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Fault tree analysis of accidents occurred in Van Lake

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Abstract

Maritime activities are one of the most important activities around the world. While maritime activities are carried out, various accidents such as collision, grounding, flooding, and on-board accidents occur. The causes of the accidents are determined and recorded with reports. However, records of accidents in inland waters are rare. Since the maritime activities carried out in inland waters remain regional and the boats operating in inland waters are of small size or small tonnage, the accidents that occur are not recorded and detailed reports are not prepared. For this reason, to draw attention to the accidents in inland waters and maritime activities, this study has been prepared by examining the accidents of grounding, collision, and flooding in Van Lake. In the study, the causes of the accidents obtained by the questionnaire and the research were analyzed with the "Fault Tree". As a result of the analysis, it has been determined that factors such as carelessness, lack of information, overconfidence, bad weather conditions, and lack of communication equipment are the main causes of accidents.

Introduction

Maritime activities cover all the world's seas and inland waters. The share of seaway in transportation is quite high. 90% of the transportation in the world is carried out by sea [1].

Many events occur during maritime activities. The most important and most influential of these are accidents. Maritime accidents negatively affect cargo, personnel, and the environment. Although many conventions, rules, and standards have been introduced to prevent maritime accidents, accidents continue to occur [2]. It is important to examine maritime accidents and take necessary precautions. Investigations of maritime accidents are generally limited to the high seas. However, accidents occurring in inland waters should also be examined and necessary precautions should be taken. Especially in inland waters where fishing, transportation, and other maritime activities are carried out intensively, the authorities should take the necessary precautions by examining the marine accidents. Maritime activities are carried out in two important inland waters in Turkey. Van Lake is one of these inland waters.

Freight transportation activities are carried out intensively between Van in Van Lake and Tatvan district of Bitlis [1]. Van Lake is the largest lake in Turkey in terms of surface area. Various maritime activities are carried out on the lake. Activities carried out in the lake can be grouped as transportation, fishing, and other activities. In particular, the rail connection between Turkey and Iran between Van and Tatvan is provided by ferries over the lake, which led to the development of maritime activities. In the document published by the Chamber of Shipping Van Representation, "2 ferries, 33 passenger motors, 117 fishing boats, 27 private boats, 2 sea buses, 1 pier construction barge, 1 small boat shelter, and 14 berths" [4]. Considering this information, the size and importance of the maritime activities carried out in the lake emerges. The aim of the study is to deal with the maritime activities carried out in Van Lake, to determine the types and causes of accidents in the lake, to identify the missing/faulty sides of the activities carried out in the lake, and to offer solutions for the development of activities.

Material and Method

The fault Tree Analysis (FTA) method is one of the most used methods for risk assessment and finding the root causes of errors. With FTA, the main causes of the undesired event or situation are determined and expressed as a figure. In FTA, all causes that will pose a hazard are defined. This method is aimed to minimize or prevent risky situations by revealing all the sub-causes of the event. It can be stated that it is the most important method used in security analysis since the 1960s. It is also an effective method in the analysis of complex systems [5-8].

The FTA method basically consists of 3 stages: analysis of the system, creation of the fault tree, and evaluation of the fault tree. A survey was conducted to determine the grounding, collision, and flooding accidents in Van Lake. The data obtained because of the survey were classified and a fault tree was created for grounding, collision, and flooding accidents (Figure 1). In addition, the probability values of the causes of the accident were calculated according to the data obtained from the survey. The generated fault tree and calculated probability values (Table 1) were analyzed with OpenFTA software. The data obtained because of the analysis were examined and the results have been revealed.

