http://www.egejfas.org
Ege Journal of Fisheries and Aquatic Sciences, 40(1), 1-14 (2023)

Su Ürünleri Dergisi (2023)
DOI: 10.12714/egejfas.40.1.01

RESEARCH ARTICLE **ARAŞTIRMA MAKALESİ**

Determination of risk perception in small-scale fishing and navigation

Küçük ölçekli balıkçılıkta ve seyir sırasında risk algısının belirlenmesi

Can Atacan[1] ● Faik Ozan Düzbastılar[2*]

[1] Ege University, Urla Maritime Vocational School, 35430, Urla, İzmir, Türkiye https://orcid.org/0000-0002-4490-7566
[2] Ege University, Faculty of Fisheries, 35100, Bornova, İzmir, Türkiye https://orcid.org/0000-0002-5376-7198

*Corresponding author: f.ozan.duzbastilar@ege.edu.tr

Received date: 27.07.2022 *Accepted date: 03.10.2022*

How to cite this paper:
Atacan, C. & Düzbastılar, F.O. (2023). Determination of risk perception in small-scale fishing and navigation. *Ege Journal of Fisheries and Aquatic Sciences, 40*(1), 1-14. https://doi.org/10.12714/egejfas.40.1.01

Abstract: In this study, risk perception and the impact of various environmental factors on accidents involving fishing vessels in small-scale fishing vessels during navigation were examined. Thirty fishing vessel captains from Çeşmealtı and İskele fishing ports evaluated the risks of environmental conditions under different scenarios in the bridge navigation simulator based on the Fine-Kinney risk assessment method. Nonparametric (Mann-Whitney U-test) and parametric tests (Pearson correlation and independent-samples t-test) were performed to analyse other related parameters. The study also conducted a small questionnaire study that included questions such as the number of past accidents by fishermen and the number of engine rudder failures. According to the sum of the fishermen's assessments, reduced visibility was the highest factor increasing the probability and consequences of accidents in sea navigation, while they identified night and heavy weather conditions as the highest factor in port navigation. Fishermen also found navigating their ports safer than sea navigation. There is a significant, positive, and strong correlation between the number of fishermen's accidents and the number of engine rudder failures ($p=0.047$, $r=0.714$), the perception of accident probabilities in port navigating with restricted visibility ($p=0.027$, $r=0.726$) and in port navigation at night and in heavy weather ($p=0.003$, $r=0.866$). According to the results of the study, using the outcomes of the pre-fishing environmental risk assessment, the competent maritime authorities may be able to take effective measures to prevent the occurrence of serious marine casualties.

Keywords: Small-scale fishery, accident probability, accident consequence, risk perception, navigation

Öz: Bu çalışmada, küçük ölçekli balıkçı teknelerinde seyir sırasında karıştığı kazalardaki risk algısı ve çeşitli çevresel faktörlerin etkisi incelenmiştir. Çeşmealtı ve İskele balıkçı barınaklarından Otuz balıkçı gemisi kaptanı, Fine-Kinney risk değerlendirme metoduna dayanarak köprü üstü seyir simülatöründe farklı senaryolar altında çevresel koşulların risklerini değerlendirmişlerdir. Diğer verilerin analizi için de parametrik (Pearson korelasyon analizi ve t testi) ve parametrik olmayan (Mann-Whitney U testi) testler kullanılmıştır. Çalışmada ayrıca balıkçıların daha önceki deneyimlerinden kaza sayıları, makine dümen arızası gibi sorulardan oluşan bir anket çalışması da yapılmıştır. Balıkçıların değerlendirmeleri sonucu ortaya çıkan puanların toplamına göre deniz seyrinde kaza ihtimal ve neticesini arttıran en yüksek etken olarak kısıtlı görüşü belirlemişken liman seyrinde gece ve şiddetli hava koşulunu en yüksek etken olarak belirlemişlerdir. Ayrıca balıkçılar kendi limanlarında yaptıkları seyri deniz seyrine göre daha emniyetli bulmuşlardır. Balıkçıların yaşadıkları kaza sayısı ile makine-dümen arıza sayısı ($p=0,047$, $r=0,714$), liman seyrinde kısıtlı görüşte ($p=0,027$, $r=0,726$) ve şiddetli havada gece seyrinde kaza ihtimali algısı ($p=0,003$, $r=0,866$) arasında anlamlı ve pozitif ve güçlü ilişki vardır. Çalışmanın sonuçlarına göre, küçük ölçekli balıkçıların denize çıkmadan önce çevresel şartlara göre risk değerlendirmesi sonuçlarından yararlanılarak ilgili denizcilik makamlarının ciddi deniz kazalarının meydana gelmesini önlemek için etkili önlemler alması mümkün olabilir.

Anahtar kelimeler: Küçük ölçekli balıkçılık, kaza ihtimali, kaza neticesi, risk algısı, seyir

INTRODUCTION

It is estimated that half a billion people worldwide make a living from artisanal (small-scale) fishing. The Food and Agriculture Organization of the United Nations reports that small-scale fishermen are responsible for 40% of the total catch and 68% of marine capture (FAO, 2021). Although small-scale fisheries depend on specific conditions such as developed or underdeveloped countries, it can be briefly defined as a type of traditional fishery for local consumption using small boats, low-tech gear, and deck equipment, mainly near shore (Halim et al., 2019; Smith and Basurto, 2019). Due to its ecological, economic, cultural, socio-political, and nutritional importance, the sustainability of small-scale fisheries is increasing worldwide (Halim et al., 2019; Smith and Basurto, 2019; FAO, 2021; Villasante et al., 2022). However, maritime and commercial fishing, in particular, is one of the most dangerous occupations in the world in terms of safety and has a high mortality rate (Jaremin and Kotulak, 2004; Jin and Thunberg, 2005; FAO, 2014).

The accident statistics of the European Maritime Safety Report show the danger in the fishing industry and endanger its sustainability (EMSA, 2022). For example, 50% of all accidents involving fishing vessels in EU countries are classified as serious or very serious. Although fishing accidents rank third among vessel types, when the severity of the accident is taken into account, they move up to second place. Especially in the case of serious accidents such as shipwreck and ship loss, fishing boats are far ahead of other types of ships (EMSA, 2022; Wang et al., 2021).

Maritime accidents have been an important subject of study in the literature for many years. In particular, some previous work has examined a significant association between fishing vessel accidents and boat length, boat age, weather, sea conditions, visibility, and time of day (Jin et al., 2001; Jin et al., 2002; Wu, 2008; Wu et al., 2009; Roberts et al., 2010; Kim and Kang, 2011; Jin, 2014; Pleskacz, 2015; Yıldırım and Başar, 2019). Most of the work in this research has focused on accident categories such as collision, stranding, sinking, fire-explosion, industrial accident, and man overboard (Wang et al., 2005; Bayar, 2010; Sur and Kim, 2020; Uğurlu et al., 2020). Much research has been done in the literature on human error concepts emphasized in accidents involving fishing vessels like other marine casualty studies (Kim and Kang, 2011; Jung, 2014; Won and Kim, 2019). One of the reasons for marine casualties is defined as the fact that fishermen at busy traffic separation lines follow different routes than other vessels, which increases the number of accidents (Oh et al., 2015). The other reasons like falling asleep on the bridge, lack of experience, and leaving the helm unattended can lead to consequences like sinking of the ship and death of the fishing vessel were mentioned by Soykan (2018). While not enough to reduce incidents at sea caused by human error, engineers over the past five decades have focused on technological improvements in hull design, ship propulsion, auxiliary deck equipment, navigation, and safety equipment (Formela et al., 2019; Hasanspahić et al., 2021).

Numerous studies have identified human error as the most important factor influencing accident occurrence (Roberts et al., 2010; Awal and Hasegawa, 2017; Kim and Na, 2017; Fan et al., 2020; Hasanspahić et al., 2021; Demirci et al., 2022). However, looking at these studies in general, environmental factors influence accident occurrence in almost all of them (Kim and Kang, 2011; Pleskacz, 2015). There is no specific study on how different environmental factors increase the probability of accidents or how they affect the risk of accidents. Previous studies on marine casualties have generally taken a reactive approach (Awal and Hasegawa, 2017) and sought a risk assessment based on previous casualties. A proactive approach in this area and a close examination of the risk development process can become more important to eliminate the risks (Psaraftis, 2002; Montewka et al., 2014; Haapasaari et al., 2015; Luo and Shin, 2019).

Many methods in the literature address the problem by identifying or preventing factors that influence marine casualties. Our potential solution is a proactive approach to risk assessment. The aim of this study was to fill the gap by proactively addressing this issue and identifying the risks of operating on small fishing vessels. Therefore, a risk assessment method for fishermen navigating in the different scenarios prepared in the bridge navigation simulator was used to determine the environmental conditions affecting the level of risk during navigation.

