AQUATIC RESEARCH

AQUATIC RESEARCH
E-ISSN 2618-6365

Aquat Res 6(2), 83-96 (2023) • https://doi.org/10.3153/AR23009

Research Article

An investigation of the maritime accident in the Aegean Sea Turkish search and rescue region

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Cite this article as:
Olgaç, T., Bayazit, O. (2023). An investigation of the maritime accident in the Aegean Sea Turkish search and rescue region. *Aquatic Research*, 6(2), 83-96. https://doi.org/10.3153/AR23009

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Submitted: 14.10.2022
Revision requested: 19.11.2022
Last revision received: 10.01.2023
Accepted: 14.01.2023
Published online: 09.02.2023

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Available online at
http://aquatres.scientificwebjournals.com

ABSTRACT

The Aegean Sea is risky for marine accidents due to its geography and dense vessel traffic. Revealing the patterns of marine accidents in the region is essential for preventing such accidents in the future. With this motivation, this study analyzes the data on maritime accidents in the Aegean Sea Turkish Search and Rescue Region. For this purpose, the descriptive analysis of the 576 marine accidents in the region between 2001 and 2020 was accomplished. Moreover, by applying hypothesis tests, the relationships between the factors that affect the occurrence of marine accidents were investigated. As a result, the most common contributing factors to the event of accidents were revealed. The relationships between the variables of the data set were determined. Accordingly, the type of ship with the most accident are yacht/recreational boat. Hull/machinery failure is the most common type of accident, and summer is the most frequent season for maritime accidents. It was revealed that there are significant relationships between the variables such as the type of accident, the sub-region where the accident occurred, the time of the accident, and the ship type. Finally, deficiencies were evaluated, and suggestions were made for more effective investigation and prevention of accidents.

Keywords: Aegean sea, Maritime casualty, Accident analysis, Search and rescue

Introduction

Geographically, the Aegean Sea is a semi-closed sea located between 41°-35° north latitudes and 23°-27°/28° east longitudes (Başeren, 2006). Its average depth is approximately 350 meters. Its length in the north-south line is 660 km. The length of the east-west line is 270 km in the north, 150 km in the middle, and 400 km in the south. Together with the Turkish Straits, the Aegean Sea forms a vital waterway connecting the Black Sea and the Mediterranean.

Maritime trading, tourism, and fishing take place in the Aegean Sea intensely. Aegean Sea shipping is 75% of all marine trade to Turkish ports. Furthermore, ships sailing in this area supply 75% of Türkiye's oil demands (Kurumahmut, 1998). Regarding marine tourism, approximately 5.4 million tourists visited Muğla and İzmir cities on the coasts of the Aegean Sea in 2019 (TÜİK, 2020). In addition, the Aegean's coasts and islands are the regions where cruise ships frequently visit and where marine activities are intense (Akay, 2020; DTO, 2019). Geographically, there are narrow passages and straits created by more than 1800 islands. Therefore, maritime accidents frequently occur in the area and pose severe risks to life, economic and environmental issues. Analyzing marine accidents and taking measures to prevent them will contribute to mitigating or eliminating these risks.

Directorate General of Coastal Safety of Türkiye provides vessel traffic services in the Aegean Sea to control maritime traffic effectively and reduce maritime accidents. İzmir Vessel Traffic Center and Turkish Straits Vessel Traffic Center, affiliated with the Directorate General of Coastal Safety, serve in the Aegean Sea Turkish Search and Rescue Region. While the marine area between Babakale and Çeşme and the İzmir Bay is under the responsibility of İzmir vessel traffic services, the marine area being used to approach the Çanakkale Strait is under the obligation of the Turkish Straits Vessel Traffic Services (KGM, 2020).

This study performed a statistical analysis of maritime accidents that occurred over 19 years in the Turkish search and rescue region of the Aegean Sea. In addition, hypothesis tests were performed in the SPSS statistics among the variables that make up the data set. The study aims to present the pattern of marine accidents in the relevant region and to present a way out of measures that can be taken to reduce such accidents in the future. The findings obtained are thought to be useful for safe management for maritime stakeholders. In the ongoing sections, the geographical field of the study, data collection process, methods, application of the method, findings, discussion, and conclusion sections are included, respectively.

Literature Review

A survey of the literature reveals that the majority of research that analyzes marine accidents included statistical analysis, causation investigation, and the determination of hazard or risk maps. Ece (2011), in the paper on marine casualties in the İstanbul Strait, studied statistical analysis of the time of the accidents, accident types, and the types of ships involved (Ece, 2011). Büber and Töz (2017) conducted an accident risk analysis using Geographical Information Systems (GIS) for maritime casualties in the Turkish Port Regions of the Aegean Sea (Büber and Töz, 2017). Kuleyin and Aytekin (2015) statistically analyzed the marine casualties in Çanakkale Strait between 2004-2014 and suggested preventing future accidents (Kuleyin and Aytekin, 2015). In his master's thesis, Kızkapan (2010) performed statistical analysis related to accidents of vessels engaged on international voyages at the coasts of Türkiye between 2004 and 2008 (Kızkapan, 2010). Park and Ahn (2007) analyzed the variance of accident information such as accident time, vessel speed and distance with the SPPS program for a period of 10 years (Park and Ahn, 2007). Aalberg et al. carried out a bivariate t-test and chi-square analysis of marine casualties in Norwegian waters in the light of data on ship information, ship behaviour, accident type, and external factors (Aalberg et. al., 2016). Kılıç and Sanal (2015) conducted a statistical analysis of the grounding accidents that took place between the borders of the Çanakkale Strait between 2000 and 2011 and analyzed the causes of these accidents using the fault tree analysis method (Kılıç and Sanal, 2015). Raiyan et al. (2017), in their study, examined the marine casualties that occurred in Bangladesh waters between 1974 and 2014 and obtained findings of the causes of accidents with the event tree analysis (Raiyan et. al., 2017). Mullai and Paulsson (2011) aimed to design a conceptual model for the analysis of marine casualties with their study using metric and non-metric variables with the marine casualty data they obtained from the Swedish Maritime Administration (Mullai and Paulsson, 2011). Dobbins and Abkowitz (2010) have explored how advanced information technologies can be used to assess US sea routes' hazard risk using GIS (Dobbins and Abkowitz, 2010). Shahrzad et al. (2014), with their study on marine casualties, proposed an accident simulation model to evaluate the accident risk in maritime transportation using Markov Modeling and Markov Chain Monte Carlo Simulation (Shahrzad et. al., 2014). Kujala et al., with their study, examined the marine casualty statistics of the last 10 years to analyze the safety of the maritime traffic in the Gulf of Finland and then evaluated the collision risk of the ships with the theoretical model they developed (Kujala et. al., 2009). Olgaç and Töz (2020) examined cooperation activities and disputes with coastal states regarding the search and rescue activities of marine casualties in Turkish seas (Olgaç and Töz, 2020). Maya et al. proposed a marine casualty learning approach with fuzzy cognitive maps combined with bayesian networks to make risk assessments by determining significance coefficients for each factor that causes marine accidents and to develop and implement risk control options more effectively (Maya et. al., 2020). Yılmaz and İlhan made a retrospective examination of the marine casualty/incidents that resulted in death, injury, or loss involving Turkish-flagged ships in the Turkish Search and Rescue Region (Yılmaz and İlhan, 2018). Seo and Bae analyzed the cause of the accident and the accident statistics by examining the court reports of the marine casualties that occurred over a period of ten years (Seo and Bae, 2002). Nas analyzed the grounding accidents at Yenikale Pass in İzmir Bay and made a risk assessment (Nas, 2011). Arslan et al. investigated the causes of accidents on board that occur during cargo operations at tanker terminals using a fault tree analysis approach and tested the results in a Monte Carlo simulation (Arslan et. al., 2018). Karabacak and Köseoğlu examined the maritime accidents that took place between 2007 and 2017 in Turkish Territorial Waters and aimed to analyze the maritime casualties by data mining method in their paper (Karabacak and Köseoğlu, 2021). In the study he prepared, Olgaç made a literature review of the maritime accident analysis methods used in the analysis of maritime accidents and introduced these analysis methods and gave general information about their use (Olgaç, 2021). Demirci and Gülmez aimed to determine the types of marine accidents caused by human errors on Ro-Ro cargo ships and analyzed the usefulness of the Human Factors Analysis and Classification System method in the classification of these accidents (Demirci and Gülmez, 2021).

