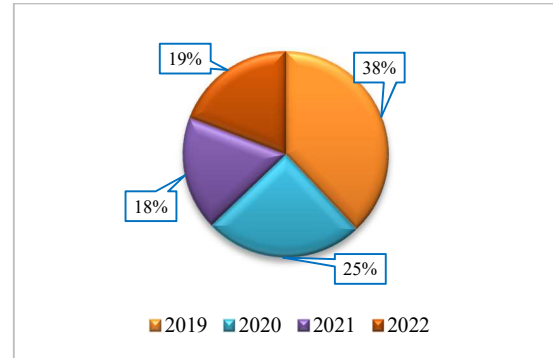


Fig. 3. The number of messages by year

Out of 718 messages, 271 (38%) was from 2019. 180 (25%) was from 2020, 129 (18%) was from 2021, and 138 (19%) was from 2022. The number of messages received was the highest in 2019. The number of messages decreased in 2020, and reached its lowest value in 2021. There is a slight increase in the number of messages in 2022 compared to 2021.

Figure 4-8 represents the annual distribution of messages based on their topics as the answer to research question number 2.

The number of messages about the first message topic, aids to navigation, is shown in Figure 4 in a year-by-year distribution.

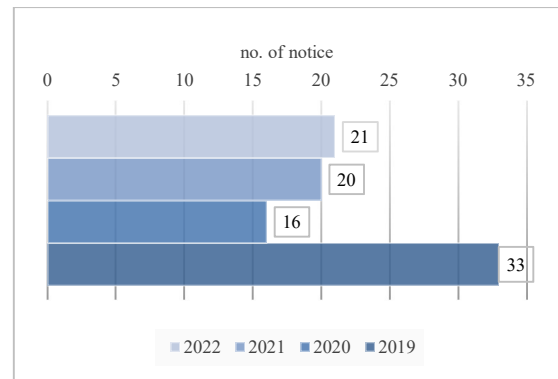


Fig. 4. The number of messages about aids to navigation by year

The most messages about navigation aids were received in 2019. The number of messages decreased by almost half in 2020, but it began to increase in 2021 and 2022.

In 2019, the topics that received the most messages were those related to temporarily extinguished or destroyed lighthouses and extinguished/broken light buoys.

The Mersin Vessel Traffic Service system activation announcement was among the messages made in this year. The messages transmitted in 2020 were about extinguished lights and buoys. Warnings about removed or installed buoys, extinguished or malfunctioning lights, and advice to stay alert for sea pollution were included in messages sent in 2021. Warnings were made in 2022 regarding the extinguished/installed lighthouses/light buoys. The distribution of messages about the second message topic, shipwrecks and floating objects, by year is shown in Figure 5.

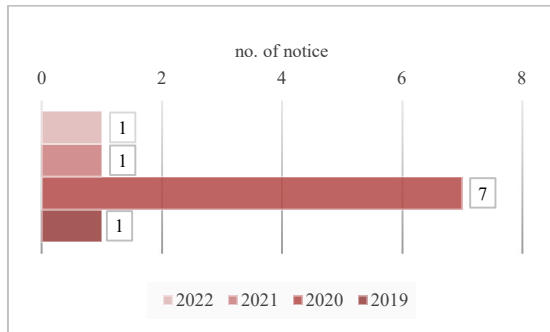


Fig. 5. The number of messages about shipwrecks and floating objects by year

In 2020, the number of messages about shipwrecks and floating objects was the highest. The evaluation of all years shows that 2 out of 10 messages were related to shipwrecks, while the remaining ones were related to floating pipes/discharge pipes.

The distribution of messages related to underwater work and research activities which is the third message topic is shown in Figure 6.