MATERIAL AND METHODS

The study consists of (1) a questionnaire with demographic and occupational questions and their statistical analysis for a better understanding of the topic and (2) simulator experiments in different scenarios in which a risk assessment is made. The second goal was the principal objective of this research. 20 out of 27 fishermen from İskele Port and 10 out of 30 fishermen from Çeşmealtı (in total, 30 fishermen from two ports) participated in the study. The fishermen completed a questionnaire containing some information from their experience along with demographic questions and finally assessed the accident probability and consequences according to a risk assessment method based on the scenarios in the simulator.

The bridge operation simulator ARI (Applied Research International, Version 1.0), classified by DNV and GL (Det Norske Veritas and Germanischer Lloyd), was used for simulator experiments. The simulator is supported by a total of 21 computers. Navigation aids such as radar, ECDIS, and echo sounder are available in the simulator (Figure 1). The methodology imposed on the simulation allows, through the simultaneous application, to effectively estimate the probabilities and consequences of different random scenarios (Li et al., 2012). Three different scenarios (sea navigation, İskele port navigation, and Çeşmealtı port navigation) have been created in the bridge simulator to allow the fishermen to navigate in 30 minutes under different environmental conditions (current, night navigation, etc.) (Figure 1). Scenarios were prepared in the bridge simulator and the fishermen were asked to use the fishing boat (LOA 18 m, width: 4.5 m, draft: 1.5 m). Only active captains of fishing vessels working in İskele and Çeşmealtı fishing ports have been included in the scenarios. No restrictions such as age, gender, experience, and competence variables were set for the participants. The same scenario has been applied to everyone in sea navigation. However, for port navigation, fishermen from İskele and Çeşmealtı Port sailed into their own port. It was considered more appropriate to conduct the navigation in their own ports and evaluate their results, since fishing boats do not call at different ports like commercial boats.

The simulation experiments were performed in the following flow order: (1) The same parameters were applied to the environmental conditions (current, heavy weather, restricted visibility, etc.) for both port and sea navigation. Scenarios in the simulator were started in calm weather and sea conditions. (2) In the scenarios, the shipping traffic was prepared according to the customs of the region. Since sea navigation is located in the traffic separation scheme, shipping traffic from east to west and vice versa was prepared. All participants were instructed to cross the separation line in a northerly direction. (3) In the port navigation, a sailing boat has been placed on the breakwater and three fishing boats have been placed in the port area outside of the port. In this condition, all participants were instructed to proceed to port about 5 cables from the breakwater. (4) In the scenario, the current speed was set to 4 knots, the range for the restricted visibility was reduced to 100 meters and the wind force was determined to be 5 Beaufort. (5) The fishermen were given sufficient time (At least 30 min.) during the simulation to adapt to the situation and provide healthy feedback. (6) Before the simulation experiments, they were informed about the test methodology and the Fine Kinney risk assessment with regard to accident probability, consequences, and frequency. (7) A maximum of four fishermen were employed in the simulator at the same time. (8) Fishermen initially navigated in the traffic separation scheme, where commercial ships, sailing boats, and fishing boats navigated in calm seas and calm weather. Then environmental conditions were changed in the simulation. After applying each environmental factor, it ceded its place to the new condition. (9) The scenario assumed a current of 4 knots that act laterally on the fishing boat and waited a while for the fishermen to notice the current. When fishermen feel the current effect, their feedback is collected and the risk perception and score are calculated. (10) Then the range for the restricted visibility was reduced to 100 meters in the experiment. Similarly, they were allowed to cruise for a while and their opinions were taken. (11) After that, night navigation was applied using the same procedure. (12) After the night's navigation, the fishing boat faced heavy weather from north winds (5 Beaufort). Again, feedback was received from the fishermen at the end of the scenario. (13) In the end, the combination of heavy weather and night navigation was applied simultaneously in the scenario. Then, the views of the fishermen were sought to carry out a risk assessment.

Occupational hazards (current, night navigation, reduced visibility, etc.) are identified before applying this risk assessment method. Work-related hazards identified by fishermen are collision, allision, grounding, flooding, and capsizing. Then the probability of occurrence of these hazards, the consequence values (*C-value*) (Table 1), and the frequency factor (F_2) (Table 2) are determined by the experts according to the environmental conditions. The risk score is obtained by multiplying the criteria defined by the experts for these three parameters.

Figure 1. ARI (Applied Research International, Version 1.0) bridge operation simulator and port navigation for İskele and Çeşmealtı fishing ports in the simulator

The probability and consequences of accidents were determined based on the personal assessments of the fishermen participating in the study. In determining the frequency factor, both the weather information in the region and the exposure to environmental and marine conditions were taken into account.

Table 1. Probability and consequence scales are rated by fishermen according to the Fine-Kinney risk assessment

Probability (*P*)		**Consequence (*C*)**	
P-value	***Statement***	***C-value***	***Statement***
10	Might well be expected	100	Catastrophic (many fatalities, or > $\$10^7$ damage)
6	Quite possible	40	Disaster (few fatality, or > $\$10^6$ damage)
3	Unusual but possible	15	Very serious (fatality, or > $\$10^5$ damage
1	Only remotely possible	7	Serious (serious injury, or > $\$10^4$ damage)
0.5	Conceivable but very unlikely	3	Important (disability, or > $\$10^3$ damage)
0.2	Practically impossible	1	Noticeable (minor first aid accident, or > $\$10^2$ damage)
0.1	Virtually impossible		

In the Fine-Kinney method, the frequency factor (*F*) shows the frequency of exposure of the worker to the working conditions. Frequency is a key factor in risk assessment. Therefore, this step is essential for making the method feasible for a valid risk assessment. According to the fishermen involved in the investigation, they cruise to fish several times a week. The frequency of occurrence of environmental conditions such as calm air-sea conditions, currents, restricted visibility, and heavy weather was determined using fisherman experience, related literature, and annual meteorological reports. It is considered that fishermen in İzmir Bay meet boats once a week; because the ships entering or leaving the ports operate in a traffic separation scheme and there are many fishing ports and marinas. Therefore, the calm air-sea condition state frequency expression was chosen from time to time (once a week) and the F_2 value was chosen as 3 from Table 2.

The current in the bay is caused by temperature-dependent density fluctuations and wind (Eronat, 2017). The literature states that the wind plays a crucial role in the current long-term winds for İzmir Bay. Accurate information about the current strength in İzmir Bay could not be obtained from the sources, but the fact that the winds act on the current means that the seasonal continuous surface currents and tidal currents are weak. Therefore, the frequency factor for the magnitude of the current was determined according to the wind. The frequency factor F_2 value for the wind variable was determined as 2 from the meteorological data and the assessments of the fishermen. A rare expression was chosen for the restricted visibility, corresponding to an F_2 value of 1, as fog/haze factor occurs several times a year in the region. The night-time condition occurs once a day, but since fishermen do not work at sea every day, the frequency of night navigation was chosen to be occasional (once a week), which corresponds to the F_2 value of 3. Since the occurrence of night and heavy weather conditions was correspondingly rare, the same value was selected for the night-heavy weather conditions with the frequency of heavy weather. The frequency values to be used to determine the risk score are listed in the F_2 values section of Table 2.

Table 2. Frequency table used in the risk assessment calculation (F_1: Fine-Kinney risk assessment frequency table. F_2: Values derived from fishermen's experience, previous studies, and local meteorological data)

Environmental condition	Frequency (*F*)			
	F_1 value	Statement	F_2 value	Statement
Calm weather and sea	10	Continuous	3	Occasional (weekly)
Current*	6	Frequently (daily)	2	Unusual (monthly)
Restricted visibility**	3	Occasional (weekly)	1	Rare (a few per year)
Night navigation	2	Unusual (monthly)	3	Occasional (weekly)
Navigation in heavy weather***	1	Rare (a few per year)	2	Unusual (monthly)
Night-heavy weather navigation***	0.5	Very rare (yearly)	2	Unusual (monthly)

*Current speed = 4 knot
**Visibility = 100 m
***Heavy weather = 5 Beaufort (NNE)

There are some well-established methods for determining risk assessment. Much research has been done on risk assessment at sea (Jin et al., 2002, Haapasaari et al., 2015, Awal and Hasegawa, 2017, Hasanspahić et al., 2021). Several methods for risk assessment have been reported in the literature. Considering the studies, risk matrix methods have been used quite frequently (Akyıldız, 2015, Gucma and Ślączka, 2018, Hsu et al., 2022). In this study, the Fine Kinney method, a qualitative and applied risk analysis method in occupational safety, was used to estimate the risk of sea and port navigation under different environmental conditions (restricted visibility, current, calm weather, sea, etc.). (Kinney and Wiruth, 1976). The Fine-Kinney method was first introduced in 1971 by William T. Fine (Fine, 1971). An improvement over this method was developed by Kinney and Wiruth (Kinney and Wiruth, 1976).