Material and Methods

Following the selection of the study's topic, a thorough literature review was conducted to look at earlier studies on maritime accidents. Then, the data were officially provided by the main search and rescue coordination centre (MSRCC). Findings were obtained through descriptive analyzes and hypothesis tests on the data. The findings of the study were compared with the findings of similar studies in the discussion section. Finally, in the conclusion section, suggestions were made for a more effective evaluation of marine accidents. The diagram showing the process of the study is as follows.

Study Area

The Search and Rescue Region of Türkiye in the Aegean Sea geographically limits the scope of this study. The borders of the Search and Rescue Region of Türkiye in the Aegean Sea are determined by Türkiye through The Search and Rescue Regulation of Marine and Air Vehicle Accidents published on October 17, 2020. The Search and Rescue Region of Türkiye in the Aegean Sea is given below in figure 1.

This study divided Türkiye's Aegean Sea Search and Rescue Region into six subregions based on the geographical structure of the coastline. Each subregion was given codes from 1 to 6. The accidents are also divided and distributed according to these six subregions. These six subregions and their codes are shown in figure 2. The subregions are 1-North Agean, 2-Edremit, 3-İzmir, 4-Kuşadası, 5-Bodrum, and 6-Marmaris.

Data Collection

In the scope of the study, the data set, which includes variables such as date, season, accident type, vessel type, subregion, loss of life, and injury, were obtained from the Main Search and Rescue Coordination Center's (MSRCC) under the Ministry of Transport and Infrastructure of the Republic of Türkiye. The centre gave the data set based on the authors' official letter. The data set includes marine accidents in the Aegean Sea Turkish Search and Rescue Region between 2001-2020 (until the 5th of March).

Literature Review

- **Data Bases:** Google Academic, Scopus, Science Direct, Wiley Online
- **Keywords:** Marine casualty, Marine accident, Accident analysis, Accident investigation, Accident analysis, Search, and rescue