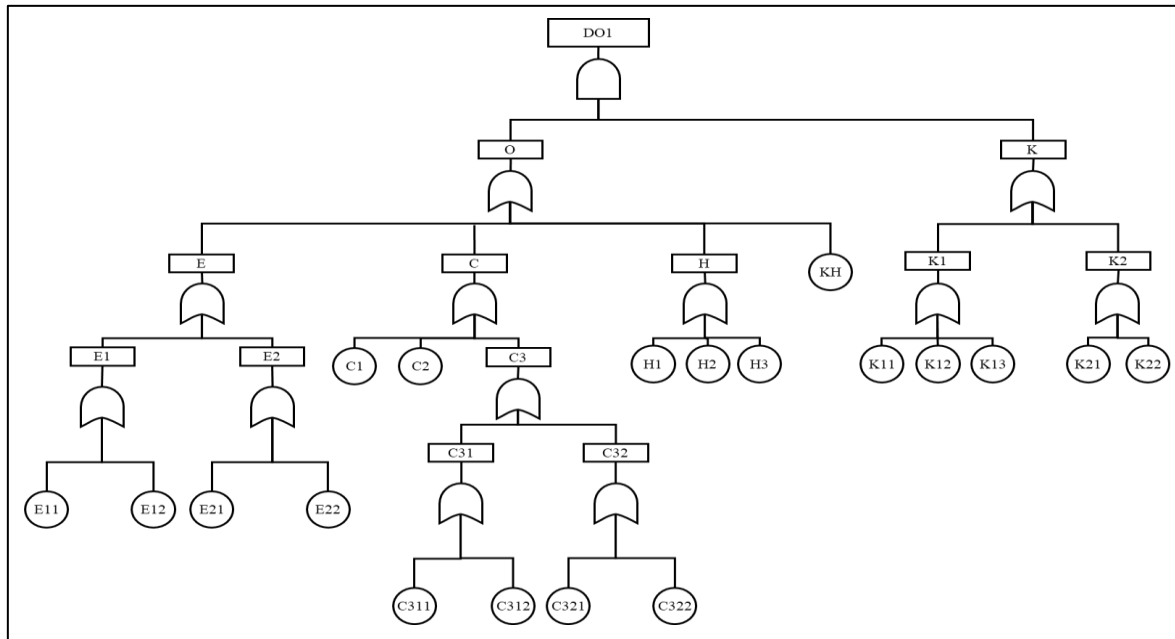


Figure 1. Fault tree for stranding, collision, and flooding accidents

Table 1. Code and probability values for grounding, collision, and flooding accidents

Code	Description	Probability	Code	Description	Probability
DO1	Grounding / Collision / Flooding	0,066100000	C32	Phone	0,061100000
O	Operational failures	0,373000000	C321	Malfunction of phone	0,019047619
E	Equipment failures	0,087600000	C322	Phone out of range	0,042857143
E1	Engine failure	0,028400000	H	Wrong loading	0,128000000
E11	Incorrect fuel use	0,014285714	H1	Calculation error	0,033333333
E12	Malfunction of part	0,014285714	H2	Unbalanced loading	0,038095238
E2	Equipment malfunction	0,061000000	H3	Overload	0,061904762
E21	Navigational equipment malfunction	0,023809524	KH	Bad weather conditions	0,066666667
E22	Rudder failure	0,038095238	K	Personal errors	0,177000000
C	Lack of communication equipment and failure	0,156000000	K1	Ability errors	0,088200000
C1	Lack of navigation equipment	0,014285714	K11	Disobeying rules	0,028571429
C2	Other equipment's	0,014285714	K12	Lack of information	0,052380952
C3	Lack of equipment	0,131000000	K13	Using the radio on the wrong channel	0,009523810
C31	Radio equipment	0,074800000	K2	Perception failures	0,097600000
C311	Lack of radio	0,047619048	K21	Carelessness	0,061904762
C312	Malfunction of radio	0,028571429	K22	Overconfidence	0,038095238

Results

As a result of the handling of the survey data, it was determined that 21 grounding, collision, and flooding accidents occurred in a period of approximately 10 years. As a result of the analysis of the detected accidents with a fault tree, taking into account the causes of the accidents, the contribution values of the causes and the minimum cut sets were determined.

When accidents such as grounding, collision, and flooding are examined in terms of their causes, the main causes that have the most impact are respectively K21 (Carelessness), K12 (Lack of information), K22 (Overconfidence), K11 (Disobeying rules), KH (Bad weather conditions). The is designated as H3 (Overload), C311 (Lack of radio), and C322 (Phone out of range).

When the minimum cut sets that must occur for the determined main causes to occur in combat accidents are examined, the cut set K21 (Carelessness) and KH (Bad weather conditions) that have the greatest effect are the minimum cut sets.

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