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Investigating Real Ship Accidents with Descriptive Analysis in Turkey

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***Abstract*—**The use of advanced methods has been increasing day by day in the maritime sector, which is one of the sectors least affected by the COVID-19 pandemic. It is aimed to minimize accidents, especially by using advanced methods in the investigation of marine accidents. This research aimed to conduct an exploratory statistical analysis of particular ship accidents in the Transport Safety Investigation Center of Turkey database. 46 ship accidents, which occurred between 2010-2018, have been selected from the database. In addition to the availability of a reliable and comprehensive database, taking advantage of the robust statistical models for investigation is critical to improving the safety of ships. Thus, descriptive analysis has been used in the research to identify causes and conditional factors related to different types of ship accidents. The research outcomes underline the fact that environmental factors and day and night ratio have great influence on ship safety.

***Keywords*—**Descriptive analysis, maritime industry, maritime safety, marine accident analysis.

I. Introduction

BOTH ships and maritime transportation are important for global supply chains. Thus, it is key to contribute to reducing trade disruptions, to strength global supply chains, and to emphasize the need for safe and effective maritime logistics networks. In that perspective, many studies have been conducted in maritime science/literature to prevent marine accidents [1]. Despite these efforts, many accidents still are occurring, resulting in economic loss, environmental pollution, death and injury [2]. Even in 2020, the M/V Wakashio struck a coral reef on Mauritius's southeast coast on July 25 and later began leaking oil [3]. The full impact of the spill is thought to emerge gradually, but the damage could affect Mauritius and its tourism-dependent economy for decades. It is possible to find hundreds of studies in the literature to prevent this type of marine accident and to prevent pollution caused by marine accidents [4]. While there have been an increasing number of publications on maritime accidents, advanced techniques and methods are required to prevent future accidents.

Descriptive analysis is advanced statistical data analysis technique which is applied to summarize the data by describing and characterizing the data [5], [6]. Scientists can use this method in data analysis with many techniques suitable for their subjects [7]. The main problems could be noticeable by assessment of descriptive analysis [8]. The results of the analyses carried out with Descriptive Analysis can form the basis of other studies to be done to solve the problems in the related issues. This method is also informative about the understanding of the data and whether the data are suitable for other researches [9].

In maritime science, accidents still occur despite many technological developments [10]. In this study, our aim is to show the basic descriptive statistical data of the accidents that occur and reveal the basic problems. At the same time, this study will be the initiative for the study to be done to prevent accidents. In addition, this study is informative for scientists who will use this accident data.

There are studies investigating the human and organizational factor in the analysis of marine accidents [11], [12]. There is also a study that analyses the sea situation, which is another factor that is effective in the occurrence of marine accidents [13]. On the other hand, there are also studies that make a risk definition under the analysis of marine accidents and analyze a marine accident over it [14], [15]. In contrast to those studies, descriptive analysis of marine accidents was made in this study. When a literature survey on descriptive analysis in the maritime industry is conducted by our researchers, only one study was found. The study we encountered is a 10-year descriptive analysis of UK Maritime and Coastguard data on lifejacket use and drowning prevention [16]. In that study, fatal maritime incident data between 2007 and 2016 are handled, data were stratified by year, sex, age and activity so relationship between lifejacket use and drowning prevention has been explained. That study is only study in literature about descriptive analysis on maritime. However, unlike maritime, examples of descriptive analysis are frequently encountered in other disciplines. There are descriptive analyses of drug incidents and accidents [17], [18]. Descriptive analysis and rates of mortality from Ontario Racehorse Death Registry between 2003 and 2015 are found in literature [19]. Disorders in patients are analyzed following motor vehicle accidents in 17 years with descriptive analysis [20]. Police assaults and accidents were handled with descriptive analysis [21]. This method also is used in analysis of Aviation Accidents; it is very similar to marine accident [22]. In short, descriptive analysis is a comprehensive analysis method used in accident analysis in the literature. Therefore, it is intended to investigate marine accidents with the descriptive analysis method.

This research focused on a detailed analysis of the main causes of maritime accidents with descriptive analysis. Firstly, a data set was generated via data processing procedures to analyze the cause of the marine accidents. Then the descriptive analysis has been performed on the obtained dataset to reveal the main causes in marine accidents. In this

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study, descriptive analysis is used in the early stage of the causation of marine accidents. Thus, this analysis provides a solid framework for the investigations to be conducted to determine the causes of the marine accident.

Data processing and descriptive analysis used as methods in this study and their application are explained in Section II, and the findings and results obtained are given in Section III.

II. Methodology

Two methods, Data processing and Descriptive analysis, are used in this study. Details of these methods are given in Subsection *A*. In Subsection *B*, information on the application of these methods is presented.