Data collection

All datas were obtained from MSRCC

Analysis process

Statistical analysis methods were used

Finding and Discussion

Conclusion

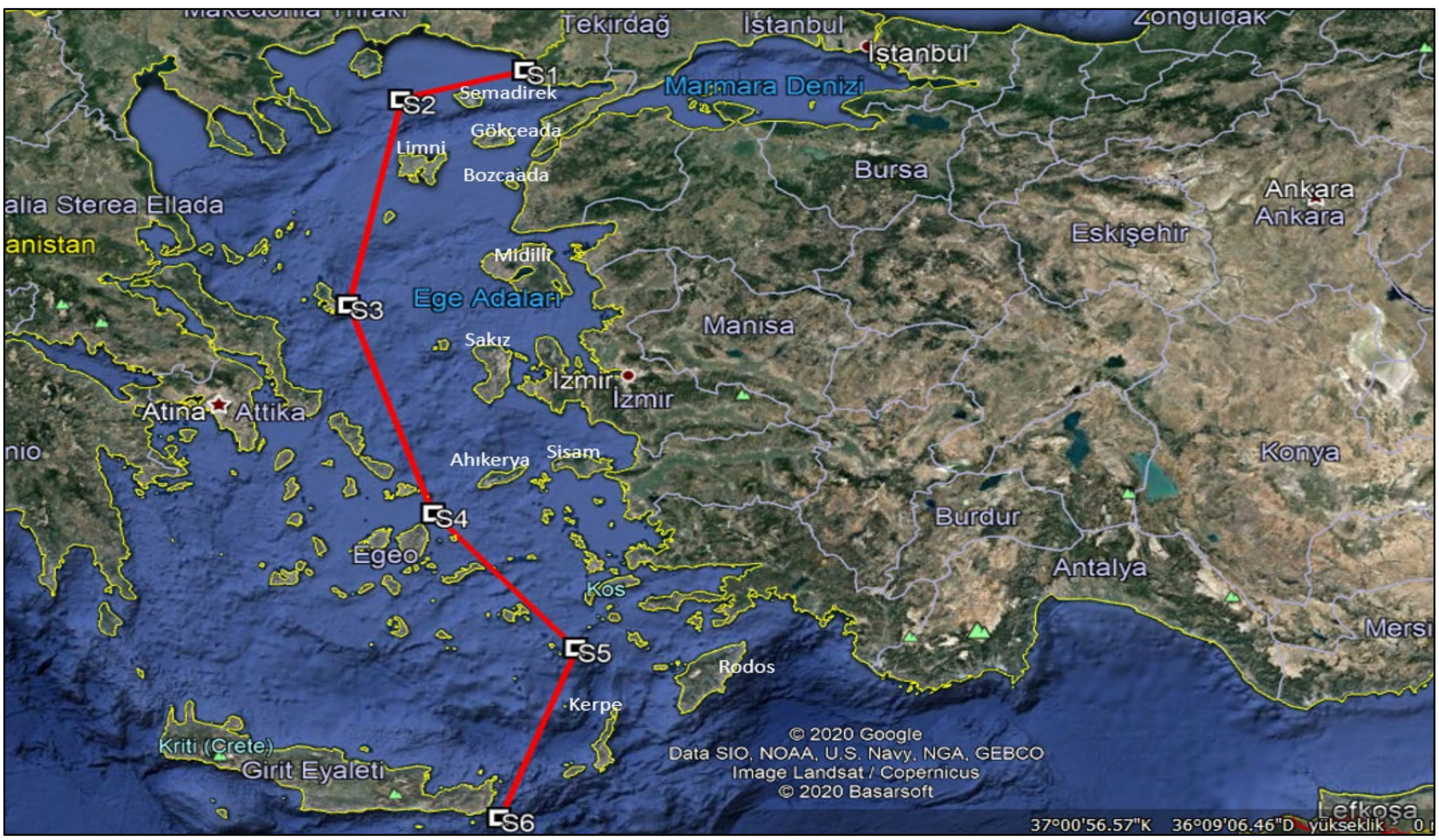


Figure 1. The search and rescue region of Türkiye in the Aegean Sea

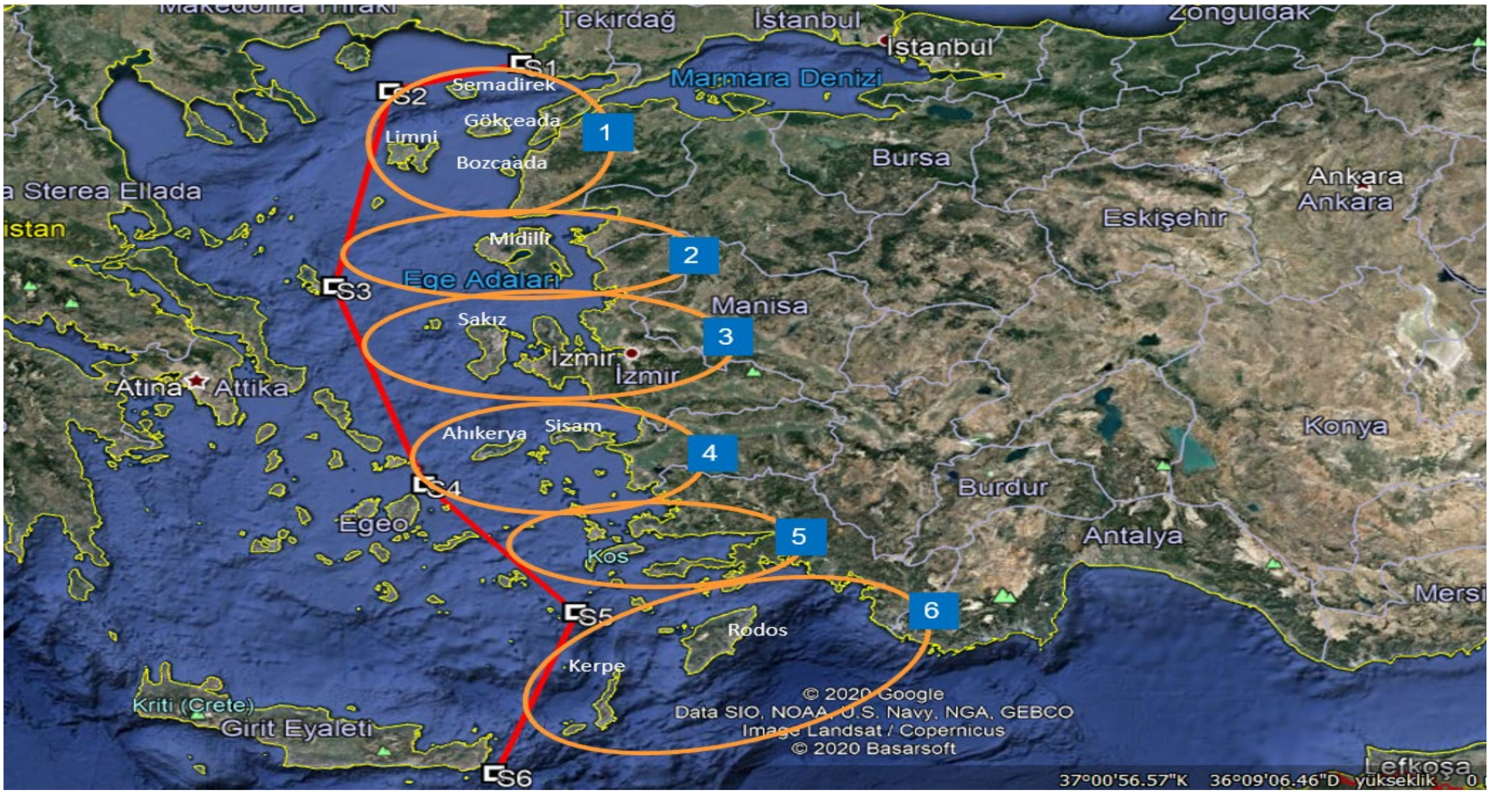


Figure 2. Subregions of the Aegean Sea Turkish search and rescue region

Statistical Analysis Method

Statistical data analysis of the marine accidents that occurred in the Aegean Sea Turkish Search and Rescue Region between 2001-2020 (till 05th March 2020) was performed using SPSS Statistics v.23. Frequency analysis, chi-square tests and Kruskal Wallis tests of the variables that make up the data set were performed. Frequency analysis is a type of content analysis that makes it easy to understand the density and importance of a particular item (Sezginsoy, 2007). The chi-square test was used to investigate significant relationships between variables that made up the data set. A Chi-square test is applied to test the relationship between two nominal variables. The null hypothesis (H0) states that the two nominal variables are independent of each other or, in other words, the absence of a significant relationship between the two nominal variables. The alternative hypothesis (HA or H1) states a significant relationship between the two nominal variables, so these variables are dependent (Güngör and Bulut, 2008). Kruskal Wallis tests were applied to investigate the existence of the relationship between categorical variables and numeric variables. The Kruskal-Wallis test is a nonparametric hypothesis test that explores the relationship between the numerical variable and the categorical variable consisting of more than two groups. The Kruskal-Wallis test is a one-way variance analysis between independent variables of populations (McKight and Najab, 2010).

Frequency Analysis

A total of 576 marine accidents occurred in the Aegean Sea Turkish Search and Rescue Region between 2001 and 2020 were examined. The frequency of these cases based on date (years), seasons, accident types, vessel types, subregions, loss of life, and injury is given below.