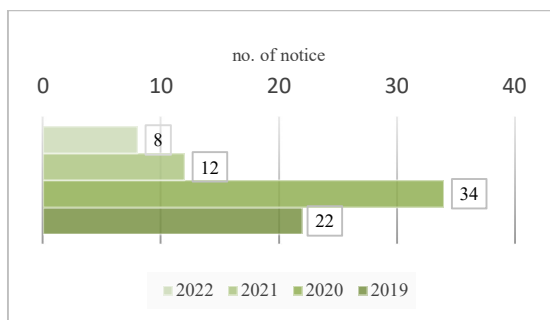


Fig. 6. The number of messages related to underwater work and research activities by year

Figure 6 shows that the most messages were transmitted in 2020. Issues like sea measurement studies, pipeline repair, underwater device backup, drilling work, seismic research, and cable repair were addressed in the messages. It has been observed that the number of messages decreased after 2020. When all years were evaluated together, it was found that the majority of messages were related to drilling and seismic research.

Figure 7 shows how messages related to drills and military activities, which is the fourth message topic, are distributed over the year.

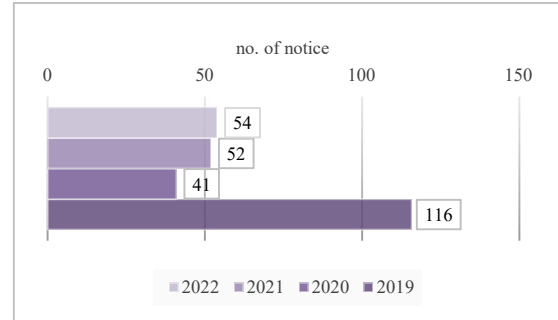


Fig. 7. The number of messages related to military activities and drills by year

The majority of messages were issued in 2019, as shown in Figure 7. It is believed that Türkiye's increase in energy resource activities in the Mediterranean Sea in 2019 is a factor in this result. In other years, it has been observed that the number of messages decreased by approximately half.

Moreover, after examining all the data, no messages were found regarding piracy and mine issues, which are the fifth and sixth message topics, respectively.

The number of messages published on other topics, which is the last message topic, is shown in Figure 8 in a year-by-year distribution.

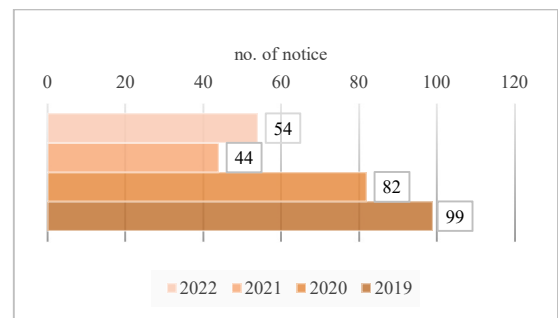


Fig. 8. The number of messages published on other topics by year

The content of the messages in Figure 8 is related to broadcasts from Turkish NAVTEX stations. The number of messages was highest in 2019, but they have decreased over the years.

An answer to research question 3 regarding the annual distribution of messages based on their type has been sought. It is seen that, all messages published between 2019 and 2022 that were examined within the scope of this study were classified as 'Navigational Warnings (A)', with code '1.' Messages under the types Meteorological Warnings (B), Ice Warnings (C), Search and Rescue Activities and Piracy (D), Weather Forecast (E) and Pilotage (F), numbered with codes 2, 3, 4, 5, 6 respectively, were not broadcast from Antalya NAVTEX Station during this date range.

Out of the 718 messages reviewed, 60 are continuing messages with repeated broadcasts, and 658 are discontinued messages. When we examine the content of the continuing messages published in the navigation area, it is seen that

- 29 messages were related to information and country policy.
- 11 messages were received about problems with navigation aids.
- There is 1 message about the shipwreck.
- There were 9 messages about platforms and drilling activities.
- 7 messages were related to drill/training and military activities,
- There were 3 messages regarding underwater work

It was determined that approximately half of the continuing messages were warning messages to other countries, while the other half were scattered among other data.

3. CONCLUSION

Every year, marine and ship technologies are being developed. This is resulting in the integration of new systems into ships. NAVTEX messages are still crucial for navigation safety. Although connecting NAVTEX with other devices on the bridge may seem to bring a complex experience in terms of use, it makes the job of officers responsible for navigational safety much easier.