A. Methods

In this study, data processing has been carried out in 2 stages: Data collection and Data preparation.

Firstly, for data collection stage, particular marine accident reports and their annexes were obtained to generate a dataset. These reports were gathered from marine accident research center database. Since the factors that heavily affect marine accidents are determined according to the literature survey, obtained accident reports have been investigated accordingly.

Next, data preparation has been conducted to clean, transform, reformat, and combine raw data to enrich the dataset. Then, they have been analyzed using summary statistics about each related variables for stage of descriptive analysis. Essential ones are presented in this paper with graphics and tables. Thus, a descriptive analysis investigated numerical information of marine accidents is realized in this study.

B. Application

TABLE I
ARRANGEMENT OF VARIABLES

Variable	*Arrangement*
Injuries / Fatalities	If both injury and fatality are absent, the value is 0. If there is any injury or fatality, or both, and the value is 1, The value is 1 If any or both injuries or fatalities are worth more than 1, the value is 2
Damage / Environmental Impact	If both damage and environmental impact are absent, the value is 0. If there is any damage or environmental, or both is not much, the value is 1 If major damage or major environmental impact are involved, the value is 2
Wind	Arrangement according to Beaufort Scale
Sea state	Arrangement according to Beaufort Scale
Visibility	Arrangement according to Optical Range Table

The methods determined at previous stage have been applied. Firstly, for data collection, 46 marine accident reports are obtained from Turkish Ministry of Transport and Infrastructure, Transport Safety Investigation Centre. Subsequently, the marine accident reports have been investigated and 15 common variables to the accident reports are determined: Vessel Details, Accident Type, Flag, Latitude, Longitude, Location of Incident, Year, Month, Hour, Injuries/ Fatalities, Damage/Environmental Impact, Wind, Sea state, Visibility, Weather Condition. Thus, format data were created with 15 variables of 46 marine accidents. Later, in these data, 5 variables are transformed as expressed in Table I in order to perform descriptive analysis.

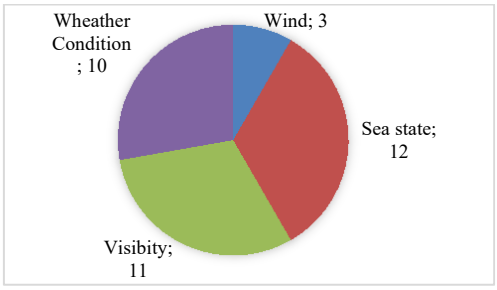

Fig. 1 Number of deficient data by variables

After the data processing stage, 4 variables that are Vessel Details, Latitude, Longitude, and Location of Incident are excluded from the sample of this study as they could not be digitized or analyzed numerically. Thus, descriptive analysis was performed on 11 variable 46 accident data in this study. Deficient data by variables are shown in Fig. 1. There is no deficient data in variables not specified in Fig. 1. This showed that every marine accident report has not same information although all reports are from the same accident investigation center. It can be deduced from this information that there is no standard for reports of accidents and the units used in accident reports for this investigation center.

III. Finding and Results

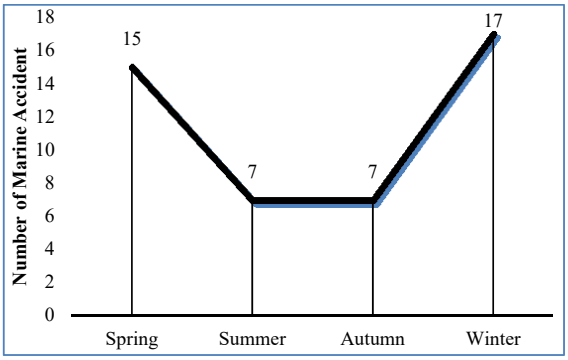

Fig. 2 Distribution of marine accidents by seasons

The accidents that are the subject of this research have been reached from the data of an only one research center. These accidents are accidents that occurred between 2010 and 2018. According to these accident data, 5 marine accidents occur every year. In addition, the seasonal distribution of these accidents is shown in Fig. 2.

In Fig. 3, the distribution of the accidents that are the subject of the study is given by 4-hour periods.