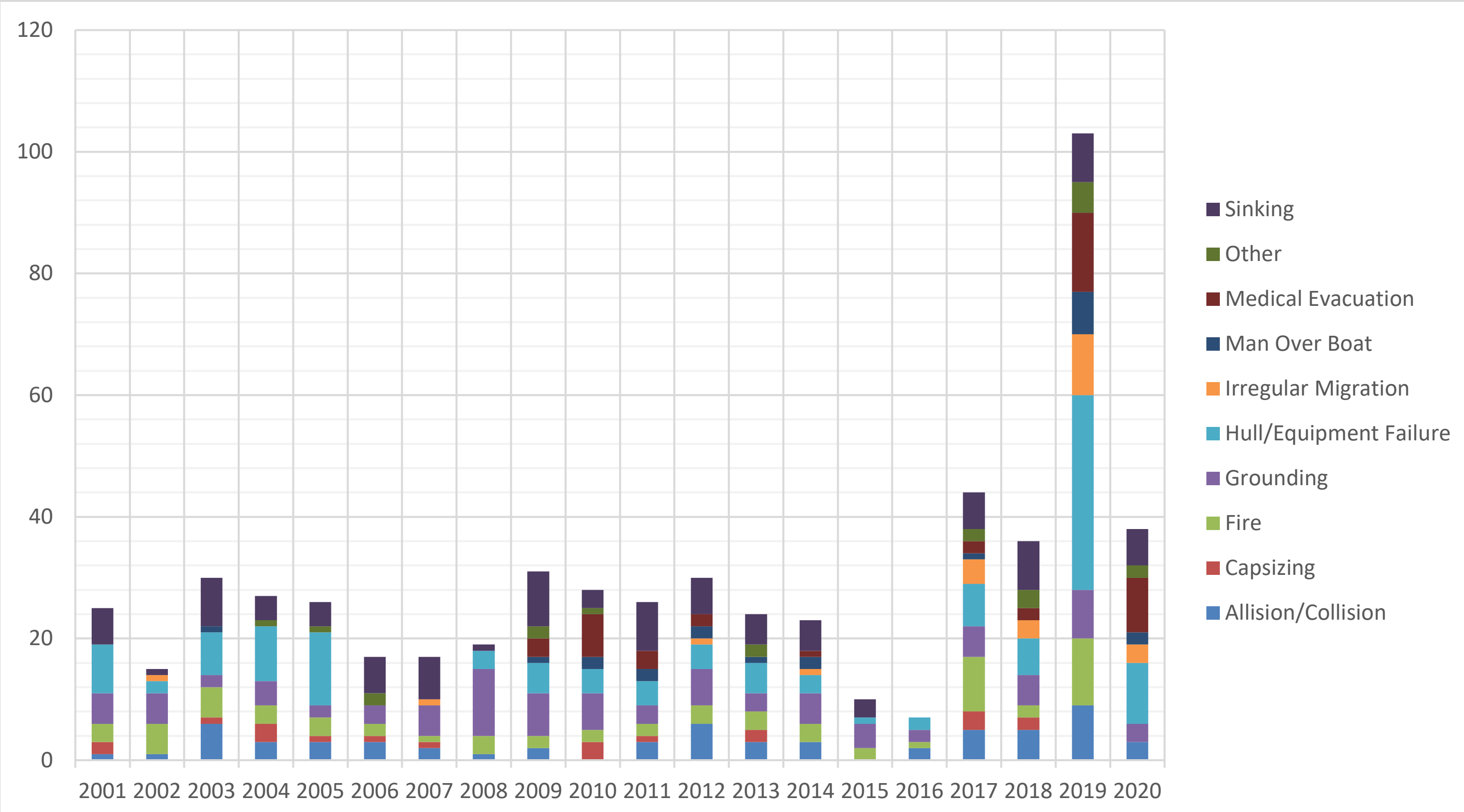


Figure 3. Distribution of accident/incident types by years

As is seen in figure 3, the frequency of accidents are as follows respectively: hull/equipment failure with the number 124, sinking with the number 104, grounding with the number 94, fire with the number 65, allision/collision with the number 61, medical evacuation with the number of 42, irregular migration with the number 24, man overboard with the number 21, other with the number 21 and capsizing with the number 20. When the distribution of marine accidents/incidents in the Aegean Sea by years is examined, it is seen that the highest number of accidents occurred in 2019 with several 103. The year in which the least accidents occurred is 2016 with several 7. Most of the accidents in 2019 took place in the third subregion, on yacht/recreational type ships, and during the summer season.

Spring and summer were the seasons with the least and highest accidents, respectively, according to an analysis of the distribution of accidents by seasons shown in figure 4. It is also observed that the most common type of accident during the summer period is hull/equipment failure, followed by sinking and fire, respectively. It was determined that the most accidents in the summer season occurred in subregion 3 and yacht/recreational vessel type.

When the types of vessels involved in accidents are examined as in figure 5, it is understood that the yacht/recreational boat comes to the fore with the number 274. The most common yacht/recreational boat accident/incident types are hull/equipment failure (77), sinking (64) and fire (42) respectively. Also, It can be seen in the figure that ro-ro vessels have the least accident number during the period under review.

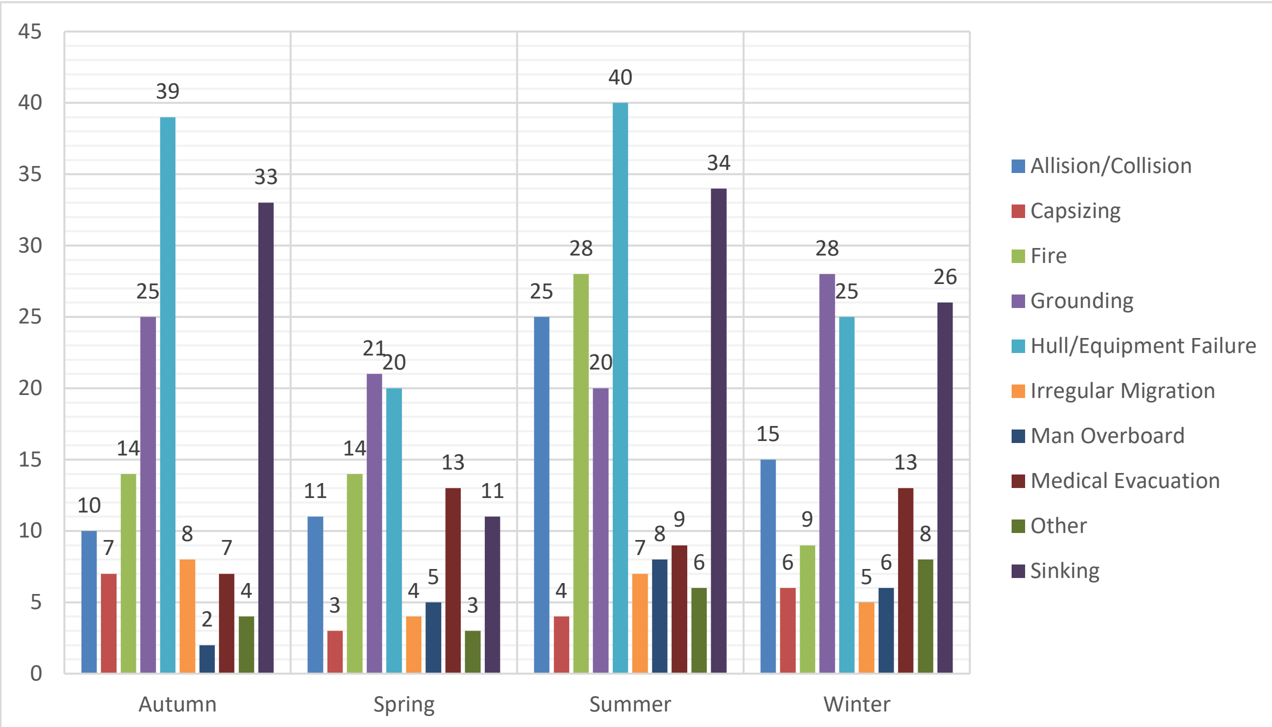
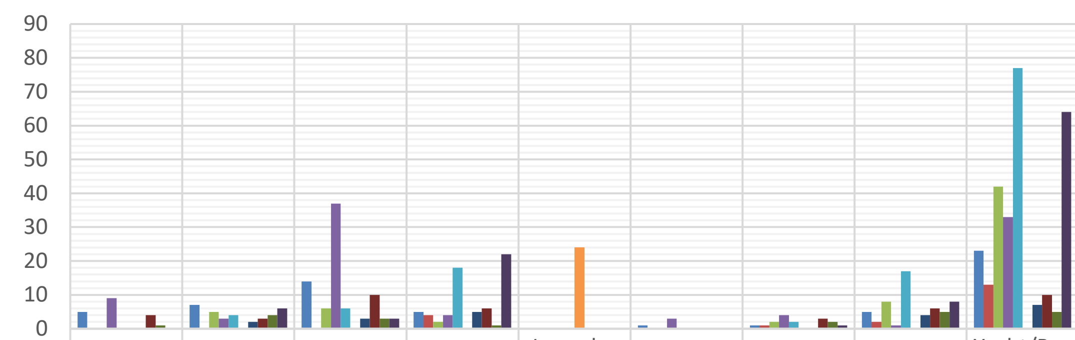