Although the Fine-Kinney method, which is similar to the risk matrix method, is not widely used in research in the maritime field, it has been used in research in various fields and has been found to provide more reliable and realistic results than the risk matrix method (Okumuş and Barlas, 2016; Bekdemir, 2019; Zaloğlu, 2019; Ölçücü and Ersöz Kaya, 2019; Usanmaz and Köse, 2020). The Fine-Kinney method differs from the risk matrix method in that it includes a wider range of parameters and the frequency factor. Offering the decision maker, a wider choice of options ensures that the risk assessment provides more reliable results. The fishermen chose the appropriate statement according to their knowledge during the simulator experiments as shown in Table 1.

After determining the probability (*P-value*) and consequence (*C-value*) values, the risk was calculated using Eq. (1). Correlation tests were performed to determine the significant differences between the fishermen's age, experience, length of the fishing boat, number of accidents, number of engine rudder failures, and accident probability and consequence values. The Mann-Whitney U test was used to determine the significant differences between two groups of fishermen from İskele and Çeşmealtı fishing ports, as well as accident probability and consequence values. The Mann-Whitney U test requires the presence of two independent variables (İskele and Çeşmealtı fishermen) and also dependent variables (probability and consequence ratings) that are not normally distributed. A secondary objective of this study was to obtain some of the occupational information presented in the Results section from the fishermen via questionnaire. An independent sample t-test was used for these data (boat size, experience, etc.) from the questionnaire. It was used to determine the significant differences between two groups of fishermen from İskele and Çeşmealtı fishing ports in terms of their experience, boat length, number of accidents, and engine-rudder failures. We use the above methods because they are simple and relatively efficient. All nonparametric and parametric tests were performed using the SPSS 22.0 software package. Figures 2, 3, 4, and 5 were drawn according to the fishermen's responses, and Figures 5, 6, 7, and 8 were drawn from the results of Eq. 1.

$$\text{Risk} = P \times C \times F_2 \qquad \text{Equation (1)}$$

RESULTS

This study examined the probability and consequences of maritime accidents related to environmental factors. First, survey questions were prepared to uncover the profile information and experiences of the participants on a topic-specific basis. The parameters in the Fine-Kinney risk assessment method were added at the end of the prepared questionnaire and communicated to the decision-makers during the scenarios. Fishing captains took turns entering the simulator room and giving their evaluations. The results were analysed and the following findings were obtained. As the results are based on the opinions of active fishermen, it is believed that the risk perceived by fishermen during the fishing trip should be appropriately assessed.

A total of 20 fishermen from the İskele fishing port and 10 fishermen from the Çeşmealtı fishing port took part in our study. All fishermen who participated in the survey were male (30). Of these, 70% of the fishermen were married. The percentage of fishermen aged 46 years or older in the study was 63.3%. The educational structure of the participants was; Elementary education (46.7%), high school (33.3%), associate degree (10.0%), bachelor's degree (6.7%), and master's degree (3.3%). When assessing the competence of the participants, it was found that 3.3% (1) bosun, 30.0% (9) able seaman, 46.7% (14) seaman, 6.7% (2) fishing boat captain, 3.3% (1) were fishermen' crew, 3.3% (1) were watchkeeping officer, and 6.7% (2) were amateur seaman's certificate.

Regarding work experience in small-scale fisheries, it was found that 13.3% (4) had 1-10 years of experience, 30.0% (9) had 11-20 years of experience, 26.7% (8) had 21-30 years of experience, 23.3% (7) had 31-40 years of experience, and 6.7% (2) had more than 41 years of experience. The average experience of the fishermen was 27.8 years (s.e.=0.285) and 21.8 years (s.e.=0.268) for İskele and Çeşmealtı fishing ports, respectively (p=0.133). There was no significant difference between the fishermen's experience and their fishing ports (p=0.324) (Table 3).

Table 3. Independent samples t-Test results (grouping variable is fishing port)

Test variables		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)
Experience	Equal variances assumed	2.400	0.133	1.005	28.000	0.324
	Equal variances not assumed			1.148	25.427	0.262
Boat size	Equal variances assumed	2.687	0.112	0.409	28.000	0.685
	Equal variances not assumed			0.508	27.999	0.615
Accident	Equal variances assumed	3.892	0.080	1.833	9.000	0.100
	Equal variances not assumed			2.360	7.643	0.047
Engine or rudder failures	Equal variances assumed	0.342	0.564	0.768	26.000	0.449
	Equal variances not assumed			0.800	14.109	0.437

Most commercial fishing boats are typically shorter than 12 meters (60% 4-7 m and 30% 8-11 m) but only three boats (10%) were longer than 15 m. The average length of fishing boats was 9.31 m (s.e.=0.243) and 8.77 m (s.e.=0.166) in İskele and Çeşmealtı fishing ports, respectively (p=0.112). No significant differences were found between the size of fishing boats and their fishing ports (p=0.685) (Table 3). While the fishermen indicated that almost all fishermen (86.7% - 26 participants) used gillnets, the remaining fishermen used other fishing gear such as handline, longline, etc. In the study, fishermen's navigational experience was assessed using eight survey questions. 70% of the participants stated that they had never had a marine casualty. 30% of the fishermen who had accidents told us how often they had an accident (three people for 1-3 times, two people for 4-7 times, two people for 8-11 times, and two people for 14+). The average number of accidents that fishermen had was 5.5 (s.e.=0.633) and 0.5 (s.e.=0.250) for İskele and Çeşmealtı fishermen, respectively (p=0.080). It was found that there was no significant difference between the number of accidents and the associated fishing ports (p=0.100) (Table 3). All fishermen accepted that the perception of risk when fishing is higher than when navigating at sea or in port.

They specified the type of accidents they had as collision and allision (3 people), grounding (5 people), flooding (4 people), and capsizing (1 person). All fishermen except two fishermen reported suffering engine or rudder failure while working at sea. When the fishermen were asked how often they had engine or rudder failures, it was found that 35.7% (10) had 1-4 failures, 32.1% (9) had 5-8 failures, 7.1% (2) had 9-12 failures, 14.3% (4) had 13-16 failures, and 10.7% (3) had 17+ failures. The mean engine or rudder failures were 10.2 (s.e.=0.320) and 5.1 (s.e.=0.462) for İskele and Çeşmealtı fishermen, respectively (p=0.564). There was no significant difference between the number of any type of failures and their fishing ports (p=0.100) (Table 3).

According to the results of the correlation test, there is a significant (p=0.038), negative (-), and moderate (r=0.381; Pearson correlation) relationship between the experience of fishermen and the probability of an accident in port navigation with the current situation (Table 4). More experienced fishermen said that under current conditions, port navigation is less likely to result in accidents than less experienced fishermen. No significant difference was found between fishermen's experience and length of boat used (p=0.361), number of accidents (p=0.850), number of engine and rudder failures (p=0.066), and probability and consequence values of accidents under other environmental conditions while navigating at sea and in port (all values greater than 0.05). No significant difference was found between the boat lengths reported by the fishermen and the number of accidents suffered (p=0.089), the number of engine and rudder failures (p=0.118), and the probability and consequence values of accidents under environmental conditions during navigation at sea and in port (all "p" values greater than 0.05).

Table 4. The results of the correlation test between experience and probability of an accident in port navigation in the current state

		Probability of accident in port navigation having the current condition
Experience	Pearson correlation	-0.381
	Sig. (2-tailed)	0.038
	Number	30

There is a significant, positive, and strong association between the number of accidents experienced by fishermen and the number of engine and rudder failures (p=0.047, r=0.714), the probability of an accident in port navigation with restricted visibility (p=0.027, r=0.726) and with the night-heavy weather conditions in port navigation (p=0.003, r=0.866) (Table 5).