Analysis of NAVTEX messages provides an important data source for the navigational safety of ships in the region. In this study, it was aimed to present that navigational risk trend in the region could be revealed by analyzing NAVTEX messages. It was assessed that using big data analysis approach to review NAVTEX messages would increase navigational safety. Therefore, the NAVTEX warnings for the Mediterranean Sea included in the notice to mariners bulletin published by the Turkish Navy Forces Office of Navigation Hydrography Oceanography between 2019 and 2022 were examined. The examination was limited to messages broadcast from Antalya station. It is aimed to find an answer to the research questions about the topics on which messages are published most, what the type of messages are and the annual change in the number of messages.

The total number of data entries made for the years 2019-2022 was 718. Out of 718 messages, 38% was from 2019, 25% was from 2020, 18% was from 2021, and 19% was from 2022. The study found that 'Navigational Warnings' was the only type of message that was published between 2019 and 2022.

The data also assessed according to the topics of warnings. The first message topic was aids to navigation. The year 2019 saw the highest number of messages about aids to navigation. The introduction of the VTS system in the region in 2019, the number of military activities and the intense warnings made about the Turkish NAVTEX system, shows that action has been taken in terms of both safety and security in the navigation area by Türkiye. In 2019, the messages were related to temporarily extinguished or destroyed lighthouses and extinguished/broken light buoys. The messages transmitted in 2020 were about extinguished lights and buoys. The warnings announced in 2021 were about removed or installed buoys, extinguished or malfunctioning lights, and advice to stay alert for sea pollution. The warnings transmitted in 2022 were about the extinguished/installed lighthouses/light buoys.

The second message topic was shipwrecks and floating objects. The number of messages about shipwrecks and floating objects was the highest in 2020. It was found that 2 out of 10 messages were related to shipwrecks, while the remaining ones were related to floating pipes/discharge pipes.

The third message topic was underwater work and research activities. The most messages under this topic were transmitted in 2020. Sea measurement studies, pipeline repair, underwater device backup, drilling work, seismic research, and cable repair were addressed in the messages. Drilling and seismic research were the most mentioned message content under this topic. The number of messages decreased after 2020.

The fourth message topic was drills and military activities. The majority of messages were sent during 2019. Turkey's increase in energy resource activities in the Mediterranean Sea in 2019 is believed to be a factor in this outcome. The number of messages has decreased by approximately half in other years.

Upon examination of the fifth and sixth topics, namely piracy and mine, it was discovered that no messages were published on these topics.

The latest message topic, namely other messages, was examined and it was discovered that the number of messages was the highest in 2019, but they have decreased over the years.

The analysis of aggregated NAVTEX messages was observed as a useful tool for providing information to ships, shipping companies, and policy makers. It is possible to ensure the navigational safety of ships navigating in the Mediterranean Sea and to make it more navigable through new systems that can be created in the light of the collected data.

This study will fill a significant gap in the literature since there has been no such a study on the Mediterranean Sea yet and there is not sufficient content on this subject in the literature. One of the limitations of this study is that it only examined data between 2019 and 2022. The time period can be extended in future studies. Another limitation is that only Antalya station's data is used. For future studies, the study area can be expanded by including warnings transmitted by other countries in the Mediterranean region. Working with a larger data set in different sea areas can lead to more detailed information in future studies. In addition, it is possible to examine and evaluate both NAVTEX and NAVAREA notices together. Through the collection and analysis of NAVTEX data on other sea areas, the captains, the shipping companies and the policy makers will benefit from the trends and potential risks obtained from the evaluation of the big data sets. A snapshot of the navigation area can be provided by big data analysis. Seafarers will be able to take proper precautions early to ensure safe navigation. Data analysis can help determine the risk distribution in certain regions by revealing the frequency of important events occurring in the region. The potential geographical distribution of these events can be determined by analyzing position information, too. Historical data analysis will allow us to determine if there is a situation that necessitates precautions in the region. The decision-making processes of shipping companies will benefit from the big data analysis.

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