Figure 4. Distribution of accident/incident types by season (from 2001 to 2020)



	Container Ship	Cruise Ship	Dry Cargo Ship	Fishing Boat	Irregular Immigrant Boat	Ro-Ro	Tanker	Unknown	Yacht/Recreational Boat
Allision/Collision	5	7	14	5		1	1	5	23
Capsizing				4			1	2	13
Fire		5	6	2			2	8	42
Grounding	9	3	37	4		3	4	1	33
Hull/Equipment Failure		4	6	18			2	17	77
Irregular Migration					24				
Man Overboard		2	3	5				4	7
Medical Evacuation	4	3	10	6			3	6	10
Other	1	4	3	1			2	5	5
Sinking		6	3	22			1	8	64

Figure 5. Distribution of accident/incident types by vessel types

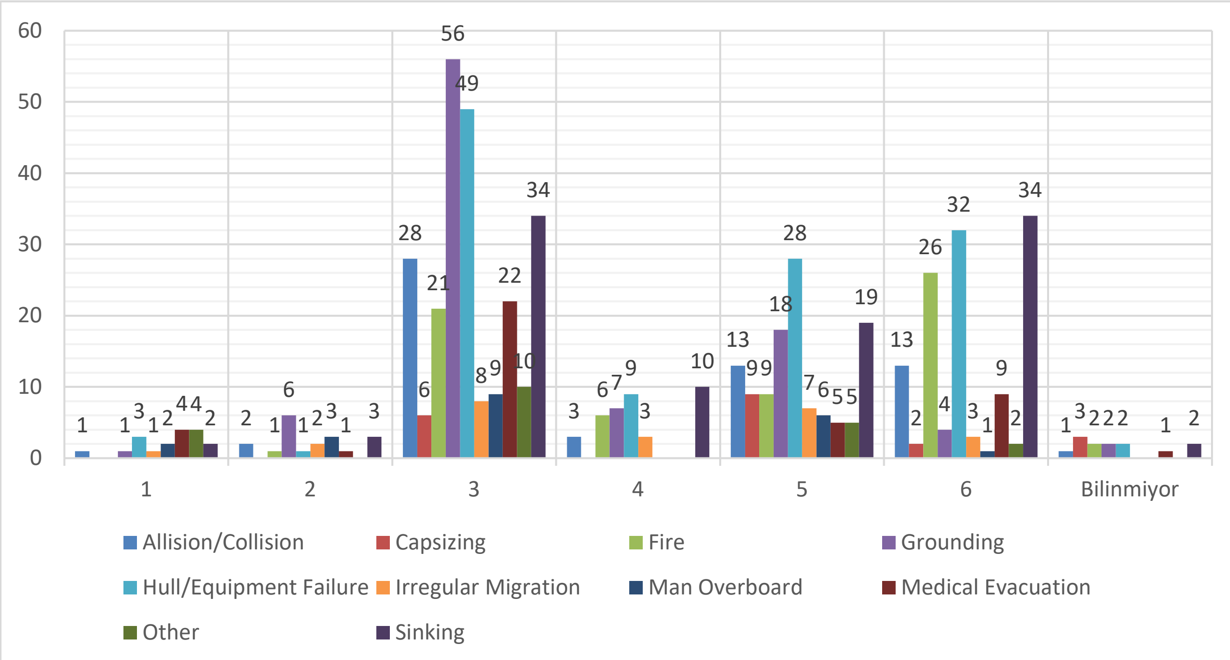


Figure 6. Distribution of accident/incident types by subregions

The subregions where the accidents occurred are examined in figure 6; it is seen that the most accidents occurred in the İzmir subregion (3) with the number of 243, followed by tourism subregions Marmaris (6) with the number of 126, and Bodrum (5) with the number of 119. Grounding is the most common accident type that occurred in the İzmir subregion.

During the period under consideration, 224 people died in 42 accidents/incidents and 114 people were injured in 22 accidents/incidents. Considering the accidents that resulted in the loss of life, it was understood that the groups with the highest number of loss of life cases were the year 2012 with 69 people, the summer season with 105 people, the 4th subregion with 80 people, the irregular migration activity with 145 people, and irregular migrants boats with 145 people. Considering the accidents/incidents that resulted in injuries, it was understood that the groups with the highest number of injury cases were the year 2013 with 34 people, the summer season with 65 people, the type of fire accident with 22 people, yacht/recreational type vessels with 59 people and the 3rd subregion with 54 people.

Binary Hypothesis Tests

Chi-square tests were applied to test the relationships between the 5 categorical variables of the data set, namely date, season, accident type, vessel type, and subregion variables. Since our categorical variables in the data set consist of more than two subgroups, in chi-square tests, a conclusion was reached according to the significance value (p) of the Fischer-Freeman-Helton exact test. To reach the p-value of the Ficher-Freeman-Helton exact test, calculations based on Monte Carlo simulation were performed at a 99% confidence interval and 10,000 sample scales. It is known that the exact test p-value obtained by Monte Carlo simulation (with 10,000 samples and 99% confidence interval) is the same up to the three decimal places with the exact test p-value obtained with the exact option in the SPSS (Mehta and Patel, 2011). In this concept, within the framework of chi-square tests, the hypothesis and Fisher-Freeman-Halton p significance values were formed as follows:

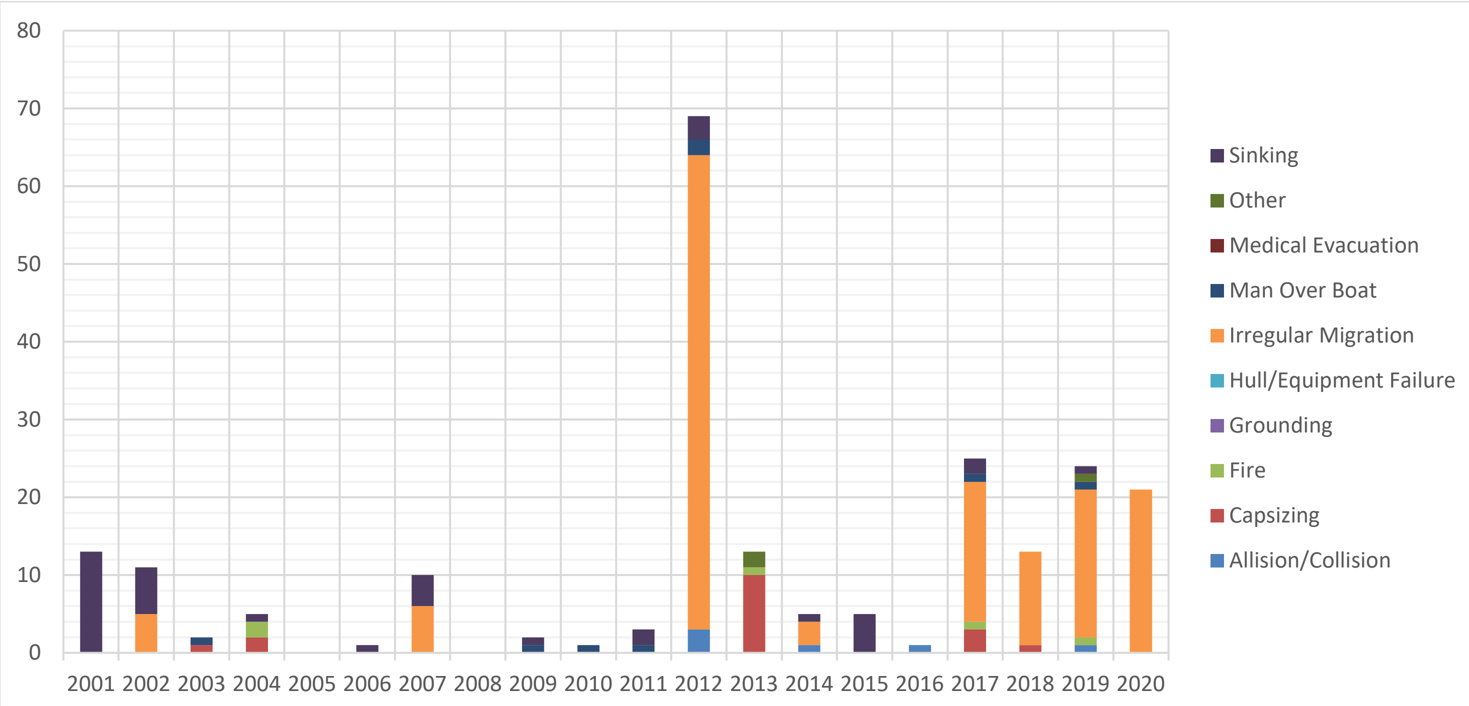


Figure 7. Distribution of loss of life by years

1. Date x Season: $\begin{cases} H_0: No\ significant\ relationship\ between\ date\ and\ season. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000^b < 0{,}05; so\ H_A\ is\ supported. \end{cases}$

2. Date x Accident Type: $\begin{cases} H_0: No\ significant\ relationship\ betweeen\ date\ and\ Acc.Inc.type. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000^b < 0{,}05; so\ H_A\ is\ supported. \end{cases}$

3. Date x Vessel Type: $\begin{cases} H_0: No\ significant\ relationship\ betweeen\ date\ and\ vessel\ type. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000^b < 0{,}05; so\ H_A\ is\ supported. \end{cases}$

4. Date x Subregion: $\begin{cases} H_0: No\ significant\ relationship\ betweeen\ date\ and\ subregion. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000^b < 0{,}05; so\ H_A\ is\ supported. \end{cases}$

5. Season x Accident Type: $\begin{cases} H_0: No\ significant\ relationship\ betweeen\ season\ and\ Acc.Inc.type. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000^b < 0{,}05; so\ H_A\ is\ supported. \end{cases}$

6. Season x Vessel Type: $\begin{cases} H_0: No\ significant\ relationship\ betweeen\ season\ and\ vessel\ type. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000^b < 0{,}05; so\ H_A\ is\ supported. \end{cases}$

7. Season x Subregion: $\begin{cases} H_0: No\ significant\ relationship\ betweeen\ season\ and\ subregion. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000^b < 0{,}05; so\ H_A\ is\ supported. \end{cases}$

8. Accident Type x Vessel Type: $\begin{cases} H_0: No\ significant\ relationship\ betweeen\ Acc.Inc.type\ and\ vessel\ type. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000^b < 0{,}05; so\ H_A\ is\ supported. \end{cases}$

9. Accident Type x Subregion: $\begin{cases} H_0: No\ significant\ relationship\ betweeen\ Acc.Inc.type\ and\ subregion. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000^b < 0{,}05;\ so\ H_A\ is\ supported. \end{cases}$

10. Vessel Type x Subregion: $\begin{cases} H_0: No\ significant\ relationship\ betweeen\ vessel\ type\ and\ subregion. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000^b < 0{,}05;\ so\ H_A\ is\ supported. \end{cases}$

As a result of the chi-square tests carried out within this framework, it has been determined that there are significant relationships between date and season, accident type, vessel type, and subregion; between season and accident type, vessel type and subregion; between accident type and vessel type and subregion; between vessel type and subregion.

According to the normality and homogeneity test results applied to the variables loss of life, and injury, it was understood that these variables don't conform to the normal distribution and their variances were not homogeneous. Therefore, to examine the relationship between categorical variables and these two numerical variables, nonparametric Kruskal Wallis tests were applied instead of the parametric one-way ANOVA test. Hypotheses and P asymptotic values obtained as a result of Kruskal Wallis tests are as follows:

1. Date x Loss of Life: $\begin{cases} H_0: The\ medians\ of\ the\ groups\ of\ the\ date\ are\ equal. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}271 > 0{,}05;\ so\ H_0\ is\ supported. \end{cases}$

2. Season x Loss of Life: $\begin{cases} H_0: The\ medians\ of\ the\ groups\ of\ the\ season\ are\ equal. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}642 > 0{,}05;\ so\ H_0\ is\ supported. \end{cases}$

3. Accident Type x Loss of Life: $\begin{cases} H_0: The\ medians\ of\ the\ groups\ of\ the\ accident\ type\ are\ equal. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000 < 0{,}05;\ so\ H_A\ is\ supported. \end{cases}$

4. Vessel Type x Loss of Life: $\begin{cases} H_0: The\ medians\ of\ the\ groups\ of\ the\ vessel\ type\ are\ equal. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000 < 0{,}05;\ so\ H_A\ is\ supported. \end{cases}$

5. Subregion x Loss of Life: $\begin{cases} H_0: The\ medians\ of\ the\ groups\ of\ the\ subregion\ are\ equal. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}553 > 0{,}05;\ so\ H_0\ is\ supported. \end{cases}$

6. Date x Injury: $\begin{cases} H_0: The\ medians\ of\ the\ groups\ of\ the\ date\ are\ equal. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000 < 0{,}05;\ so\ H_A\ is\ supported. \end{cases}$