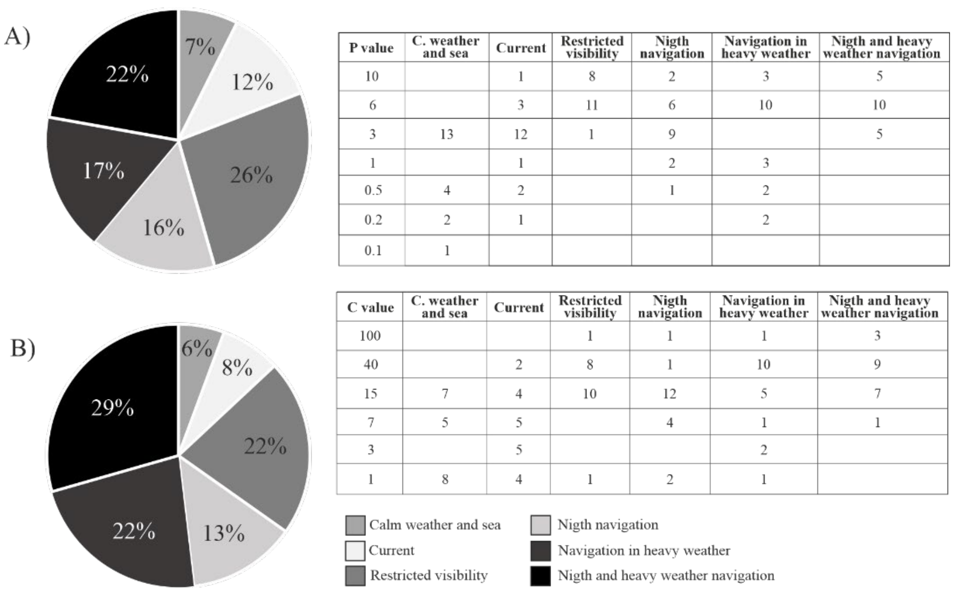
Table 5. The results of the correlation test between the number of accidents and other parameters show a significant connection

		Number of machine-rudder failures	Probability of accident in port navigation with restricted visibility	Probability of accident with the night-heavy weather condition in port navigation
Number of accidents	Pearson correlation	0.714	0.726	0.866
	Sig. (2-tailed)	0.047	0.027	0.003
	Number	8	9	9

Fishermen from both fishing ports reported being at sea several times a week to fish throughout the year. Before the simulator experience, all participants foresaw stranding, collision, and allision as a risk of navigation at sea. In order to design a scenario on the ship bridge simulator, we were told that the prevailing wind direction is north.

According to the simulator experiments, the most important condition emerged as restricted visibility (26%), followed by night and weather navigation (22%), and heavy weather navigation for accident probability of fishermen from the İskele fishing port in sea navigation (Figure 2).

The most hazardous conditions were identified as night and weather navigation (29%), restricted visibility (22%), and heavy weather navigation (22%) for the consequences of marine casualties assessed by fishermen from İskele fishing port (Figure 2).



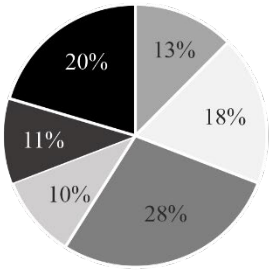
P value	C. weather and sea	Current	Restricted visibility	Nigth navigation	Navigation in heavy weather	Nigth and heavy weather navigation
10		1	8	2	3	5
6		3	11	6	10	10
3	13	12	1	9		5
1		1		2	3	
0.5	4	2		1	2	
0.2	2	1			2	
0.1	1					

C value	C. weather and sea	Current	Restricted visibility	Nigth navigation	Navigation in heavy weather	Nigth and heavy weather navigation
100			1	1	1	3
40		2	8	1	10	9
15	7	4	10	12	5	7
7	5	5		4	1	1
3		5			2	
1	8	4	1	2	1	

Figure 2. A) Percentages of probability and rating of fishermen from İskele fishing port in sea navigation. B) Percentages of consequences and ratings of fishermen from İskele fishing ports in sea navigation (*P-value*: value of the probability of accidents; *C-value*: value of the consequences of accidents)

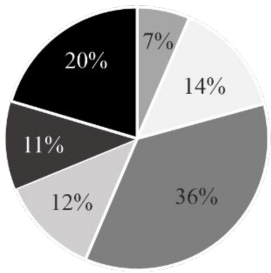
The most dangerous factor, according to Çeşmealtı fishermen, was restricted visibility (28%), followed by night and weather navigation (20%), and current (18%) for accident probability in sea navigation (Figure 3). When assessing the accident consequence of fishermen from Çeşmealtı fishing port in the sea navigation, the factors with the highest percentages were restricted visibility (36%), night and weather navigation (20%), and current (14%) (Figure 3).

A)



P value	C. weather and sea	Current	Restricted visibility	Nigth navigation	Navigation in heavy weather	Nigth and heavy weather navigation
10	2	3	7	1	1	4
6	2	4	3		2	2
3	2	1		7	3	4
1					1	
0.5	2	1		2	1	
0.2		1				
0.1					2	

B)



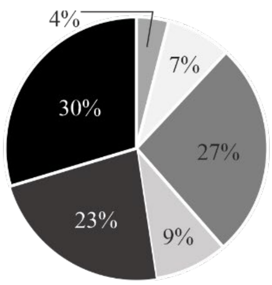
C value	C. weather and sea	Current	Restricted visibility	Nigth navigation	Navigation in heavy weather	Nigth and heavy weather navigation
100		1	4		1	2
40		2	3	4	1	2
15	6	1	1	1	1	1
7	1	3	2	1		1
3				2	2	4
1	3	3		2	5	

Calm weather and sea
Current
Restricted visibility
Nigth navigation
Navigation in heavy weather
Nigth and heavy weather navigation

Figure 3. A) Percentages of probability and rating of fishermen from Çeşmealtı fishing port in sea navigation. B) Percentages of consequences and ratings of fishermen from Çeşmealtı fishing ports in sea navigation (*P-value*: value of the probability of accidents; *C-value*: value of the consequences of accidents)

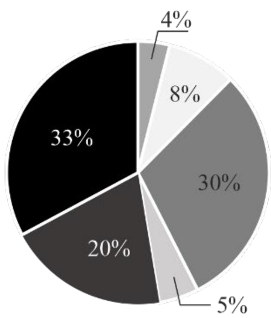
In port navigation, night and weather navigation (30%), restricted visibility (27%), and heavy weather navigation (23%) were the most important factors for the accident probability of İskele fishermen (Figure 4). The most dangerous accident consequence condition, rated by fishermen from the same port, was night and weather navigation (33%), followed by restricted visibility (30%), and heavy weather condition (20%) in port navigation (Figure 4).

A)



P value	C. weather and sea	Current	Restricted visibility	Nigth navigation	Navigation in heavy weather	Nigth and heavy weather navigation
10			8	1	1	5
6		2	10		8	7
3	4	3	8	5	10	8
1	1	8		9	1	
0.5	1	3		3		
0.2	7	3				
0.1	7	1		2		

B)

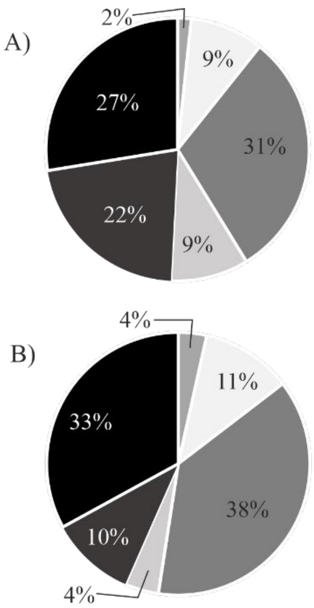


C value	C. weather and sea	Current	Restricted visibility	Nigth navigation	Navigation in heavy weather	Nigth and heavy weather navigation
100		1	1		1	2
40	1		5		2	4
15			7	1	2	6
7		1	7	3	12	6
3		2		11	1	1
1	19	16		5	2	1

Calm weather and sea
Current
Restricted visibility
Nigth navigation
Navigation in heavy weather
Nigth and heavy weather navigation

Figure 4. A) Percentages of probability and rating of fishermen from İskele fishing port in port navigation. B) Percentages of consequences and ratings of fishermen from İskele fishing ports in port navigation (*P-value*: value of the probability of accidents; *C-value*: value of the consequences of accidents)

In the Çeşmealtı fishing port, fishermen cited restricted visibility (31%) as the number one determinant of accident probability (Figure 5). In the same fishing port, they chose restricted visibility (38%) as the most dangerous factor influencing the consequences of the accident, followed by night and weather navigation (33%), and current (11%) in port navigation (Figure 5). Restricted visibility (mean=7.90) for the probability of accidents and heavy weather navigation at night (mean=37.03) for the consequence of the accident was identified as the most dangerous factor for all fishermen in sea navigation (Table 6). For port navigation, night-heavy weather navigation was the most important factor for both the accident probability (mean=5.56) and consequence (mean=19.70) for all fishermen (Table 6).