When the seasonal and hourly distributions of the accidents are investigated, it is seen most accidents by season are at winter and autumn, and the most accidents by 4-hours periods are 00:00-04:00 and 12:00-16:00. When the distribution of

marine accidents by seasons was examined in Fig. 2, it seems that accidents increase in winter and spring seasons, due to predominance of environmental conditions such as cold water and dark sky. The reason behind this is effects of this environmental condition on people, such as increment of fatigue and anxiety [23]. When another variable that is distribution of marine accident by 4-hour periods is analyzed, it is seen that the common aspect of the hours when accidents are intense is the same as the officer on watch. Usually the most experienced captains keep 4-8 shifts on ships; other shifts are carried out by less experienced captains [24]. This situation, combined with other factors such as suppression of sleep at 00:00-04:00 or excessive workload such as 12:00-16:00, causes an accident. Although these situations arise with accident reports and accident statistics, the Maritime Labour Convention (MLC) only sets min-max standards for working hours [25]. However, there is needed a regulation to be considered not only in working hours but also in other factors like inexperience, tiredness as stated in other studies [26].

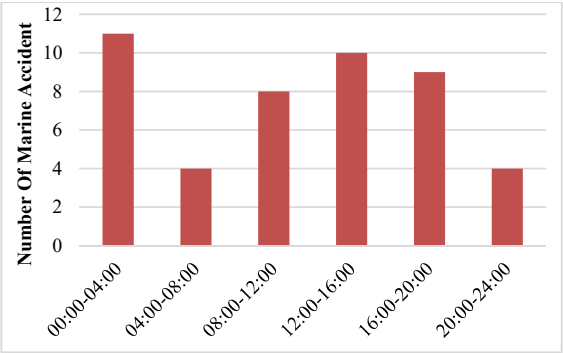

Fig. 3 Distribution of marine accidents by 4-hour periods

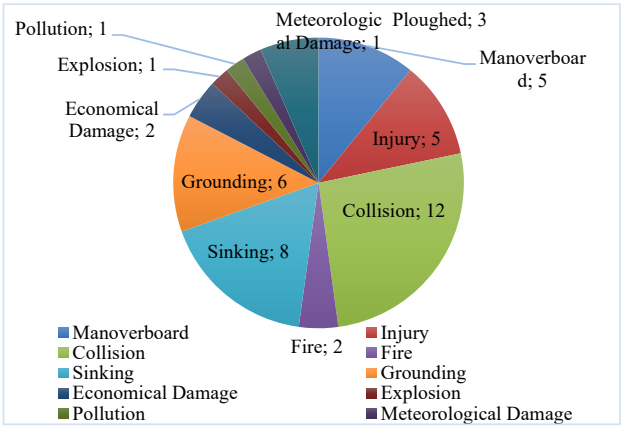

Fig. 4 Distribution of marine accidents by accident type

Fig. 4 shows the distribution of the accidents in terms of accident type. When this figure is examined, it is seen that the most common accident types are collision, sinking and grounding. This case is shown that the topic of Navigation Safety has not been handled correctly in general [27]. Therefore it is possible to prevent many accidents by increasing the studies on this topic.

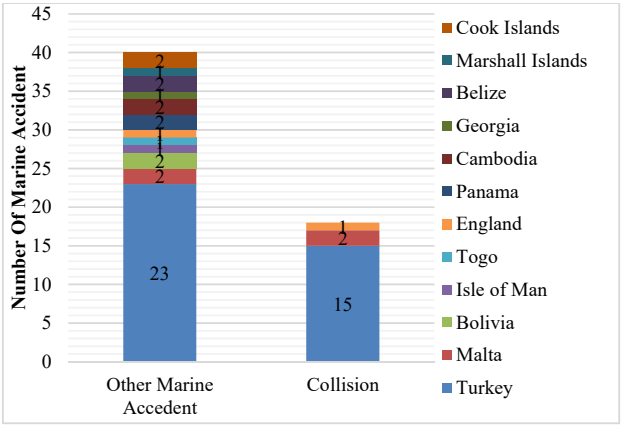

Fig. 5 Distribution of marine accidents by flag

In Fig. 5, the distribution of the flags of the ships involved in marine accidents is shown. Since there are two ships in collision accidents, these accidents are evaluated under a separate heading. The most common flag in both titles is the Turkish flag because 46 marine accident reports are attained from Turkish Ministry of Transport and Infrastructure, Transport Safety Investigation Centre. This shows that this organization mostly prepares the accident reports of the ships belonging to its flag. This prevents standardization in accident reporting and the development of accident reports.

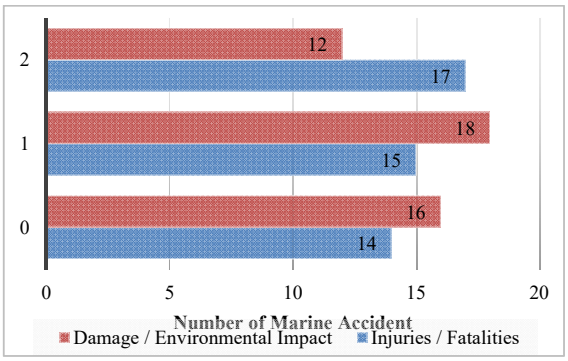

Fig. 6 Distribution of marine accidents by class of damage/ environmental impact and injuries/fatalities

Fig. 6 shows that class distribution of damage/ environmental impact and injuries/fatalities of marine accidents. In this graph, it could be seen that there are many casualties in most of the accidents but we see that it is less in damage/environmental impact. This shows that while pollution and damage measures have developed, security measures have not improved. Thus, it is possible to say that safety measures should be increased for ships.