7. Season x Injury: $\begin{cases} H_0: The\ medians\ of\ the\ groups\ of\ the\ season\ are\ equal. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}043 < 0{,}05;\ so\ H_A\ is\ supported. \end{cases}$

8. Accident Type x Injury: $\begin{cases} H_0: The\ medians\ of\ the\ groups\ of\ the\ accident\ type\ are\ equal. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}000 < 0{,}05;\ so\ H_A\ is\ supported. \end{cases}$

9. Vessel Type x Injury: $\begin{cases} H_0: The\ medians\ of\ the\ groups\ of\ the\ vessel\ type\ are\ equal. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}377 > 0{,}05;\ so\ H_0\ is\ supported. \end{cases}$

10. Subregion x Injury: $\begin{cases} H_0: The\ medians\ of\ the\ groups\ of\ the\ subregion\ are\ equal. \\ H_A: H_0\ is\ false. \\ p\ value = 0{,}606 > 0{,}05;\ so\ H_0\ is\ supported. \end{cases}$

According to the results of the Kruskal Wallis tests, it was determined that the medians of the groups in the accident type and vessel type have a significant difference in terms of the number of losses of life. it was also determined that the medians of the groups of the date, season, and subregion do have not a significant difference in terms of the number of losses of life.

In the Kruskal Wallis tests performed for the injury, it was observed that the medians of the groups in the date, season, and accident type have a significant difference in terms of the number of injuries. No significant difference was found between the medians of the groups of subregion and vessel type in terms of the injury.

Results and Discussion

According to the findings obtained within the scope of the study, the region with the highest number of accidents in the Aegean Sea is the İzmir subregion, which includes the İzmir Bay, Çandarlı Bay, and İzmir offshore. When the locations of marine accidents in this region are examined, it is seen that grounding accidents occur frequently in the Yenikale Passage. Büber and Töz (2017) stated that there were many grounding accidents in the Yenikale Passage in İzmir Bay and that this area poses a high risk for ships with large draughts (Büber and Töz, 2017). Nas (2011) reported similar results that the frequent occurrence of grounding accidents at the Yenikale Passage. In the same study, Nas stated that the riskiest action for the Yenikale Passage is collusion during the manoeuvre to avoid grounding, and collusion at this location may stop the marine transport to İzmir Port for a long time (Nas, 2011). Within the Aegean Sea Turkish Search and Rescue Region, it has been observed that summer is the season with the highest number of accidents and the type of ship involved in the most accidents is a yacht/recreational boat. Yılmaz and İlhan (2018), in their study analyzing the marine accidents in the Turkish Search and Rescue Region, in addition to reporting the same results, also stated that more than half of those injured in these accidents were amateur fishermen/amateur sailors (34.6%) and professional seafarers (29.6%) (Yılmaz and İlhan, 2018).

Karabacak and Köseoğlu examined 738 maritime accidents that took place in Turkish territorial waters between 2007-2017 and they reached some statistical findings about these accidents (Karabacak and Köseoğlu, 2021). Karabacak and Köseoğlu found that the most common type of accident was conflict accidents, and the most common type of ship involved in the accident was a dry cargo ship. In the study they prepared, they stated that the majority of the accidents occurred in the Turkish Straits and the Marmara Sea, where maritime traffic is the most intense. In this study, it was found that yacht/recreational boats were the most involved in the accident in the Aegean Sea Turkish Search and Rescue Region, and the accidents resulting in hull/equipment failures were the most common accidents. Due to the geographical structure of the Aegean Sea and the fact that this region is a denser sea area than the Marmara Sea in terms of tourism activities, it is considered that the findings related to the accidents in this sea are different from the study by Karabacak and Köseoğlu.

Aalberg et.al. (2016) analyzed the marine casualties in Norwegian seas by performing t-test and chi-square tests within the framework of data such as ship type, ship's age, ship's flag, route, speed, operation time, accident type, and external factors (traffic density, day or night, etc.) (Aalberg, 2016). It has been understood that studies conducted with data sets containing such detailed information give more healthy and understandable results. Generally, such detailed information is not taking place in the data sets used in the statistical analysis of marine casualties. In this respect, it is important to record data completely after accidents in order to make a more accurate analysis of marine casualties. Also, in order to benefit from previous academic studies on marine casualties, it is crucial to standardize the classification of data such as accident type and ship type, etc. Classification of maritime accidents as specified in the code and directive IMO, 2009/18 / EC published by IMO in 2009 will be useful in achieving this goal (IMO, 2019).

Conclusion

In this study, the marine accidents/incidents that occurred in the years between 2001-2020 in the Aegean Sea Turkish Search and Rescue Area are examined. As a result of the analysis, it was found that the yachts/recreational boats were the most frequent ship type that accidents occurred, and hull/equipment failure was the most common accident type, in the mentioned region and period. Besides, it was determined that in İzmir Bay and Aliağa-Nemrut Port Regions, large ships such as dry cargo ships were involved in accidents such as grounding and allision to the pier.

As a Peninsula country, in Türkiye, the private and commercial activities of yachts are getting increased year by year. Hence, the ascending accident rate of these ships is an expected situation. In order to reduce accidents in yachts/recreational boats, it would be beneficial to handle, analyse and publish such accidents differently from cargo ships. In this manner, the authorities will be assisted in taking effective measures to prevent such accidents. It is vital that ships navigating in the region comply with the guidance of İzmir Vessel Traffic Services and benefit from pilotage and towage services when necessary, in order to prevent accidents.

Due to marine transport density, marine tourism level, and irregular migration activities, the Aegean Sea is a waterway that contains importance and risk together. The effectiveness of marine casualty analysis has of great significance in reducing marine casualties in this region. For an effective accident analysis, it is necessary to keep an accurate and detailed record of the data of each accident. The results obtained from the analysis should be discussed altogether by public institutions, academics, and maritime sector stakeholders and the most effective steps should be taken to prevent accidents.

Compliance with Ethical Standards

Conflict of interests: The authors declare that for this article they have no actual, potential, or perceived conflict of interest.

Ethics committee approval: Ethics committee approval is not required.