P value	C. weather and sea	Current	Restricted visibility	Nigth navigation	Navigation in heavy weather	Nigth and heavy weather navigation
10			3	1		
6		1	4		4	7
3		2		2	5	3
1		3	2		1	
0.5	5	3	1	2		
0.2	1	1		2		
0.1	4			3		

C value	C. weather and sea	Current	Restricted visibility	Nigth navigation	Navigation in heavy weather	Nigth and heavy weather navigation
100						
40			1			1
15			4			2
7		3			2	2
3		2	2	1	4	3
1	10	5	3	9	4	2

Calm weather and sea
Current
Restricted visibility
Nigth navigation
Navigation in heavy weather
Nigth and heavy weather navigation

Figure 5. A) Percentages of probability and rating of fishermen from Çeşmealtı fishing port in port navigation. B) Percentages of consequences and ratings of fishermen from Çeşmealtı fishing ports in port navigation (*P-value*: value of the probability of accidents; *C-value*: value of the consequences of accidents)

Table 6. Results of the descriptive analysis of values related to the probability and consequences of the accident

		Probability (Mean)			Consequence (Mean)		
		İskele	**Çeşmealtı**	***Total***	**İskele**	**Çeşmealtı**	***Total***
Sea	Calm weather and sea	2.2	5.90	3.43	7.40	10.80	8.53
	Current	3.56	5.77	4.29	9.15	21.90	13.40
	Restricted visibility	7.45	8.80	7.90	27.40	44.40	33.06
	Night navigation	4.28	3.70	4.08	16.70	5.00	12.80
	Heavy weather	4.97	3.52	4.48	30.70	13.1	24.83
	Night-heavy weather navigation	6.25	6.40	6.30	39.85	31.40	37.03
Port	Calm weather and sea	0.78	0.31	0.62	2.95	1.00	2.30
	Current	1.56	1.67	1.59	6.40	3.20	5.33
	Restricted visibility	5.20	5.60	5.33	22.00	10.90	18.30
	Night navigation	1.91	1.77	1.86	4.40	1.20	3.33
	Heavy weather	4.45	4.00	4.30	14.90	3.60	11.13
	Night-heavy weather navigation	5.80	5.10	5.56	24.80	9.50	19.70

Regarding sea navigation in calm weather and sea, the fishermen's mean accident probability values were 2.20 (s.e.=0.28) and 5.90 (s.e.=1.25) for İskele and Çeşmealtı, respectively. There was a significant difference in this condition between fishermen from two different ports (p=0.008) (Table 7). The results of the fishermen from Çeşmealtı fishing port (Figure 3) on the probability of sea navigation accidents in calm weather were higher than those of the fishermen from İskele port (Figure 2). In night navigation, the mean values for the consequences of accidents for fishermen were 16.70 (s.e.=4.77) and 5.00 (s.e.=1.26) for İskele and Çeşmealtı in the sea, respectively. There was a significant difference between the two fishing ports (Table 7) (p=0.007) in terms of the consequences of the accident for night navigation. The values of the İskele fishermen (Figure 2) for the accident consequence of sea navigation at night were found higher than the results of the Çeşmealtı fishermen (Figure 3). The average heavy weather sea navigating scores for accident consequences were 30.70 (s.e.=5.05) and 13.10 (s.e.=9.75) for İskele and Çeşmealtı, respectively. There was a significant difference in the consequences of the accident between the two fishing ports (p=0.003) (Table 7).

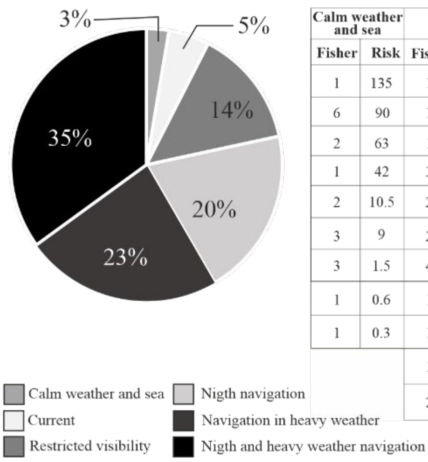
Table 7. The results of the Mann-Whitney U test

	Sea navigation			Port navigation		
	Probability	Consequence		Consequence		
	Calm weather and sea	Night navigation	Heavy weather	Night-heavy weather navigation	Heavy weather	Night navigation
Mann Whitney U	45.000	41.000	35.000	53.5000	42.000	27.500
Wilcoxon W	255.000	96.000	90.000	108.500	97.000	82.500
Z	-2.638	-2.699	-2.955	-2.094	-2.738	-3.451
Asymp. Sig. (2-tailed)	0.008	0.007	0.003	0.036	0.006	0.001
Exact Sig. [2*(1-tailed Sig.)]	0.015[b]	0.008[b]	0.003[b]	0.039[b]	0.010[b]	0.001[b]

The results of the İskele fishermen (Figure 2) for the consequences of sea navigating accidents in heavy weather were higher than those of the Çeşmealtı fishermen (Figure 3). The mean values for night and heavy weather port navigation with regard to the consequences of the accident were 24.80 (s.e.=6.43) and 9.50 (s.e.=3.76) for İskele and Çeşmealtı, respectively. There was a significant difference between two fishing ports in the accident consequences of night and heavy weather port navigation (p=0.036) (Table 7). The results of the İskele fishermen were higher than those of the Çeşmealtı fishermen for the accident consequences of night and heavy weather port navigation (Figure 4 and 5). The mean heavy weather accident consequences for port navigation were 14.9 (s.e.=5.07) and 3.6 (s.e.=0.79) for İskele and Çeşmealtı, respectively. We found a significant difference in the consequences of port navigation accidents in heavy weather between two fishing ports (p=0.006) (Table 7). The İskele fishermen's score for the consequences of port navigating accidents in heavy weather was higher than the Çeşmealtı fishermen's scores (Figure 5 and 6).

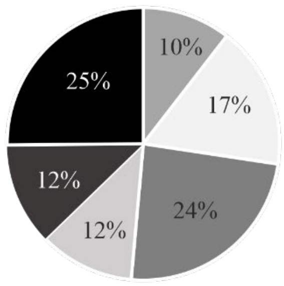
When assessing port navigation under all conditions, there was no significant difference in the probability of accidents between the two different fishing ports (Figure 5 and 6). The mean accident consequences in port navigating at night were 4.40 (s.e.=0.90) and 1.20 (s.e.=0.20) for İskele and Çeşmealtı fishing ports, respectively. There was a significant difference between the consequences of accidents in port navigation at night and their fishing ports (p=0.001) (Table 7). It has been established that İskele fishermen are more likely than Çeşmealtı fishermen to have accidents in port navigation at night (Figure 5 and 6).

If the risk assessment analysis includes the frequency factor (F_2), a statement can be made about the effects of the environmental conditions at sea and in port navigation on site. The results of the risk assessments of the fishermen's estimates from the İskele port showed that the most dangerous situation was night and heavy weather navigation (35%), followed by heavy weather navigation (23%), and night navigation (20%) for sea navigation in the Gulf of İzmir (Figure 6). These assessments by fishermen from Çeşmealtı fishing port showed that the most dangerous situation was night and heavy weather navigation (25%), followed by restricted visibility (24%), and current (17%) for sea navigation in the Gulf of İzmir (Figure 7). The results of the risk assessment of fishermen's decisions from İskele fishing port showed that the most dangerous situation was night and heavy weather navigation (45%), followed by navigation in heavy weather (24%), and restricted visibility (17%) for İskele port (Figure 8). The results from the fishermen from Çeşmealtı fishing port showed that the most hazardous situation was night and heavy weather navigation (46%), followed by restricted visibility (32%), and heavy weather navigation (12%) for Çeşmealtı fishing port (Figure 9).