Table II shows interval numbers of meteorological variables and Fig. 7 shows meteorological variables' distribution by these interval numbers. With this graph, it can be said that the opinion that bad conditions caused the accident in terms of

meteorology is wrong. On the contrary, it is possible to say that in good weather conditions, the risk of accidents is increasing due to comfort and self-confidence [28].

TABLE II
INTERVAL NUMBERS OF METEOROLOGICAL VARIABLES

Interval Number	Wind Speed	Sea state	Visibility
1	0-1	0-1	6-8
2	2-4	2-3	4-6
3	5-6	4-5	2-4
4	7-11	6-11	0-2

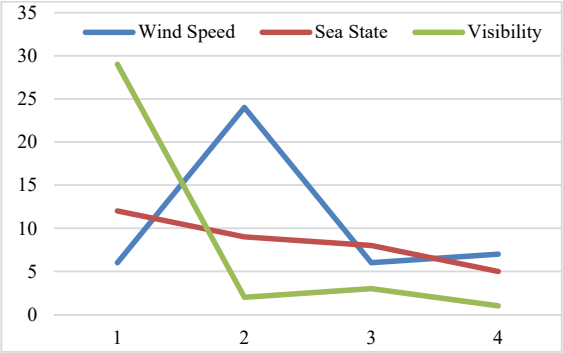

Fig. 7 Distribution of marine accidents by meteorological variables

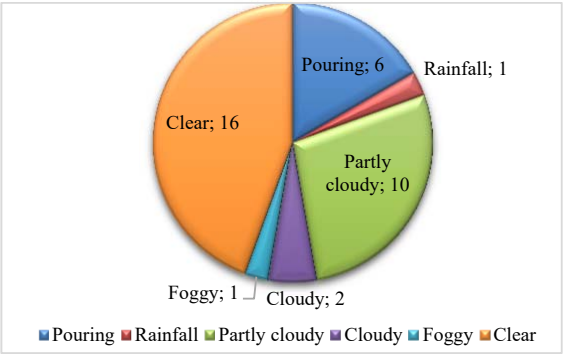

Fig. 8 Distribution of marine accidents by weather condition

Fig. 8 shows weather condition distribution of marine accidents. This graph shows that the most accidents occurred when sky is clear or a partly cloudy. Just like other meteorological variables, it is possible to say that comfort and self-confidence invite accidents in good weather condition [28].

IV. CONCLUSION

With this study, it was realized that accident reports do not have a standard form for Transport Safety Investigation Center of Turkey. There is no standard form for accident reports, and there is no standard form for units such as kilometer knots used in reports. It is clear that meteorological variables in particular are neglected in most marine accident reports. It is possible to see units such as knots in some reports, Beaufort in other reports. The absence of domestic accident reporting requirements prevents researcher and administrators from obtaining a clear understanding of what causes marine accidents. Thus, a standard should be set in accident reports together with its units.

As a result of the analyses made in this study, the effect of the season, time and officer's experience on the occurrence of accidents was explained. The result indicates that seafarers both working and resting hours should be arranged regarding with seasons. Hence, it has been noticed that there are deficiencies in conventions such as MLC in these manner.

In the light of the findings, it was realized that most of the accidents that occurred were related to Navigational Safety as the accident type. It is inferred that there are still problems to be solved in this regard, from the occurrence of accidents related to this issue. In addition, the statistics of the dead and injured situation in the accidents that occurred showed that the safety studies on the ships are not sufficient. For this reason, it is clear that there are issues to be resolved in safety that cause accidents. Therefore, it is crucial to improve maritime safety and handle these problems to prevent the future accidents.

Finally, as a result of the analyses performed on meteorological variables in this study, it has been revealed that the effect of meteorological variables on the occurrence of accidents is less than expected [13,p1]. This is because officers try to be more careful in bad weather conditions. On the contrary, it has been shown that comfort and excessive confidence cause accidents in good weather conditions. It has been revealed with this study that studies should be done to solve this issue.

This study is one of the pioneering examples of research to be conducted in this field. However, present study has investigated 46 marine accidents that collected from one marine accident research center. At the same time, 11 variables have been focused. These mentioned drawbacks are the main limitations of the study. Future studies should be expanded to overcome these fundamental limitations.

FUNDING

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