Funding disclosure: -

Acknowledgments: -

Disclosure: -

References

Aalberg, A.L., Kleiven, E., Bye, R.J. (2016). Risk, reliability and safety: Innovating theory and practice. In Editor Lesley Walls, Matthew Revie, and Tim Bedford, *26th European Safety and Reliability Conference* (pp. 97-104). Glasgow: Taylor & Francis. https://doi.org/10.1201/9781315374987-18

Akay, B. (2020). Mavi büyüme stratejisi: Türkiye'nin kıyı ve deniz turizmine yönelik bir inceleme, *Türk Turizm Araştırmaları Dergisi*, 4(3), 3051-3063. https://doi.org/10.26677/TR1010.2020.525

Arslan, Ö., Zorba, Y., Svetak, J. (2018). Fault tree analysis of tanker accident during loading and unloading operations at the tanker terminals. *Journal of ETA Maritime Science*, 6(1), 3-16. https://doi.org/10.5505/jems.2018.29981

Başeren, S.H. (2006). *Ege Sorunları*. Ankara: Türk Deniz Araştırmaları Vakfı (TÜDAV) Yayınları. ISBN: 975-8825-14-3

Büber, M., Töz, A.C. (2017). Liman sahasında meydana gelen deniz kazalarının konumsal analizi: Ege Denizi için bir uygulama, *III. Ulusal Liman Kongresi*, 2017: İzmir. https://doi.org/10.18872/DEU.df.ULK.2017.018

Demirci, E.C., Gülmez, S. (2021). S. Ro-Ro gemi kazalarının vaka bazlı HFACS analizi. *Marine and Life Sciences*, 3(2), 105-114. https://doi.org/10.51756/marlife.1027858

Dobbins, J.P., Abkowitz, M. (2010). Use of advanced information technologies for marine accident data analysis visualization and quality control. *Journal of Transportation Safety and Security*, 2(1), 1-13. https://doi.org/10.1080/19439960903560312

DTO (Deniz Ticaret Odası), (2019). Türkiye'de deniz turizmi. *Deniz Ticareti* 5(9), 3-15.

Ece, N.J. (2011). İstanbul Boğazı'nda meydana gelen deniz kazalarının incelenmesi ve analizi. *Dokuz Eylül Üniversitesi Denizcilik Fakültesi Dergisi*, 3(2), 37-59.

Güngör M., Bulut, Y. (2008). Kikare testi üzerine. *Fırat Üniversitesi Doğu Araştırmaları Dergisi,* 7(1), 84-89.

IMO (International Maritime Organisation), (2019). casualty investigation code and the directive 2009/18/EC. https://www.legislation.gov.uk/eudr/2009/18/body/2020-01-31

Karabacak, A., & Köseoğlu, B. (2021). Türk karasularında meydana gelen gemi kazalarının analizi: Bir Veri Madenciliği Uygulaması. *Turkish Journal of Maritime and Marine Sciences,* 7(1), 54-74.
https://doi.org/10.52998/trjmms.789498

KGM (Kıyı Emniyeti Genel Müdürlüğü). Gemi trafik hizmetleri. Retrieved December 12, 2020, from https://www.kiyiemniyeti.gov.tr/gemi_trafik_ve_kilavuzluk_hizmeti

Kılıç, A., Sanal, H.T. (2015). Çanakkale boğazı'nda karaya oturmayla sonuçlanan gemi kazaları. *Balıkesir Üniversitesi Fen Bilimleri Enstitüsü Dergisi,* 17(2), 38-50.

Kızkapan, T., (2010). *Kıyı Alanlarında Gemi Emniyet Yönetimi ve Deniz Kazaları Analizi (MSc Thesis)*. Dokuz Eylül University. Institute of Social Sciences. Department of Maritime Businness Administration. İzmir.

Kujala, P., Hanninen, M., Arola, T., Ylitalo, J. (2009). Analysis of the marine safety in the Gulf of Finland. *Reliability Engineering and System Safety*, 94(8), 1349-1357.
https://doi.org/10.1016/j.ress.2009.02.028

Kuleyin, B, Aytekin, H. (2015). Çanakkale Boğazında 2004-2014 yılları arasında gerçekleşen deniz kazalarının analizi ve kazaların önlenmesine yönelik öneriler. *Dokuz Eylül Üniversitesi Denizcilik Fakültesi Dergisi*, 7(1), 21-38.
https://doi.org/10.18613/deudfd.87984

Kurumahmut, A. (1998). *Ege'de Temel Sorun Egemenliği Tartışmalı Adalar*. Ankara: Türk Tarih Kurumu.

Maya, B.N., Babaleye, A.O., Kurt, R.E. (2020). Marine accident learning with fuzzy cognitive maps (MALFCMs) and bayesin networks. *Safety in Extreme Environments,* 2(2020), 69-78.
https://doi.org/10.1007/s42797-019-00003-8

McKight, P.E., Najab, J. (2010). Kruskal-Wallis test. *The Corsini Encyclopedia of Psychology.* (eds I.B. Weiner and W.E. Craighead).
https://doi.org/10.1002/9780470479216.corpsy0491

Mehta, C.R., Patel, N.R. (2011). *IBM SPSS exact tests*. Armonk, NY: IBM Corporation, 23-24.

Mullai, A., Paulsson, U. (2011). A Grounded theory model for analysis of marine accidents. *Accident Analysis and Prevention*, 43(4), 1590-1603.
https://doi.org/10.1016/j.aap.2011.03.022

Nas, S. (2011). İzmir körfezi deniz ulaştırma emniyeti ve yenikale geçidi karaya oturma kazalarının analizi. *Dokuz Eylül Universitesi Mühendislik Fakültesi Mühendislik Bilimleri Dergisi,* 13(1), 9-21.

Olgaç, T., Töz, A.C. (2020). Türk arama ve kurtarma organizasyonu: Uluslararası işbirliği faaliyetleri ve yaşanan anlaşmazlıklar. *Gemi ve Deniz Teknolojisi*, 217(2020), 44-56.

Olgaç, T. (2021). Deniz kazaları ve deniz olaylarını inceleme çalışmalarında kullanılan analiz yöntemleri üzerine bir değerlendirme. *Deniz Taşımacılığı ve Lojistiği Dergisi,* 2(2), 101-112.
https://doi.org/10.52602/mtl.885205

Park, B. S., Ahn, Y. S. (2007). Statistical analysis of marine accidents by ANOVA. *Journal of the Korean Society of Marine Environment & Safety*, 13(3), 191-198.

Raiyan, A., Das, S., Islam, M.R. (2017). Event tree analysis of marine accidents in Bangladesh. *Procedia Engineering*, 194(2017), 276-283.
https://doi.org/10.1016/j.proeng.2017.08.146

Seo, M.S., Bae, S.J. (2002). The study on the analysis of marine accidents and preventive measures. *Journal of Fisheries and Marine Science Education*, 14(1), 149-160.

Sezginsoy, B. (2007). *Bilim ve sanat merkezi uygulamasının değerlendirilmesi* (MSc Thesis). Balıkesir Üniversitesi. Balıkesir University. Institute of Social Sciences. Education Department. Balıkesir.

Shahrzad F.R., Xie, M., Ng, K.M. (2014). Accident risk assessment in marine transportation via Markov modelling and Markov Chain Monte Carlo simulation. *Ocean Engineering,* 91(2014), 363-370.
https://doi.org/10.1016/j.oceaneng.2014.09.029

TÜİK (Türkiye İstatistik Kurumu), (2020). Temel istatistikler: İl Göstergeleri. https://data.tuik.gov.tr/Bulten/Index?p=Turizm-Istatistikleri-IV.Ceyrek:-Ekim-Aralik-ve-Yillik,-2019-33669

Yılmaz F., İlhan, M.N. (2018). Türk bayraklı gemilerin karıştığı deniz kazaları ve denizcilere etkilerine ilişkin bir analiz. *Gemi ve Deniz Teknolojisi*, 211(2018), 78-93.