Calm weather and sea		Current		Restricted visibility		Nigth navigation		Navigation in heavy weather		Nigth and heavy weather navigation	
Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk
1	135	1	480	1	1000	1	3000	1	2000	3	2000
6	90	1	300	5	400	1	1200	2	800	2	800
2	63	1	240	3	240	5	270	8	480	6	480
1	42	3	90	2	150	7	135	2	180	1	240
2	10.5	2	84	7	90	1	126	1	15	4	180
3	9	2	42	1	45	1	63	1	14	3	90
3	1.5	4	18	1	42	1	21	4	6	1	42
1	0.6	1	6			1	9	1	1		
1	0.3	1	4			1	3				
		1	2.8			1	1.5				
		2	1								

Figure 6. Risk percentage and rating of fishermen from İskele fishing port in sea navigation



Calm weather and sea		Current		Restricted visibility		Nigth navigation		Navigation in heavy weather		Nigth and heavy weather navigation	
Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk
4	450	1	2000	4	1000	1	1200	1	2000	2	2000
1	270	1	800	3	400	3	360	1	480	1	800
1	135	1	480	1	90	1	135	1	180	1	480
1	126	1	180	2	42	1	63	2	18	1	180
1	9	1	140			2	27	1	6	1	60
2	1.5	2	84			2	1.5	1	2	1	42
		1	6					1	1	3	18
		1	1					2	0.2		
		1	0.4								

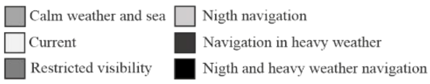
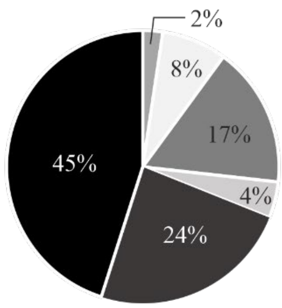


Figure 7. Risk percentage and rating of fishermen from Çeşmealtı fishing port in sea navigation



Calm weather and sea		Current		Restricted visibility		Nigth navigation		Navigation in heavy weather		Nigth and heavy weather navigation	
Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk
1	360	1	1200	1	600	1	450	1	2000	2	2000
3	9	1	42	2	400	2	63	2	480	1	800
1	3	1	12	3	240	1	27	2	180	3	480
1	1.5	4	6	4	90	1	10.5	4	84	1	300
1	0.6	6	2	3	45	11	9	8	42	2	180
6	0.4	3	1	2	42	1	4.5	3	6	1	140
6	0.3	3	0.4	5	21	1	1.5			3	90
1	0.2	1	0.2			2	0.3			5	42
										1	36
										1	12

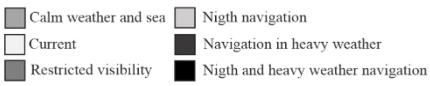
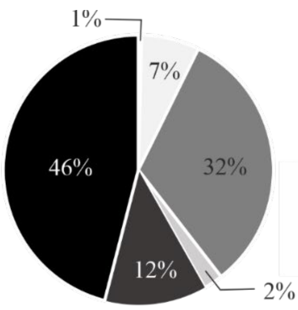


Figure 8. Risk percentage and rating of fishermen from İskele fishing port in port navigation



Calm weather and sea		Current		Restricted visibility		Nigth navigation		Navigation in heavy weather		Nigth and heavy weather navigation	
Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk	Fisher	Risk
5	1.5	1	84	1	240	1	30	1	84	1	480
1	0.6	1	42	2	150	2	9	2	42	2	180
4	0.3	1	18	2	90	1	1.8	2	36	1	84
		1	7	1	30	2	1.5	1	18	1	42
		1	6	1	6	1	0.6	1	12	3	36
		2	2	1	3	3	0.3	3	6	2	6
		2	1	1	1						
		1	0.4	1	0.5						

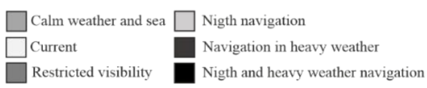


Figure 9. Risk percentage and rating of fishermen from Çeşmealtı fishing port in port navigation

DISCUSSION

There is much research aimed at preventing accidents at sea, especially on commercial ships (Haapasaari et al., 2015; Awal and Hasegawa, 2017; Formela et al., 2019; Hasanspahić et al., 2021). Although it has a high economic value and the accidents have many and serious consequences, such studies on the fishing side have been found to be lacking. This study attempted to address the deficiency in this area. Measuring the perception of risk during navigation from the perspective of fishermen has introduced a new approach to the studies in this field. This study also aims to identify the key factors that increase risk perception and raise awareness of this issue. This is intended to help reduce accidents. Our results have been remarkably close to those expected. In this regard, the desired results have been achieved and the nature of environmental conditions arranged in the simulator scenarios. Much more can be revealed by changing the nature and severity of environmental conditions.

Simulators have been used for training and certification in Maritime Education and Training since their first appearance in the 1950s (Sellberg, 2017). For example, today simulators are used in several areas of the maritime industry; offshore operational training on ships and oil platforms, bridge operations, cargo handling, engine controls, crane operations, towing, and anchor handling. One of them, bridge simulators are real-time simulators that bring users a very realistic feeling. Developing new ship bridge software components based on many sophisticated and long phases to make them reliable and realistic is a very complex subject (Stratmann et al., 2018). Simulated reality provides a realistic practical training environment for participants to make situational decisions in a protected environment (Tichon & Burgess-Limerick, 2011). With simulators, the closer the simulation is to the real task, the more likely it is that skills will transfer from one context to another (Sellberg, 2017). Regardless of the quality of the simulators (high-fidelity or low-fidelity simulators) (Dahlstrom et al., 2009), realistic simulations depend on designing scenarios that match the capabilities of the simulator users (Saus et al., 2010) as fishermen correspond in our study. From another perspective, to improve safety and reduce the risk of fatal accidents, the computerized simulator experience with a realistic environment has become the method of choice in maritime education. High simulator realism means that the participants experience the training realistically from their areas of interest (Saus et al., 2010). In fact, during this study, it was observed that some fishermen lost their balance in the severe weather scenario. It is possible to create a realistic scenario by adding ships and buoys in the desired place in relation to the number and type of other ships included in the simulator. Almost the same equipment that is used on a real ship is used in simulators. While it feels realistic, it wouldn't be right to expect users to react the same way they would in a real emergency. The fact is that it is almost impossible to conduct the study without the simulator under the same environmental conditions and with the same procedures.

The study showed that changing weather and sea conditions had an impact on the probability and consequences of accidents at sea. Similarly, one study examined fishing boat accidents from a human factor perspective and found that environmental factors were the underlying causes of the accident (Yıldırım and Başar, 2019). The heavy weather conditions examined in the study were shown to be one of the most important restricted visibility factors increasing the probability and consequences of accidents (Table 6). The mean values reported by the fishermen showed that navigating in heavy weather was a factor that increased the probability and consequences of accidents more than navigating in calm weather, current and night hours (Table 6). Pleskacz (2015) found that limited space during severe weather, shallow waters, and limitations in the manoeuvrability of fishing gear are factors that increase the probability of accidents for fishermen. In this study, the limitation of visibility was identified as a very important element of meteorology that directly affects the safety of navigation. Jin (2014) also showed that heavy daytime weather conditions increase the severity of accidents. Wu (2008) and Wu et al. (2009) define that wave height and ice concentration are determinants of the severity and relative casualty rate of fishing boat casualties. Wang et al. (2021) reported that the severity of maritime accidents is positively correlated with distance from the port, strong wind, rough seas, strong currents, and/or good visibility. Similar to Wang et al. (2021), this study found that the above environmental factors increase the probability and consequences of accidents compared to calm weather and sea conditions (Table 6). In addition, this study gives an idea of the relative ranking of weather conditions that increase the probability and consequences of accidents (Figure 2, 3, 4, and 5).

The mean value of the accident probability and impact assessments by the fishermen according to various environmental and sea conditions showed that navigating in their own ports was safer than when the sea cruise was under the same environmental and sea conditions. In parallel with the results of this study in the in the European Maritime Safety Report, it was found that accidents and injuries mainly occur during the route legs of the journey, excluding arrival, departure, and other legs (EMSA, 2022). Similarly, Jin (2014) found that the probability of accidents and consequences is higher when the vessel is not close to shore.

There were slight differences in rating between fishermen working in different ports. Although the fishing ports of Çeşmealtı and İskele are structurally similar, the probability of exposure to the north wind applied in the scenario may not be the same for both ports due to their different orientations of construction. For this reason, it can be assumed that the directions in which the ports were built increase or decrease the probability of accidents, depending on the prevailing wind direction. Galor (2005) mentioned that to maintain ship movement safety, one of the critical design aspects was the depth of the port waters. In our study, fishermen did not mention draft problems when entering their fishing ports. Çınar

(2020) found that the Fine-Kinney risk assessment method can be crucial in port construction. In this study, it was found that increasing wind intensity significantly increased risk scores. In our study, high wind intensity increases accident probability, impact scores, and risk assessment compared to calm weather and rough seas.

In the studies by Wang et al. (2005) and Pleskacz (2015), found that accident probability and consequence values are higher during fishing than during navigation at sea. The fishermen explained that they were neglecting their lookout duties as they would be busy with their work while setting or hauling in their nets, increasing their risk value. Our findings parallel these studies in that fishing activity is more dangerous than navigating the fishing boat at sea or in port. Jin et al. (2001), Roberts et al. (2010), and Yıldırım and Başar (2019) analyzed previous accidents and found that collision accidents are more common in dark hours. In parallel with these studies, the fishermen participating in our investigation found that the risk level for navigating during the night hours is higher than navigating during the day and navigating in heavy weather at night compared to navigating in heavy weather during the day (Table 6). Jin (2014) emphasized that while the severity of damage to fishing vessels is inversely related to vessel length, it is positively related to capsizing, sinking, daily wind speed, boat age, and distance from shore. In this study, it was shown that boat lengths reported in the low range were unrelated to other parameters, including the number of accidents ($p=0.089$) and the probability of accidents and the assessment of consequences.

Avoiding loss of life and property due to marine casualties as a result of various factors is a very important issue in maritime shipping both locally and globally. Therefore, dynamic studies like the ones we are conducting could provide important clues to reduce marine casualties involving fishermen. However, the authors are aware that there are several limitations of the study, e.g. work with commercial fishermen and are forced to stay in the simulator for at least 30 minutes. The other limitation is the number of participants contributing to the experiment, which can lead to low study reliability. Nevertheless, this is the first proactive study to determine risk perceptions in small-scale fisheries off Turkish coasts.

In this study, the problem of marine casualties was examined from the perspective of fishermen. The results obtained are parallel to previous similar studies. External environmental conditions such as restricted visibility and heavy weather increase the risk of accidents. For fishermen, night navigation and currents are not as dangerous conditions as heavy weather and restricted visibility. It was also found that fishermen are more likely to avoid sea navigation than port navigation.

Only a limited environmental variable such as current, weather, etc. could be tested with the bridge simulator. Sufficient observation time is required to obtain data in the studies conducted in the simulator room. The number of participants may seem small but including more than enough participants in the simulator can be one of the challenging aspects of the study as it increases observation time. Despite these limitations, the findings of this study are important because we could have obtained sufficient results close to real sea conditions. Nonetheless, further studies involving more participants and incorporating a greater variety of environmental factors can support this work. For example; some fishing techniques require night navigation and even turning off navigation lights and all other lights to prevent fish from escaping. Likewise, in the case of illegal fishing, fishermen turn off all their lanterns and lights so as not to be noticed. These two conditions can include additional scenarios in the bridge simulator for further study.

CONCLUSION

These results demonstrate that simulator experiments can be a useful tool to prevent accidents at sea in terms of a proactive approach. Although an important part of the maritime causes of damage are accidents involving fishing vessels, investigating marine casualties on the fishing side is not enough. Available data are limited and no previous study has focused on measuring risk perception during navigation from the fishermen's perspective using the Fine-Kinney risk assessment method. Our results are relevant for both local and general maritime navigation. In this study, it can be assumed that environmental factors could increase the probability and consequence of accidents without considering regional differences. On the other hand, if the risk assessment is evaluated taking into account the frequency factor of the environmental conditions, the results we had are local.

If the risk rating is high as a result of the experimental study, fishermen should not go to sea without taking precautions. Fishermen should navigate at a safe cruising speed when visibility is limited. Before leaving the port, one should find out about the weather conditions at sea and if possible precautions do not reduce the probability of accidents, the cruise should be cancelled. Similar results mentioned above can be used to assist the relevant maritime authorities to take effective measures to prevent serious maritime accidents. For this reason, this study has significant potential for many future applications in risk assessment for maritime accidents.

ACKNOWLEDGMENTS AND FUNDING

This study arose from the master's thesis of Can Atacan under the supervision of the corresponding author. The authors are grateful to the fishermen for their unconditional cooperation during the simulator experiments.

AUTHORSHIP CONTRIBUTIONS

Can Atacan: Conceptualization, methodology, investigating, writing - original draft, writing - review & editing. F. Ozan Düzbastılar: Conceptualization, writing - original draft, writing - review & editing, visualization.

CONFLICT OF INTEREST STATEMENT

The authors state that they are not aware of any competing financial or non-financial, professional, or personal conflicts that may have influenced this study.

ETHICS APPROVAL

Ethical approval for this study was obtained from Ege University Science and Engineering Sciences Scientific Research and Publication Ethics Committee.

DATA AVAILABILITY

All relevant data is in the article.

REFERENCES

Akyıldız, H. (2015). Formal safety assessment of a fishing vessel. *GİDB Dergi*, 2, 31-46.

Awal, Z.I., & Hasegawa, K. (2017). A study on accident theories and application to maritime accidents. *Procedia Engineering*, *194*, 298-306. https://doi.org/10.1016/j.proeng.2017.08.149

Bayar, N. (2010). *Analysis of maritime traffic safety in İstanbul Strait using fuzzy AHP and FMEA methods based on risk*. Doctoral dissertation, Yıldız Teknik University, Turkey.

Bekdemir, E. (2019). *Application of Fine Kinney and 5x5 matrix risk analysis methods in building construction* (in Turkish with English abstract). Doctoral dissertation, İstanbul Aydın University, Turkey.

Çınar, F. (2020). *A model on risk analysis methods in ship handling during port manoeuvres*. Master's thesis, Piri Reis University, Turkey.

Dahlstrom, N., Dekker, S., Van Winsen, R. & Nyce, J. (2009) Fidelity and validity of simulator training. *Theoretical Issues in Ergonomics Science*, *10*(4):305-314. https://doi.org/10.1080/14639220802368864

Demirci, S. M. E., Canımoğlu, R., & Elçiçek, H. (2022). An evaluation of the effects of human factors on potential ship accidents under pilotage. *Marine Science and Technology Bulletin*, *11*(1), 76-87. https://doi.org/10.33714/masteb.1064311

EMSA (2022). *European Maritime Safety Report 2022*. Retrieved from https://emsa.europa.eu/publications/item/4735-emsafe-report.html

Eronat, C. (2017). An overview on İzmir Bay physical oceanography. *Ege Journal of Fisheries and Aquatic Sciences*, *34*(1), 1-9. https://doi.org/10.12714/egejfas.2017.34.1.01

Fan, S., Zhang, J., Blanco-Davis, E., Yang, Z., & Yan, X. (2020). Maritime accident prevention strategy formulation from a human factor perspective using Bayesian Networks and TOPSIS. *Ocean Engineering*, *210*(107544), 1-12. https://doi.org/10.1016/j.oceaneng.2020.107544

FAO (2014). *The State of World Fisheries and Aquaculture: Opportunities and challenges*. Retrieved from https://www.fao.org/3/i3720e/i3720e.pdf

FAO (2021). *FAO Yearbook. Fishery and Aquaculture Statistics*, 2019. Rome/Roma. https://doi.org/10.4060/cb7874t

Fine, W.T. (1971). Mathematical evaluations for controlling hazards. *Journal of Safety Research*, 3, 157-166.

Formela, K., Neumann, T., & Weintrit, A. (2019). Overview of definitions of maritime safety, safety at sea, navigational safety and safety in general. *TransNav, The International Journal on Marine Navigation and Safety of Sea Transportation*, *13*(2), 285-290. https://doi.org/10.12716/1001.13.02.03

Galor, W. (2005). The managing of the navigational safety of ships in port water areas. *WIT Transactions on the Built Environment*, 82, 151-160.

Gucma, S. & Ślączka, W. (2018). Comprehensive method of formal safety assessment of ship manoeuvring in waterways. *Scientific Journals of the Maritime University of Szczecin*, *54*(126), 110-119. https://doi.org/10.17402/292

Haapasaari, P., Helle, I., Lehikoinen, A., Lappalainen, J. & Kuikka, S. (2015). A proactive approach for maritime safety policy making for the Gulf of Finland: Seeking best practices. *Marine Policy*, *60*, 107-118. https://doi.org/10.1016/j.marpol.2015.06.003

Halim, A., Wiryawan, B., Loneragan, N. R., Hordyk, A., Sondita, M. F., White, A. T., Koeshendrajana, S., Ruchimat, T., Pomeroy, R. S., & Yuni, C. (2019). Developing a functional definition of small-scale fisheries in support of marine capture fisheries management in Indonesia. *Marine Policy*, *100*, 238-248. https://doi.org/10.1016/j.marpol.2018.11.044

Hasanspahić, N., Vujičić, S., Frančić, V., & Čampara, L. (2021). The role of the human factor in marine accidents. *Journal of Marine Science and Engineering*, *9*(3), 261. https://doi.org/10.3390/jmse9030261

Hsu, W.K.K., Chen, J.W., Huynh, N.T., & Lin, Y.Y. (2022). Risk assessment of navigation safety for ferries. *Journal of Marine Science and Engineering*, *10*(5) 700, 1-17. https://doi.org/10.3390/jmse10050700

Jaremin, B. & Kotulak, E. (2004). Mortality in the Polish small-scale fishing industry. *Occupational Medicine*, *54*(4), 258-260. https://doi.org/10.1093/occmed/kqh054

Jin, D. (2014). The determinants of fishing vessel accident severity. *Accident Analysis & Prevention*, 66, 1-7. https://doi.org/10.1016/j.aap.2014.01.001

Jin, D., Kite-Powell, H., & Talley, W. (2001). The safety of commercial fishing: Determinants of vessel total losses and injuries. *Journal of Safety Research*, *32*(2), 209-228. https://doi.org/10.1016/s0022-4375(01)00047-0

Jin, D., Kite-Powell, H. L., Thunberg, E., Solow, A. R., & Talley, W. K. (2002). A model of fishing vessel accident probability. *Journal of Safety Research*, *33*(4), 497-510. https://doi.org/10.1016/s0022-4375(02)00050-6

Jin, D., & Thunberg, E. (2005). An analysis of fishing vessel accidents in fishing areas off the northeastern United States. *Safety Science*, *43*(8), 523-540. https://doi.org/10.1016/j.ssci.2005.02.005

Jung, C. (2014). A study on the requirement to the fishing vessel for reducing the collision accidents. *Journal of the Korean Society of Marine Environment and Safety*, *20*(1), 18-25. https://doi.org/10.7837/kosomes.2014.20.1.018

Kim, H.T., & Na, S. (2017). Development of a human factors investigation and analysis model for use in maritime accidents: A case study of collision accident investigation. Journal of Navigation and Port Research, *41*(5), 303-318. https://doi.org/10.5394/KINPR.2017.41.5.303

Kim, S.K., & Kang, J.P. (2011). A Study on the relationships between the casualties of fishing boats and meteorological factors. *Journal of Fisheries and Marine Sciences Education*, *23*(3), 351-360.

Kinney, G.F., & Wiruth, A.D. (1976). Practical risk analysis for safety management, NWC Technical Publication 5865, Naval Weapons Center, China Lake CA, USA, 1976.

Li, S., Meng, Q., & Qu, X. (2012). An overview of maritime waterway quantitative risk assessment models. *Risk Analysis*, *32*(3), 496-512. https://doi.org/10.1111/j.1539-6924.2011.01697.x

Luo, M., & Shin, S. (2019). Half-century research developments in maritime accidents: Future directions. *Accident Analysis & Prevention*, *123*, 448-460. https://doi.org/10.1016/j.aap.2016.04.010

Montewka, J., Ehlers, S., Goerlandt, F., Hinz, T., Tabri, K., & Kujala, P. (2014). A framework for risk assessment for maritime transportation systems - A case study for open sea collisions involving RoPax vessels. *Reliability Engineering & System Safety*, *124*, 142-157. https://doi.org/10.1016/j.ress.2013.11.014

Oh, J., Kim, K., & Jeong, J. (2015). A study on the risk analysis based on the trajectory of fishing vessels in the VTS area. *International Journal of e-Navigation and Maritime Economy*, 2, 38-46. https://doi.org/10.1016/j.enavi.2015.06.004

Okumuş, D., & Barlas, B. (2016). *An applied comparison of 5x5 analysis matrix and Fine-Kinney methods in the shipbuilding industry* (in Turkish). *Gemi ve Deniz Teknolojisi,* 22 (Supp: 204-205):95-106.

Ölçücü, H., & Ersöz Kaya, İ. (2019). Comparative risk analysis and risk assessment of biological factors in hazardous waste disposal facilities (in Turkish with English abstract). *European Journal of Science and Technology*, 1375-1382. https://doi.org/10.31590/ejosat.668653

Pleskacz, K. (2015). The impact of hydro-meteorological conditions on the safety of fishing vessels. *Scientific Journals of the Maritime University of Szczecin*, *41*(113), 81-87.

Psaraftis, H.N. (2002). Maritime Safety: To be or not to be proactive. *WMU Journal of Maritime Affairs*, *1*, 3-16.

Roberts, S.E., Jaremin, B., & Marlow, P.B. (2010). Human and fishing vessel losses in sea accidents in the UK fishing industry from 1948 to 2008. *International Maritime Health*, *62*(3), 143-153.

Saus, E.R., Johnsen, B.H. & Eid, J. (2010). Perceived learning outcome: the relationship between experience, realism, and situation awareness during simulator training. *International Maritime Health*, *61*(4), 258-264.

Sellberg, C. (2017). Simulators in bridge operations training and assessment: a systematic review and qualitative synthesis. *WMU Journal of Maritime Affairs, 16*, 247-263. https://doi.org/10.1007/s13437-016-0114-8

Smith, H., & Basurto, X. (2019). Defining small-scale fisheries and examining the role of science in shaping perceptions of who and what counts: A systematic review. *Frontiers in Marine Science*, *6,* 236, 1-19. https://doi.org/10.3389/fmars.2019.00236

Soykan, O. (2018). Risk assessment in industrial fishing vessels by L type matrix method and its usability. *Ege Journal of Fisheries and Aquatic Sciences*, *35*(2), 207-217. https://doi.org/10.12714/egejfas.2018.35.2.15

Stratmann, T.C., Gruenefeld, U., Hahn, A., Boll, S., Stratmann, J., & Schweigert, S. (2018). Mobile bridge - A portable design simulator for ship bridge interfaces. *The International Journal on Marine Navigation and Safety of Sea Transportation*, *12*(4), 763-768. https://doi.org/10.12716/1001.12.04.16

Sur, J.M., & Kim, D.J. (2020). Comprehensive risk estimation of maritime accident using fuzzy evaluation method–Focusing on fishing vessel accident in Korean waters. *The Asian Journal of Shipping and Logistics*, *36*(3):127-135. https://doi.org/10.1016/j.ajsl.2019.12.013

Tichon, J. & Burgess-Limerick, R. (2011). A review of virtual reality as a medium for safety related training in mining. *Journal of Health & Safety Research & Practice*, *3*(1), 33-40.

Uğurlu, F., Yıldız, S., Boran, M., Uğurlu, Ö., & Wang, J. (2020). Analysis of fishing vessel accidents with Bayesian network and CHI-square methods. *Ocean Engineering*, *198*, 106956. https://doi.org/10.1016/j.oceaneng.2020.106956

Usanmaz, D. & Köse, E. (2020). Comparative statistical analysis of two different methods for risk assessment in chemical research laboratory (in Turkish with English abstract). *International Journal of Engineering Research and Development*, *12*(2):337-348. https://doi.org/10.29137/umagd.606402

Villasante, S., Gianelli, I., Castrejón, M., Nahuelhual, L., Ortega, L., Sumaila, R. & Defeo, O. (2022). Social-ecological shifts, traps and collapses in small-scale fisheries: Envisioning a way forward to transformative changes. *Marine Policy*, *136*(104933), 1-8. https://doi.org/10.1016/j.marpol.2021.104933

Wang, H., Liu, Z., Wang, X., Graham, T., & Wang, J. (2021). An analysis of factors affecting the severity of marine accidents. *Reliability Engineering & System Safety*, *210*, 107513. https://doi.org/10.1016/j.ress.2021.107513

Wang, J., Pillay, A., Kwon, Y.S., Wall, A.D. & Loughran, C.G. (2005). An analysis of fishing vessel accidents, *Accident Analysis & Prevention*, *37*(6):1019-1024.

Won, Y., & Kim, D. (2019). Risk analysis and selection of the main factors in fishing vessel accidents through a risk matrix. *Journal of the Korean Society of Marine Environment and Safety*, *25*(2), 139-150. https://doi.org/10.7837/kosomes.2019.25.2.139

Wu, Y. (2008). *Statistical evaluation of weather patterns on fishing vessel incidents in Atlantic Canada*. Doctoral dissertation, Dalhousie University, Canada.

Wu, Y., Pelot, R.P., & Hilliard, C. (2009). The influence of weather conditions on the relative incident rate of fishing vessels. *Risk Analysis*, *29*(7), 985-999. https://doi.org/10.1111/j.1539-6924.2009.01217.x

Yıldırım, U., & Başar, E. (2019). Analysis of collision accidents on fishing vessels through human factors analysis and classification system (HFACS) (in Turkish with English abstract), *Dokuz Eylül University Maritime Faculty Journal*, *11*(2):203-219. https://doi.org/10.18613/deudfd.659807

Zaloğlu, D.I. (2019). *Risk assessment with Fine Kinney Method in the fossil location in the scope of occupational health and safety* (in Turkish with English abstract). Master's thesis, Başkent University, Turkey.