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Human error in marine accidents: Is the crew normally to blame?

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ABSTRACT

This paper analyses the marine accident reports published by the USA National Transportation Safety Board (NTSB) between June 1975 and September 2017, in order to ascertain the exact influence of the crew and/or other people involved (pilots, company, etc.) on the cause of the incident and to find out the types of errors made by them. Additionally, the mistakes and those involved are analysed together to verify the correct implementation of international regulations concerning seafarers. The results suggest that crew error is relatively uncommon in cargo and passenger fleets. This points to the effectiveness of the International Convention on Standards of Training, Certification and Watchkeeping (STCW convention). However, taking into consideration the high percentage of human error due to failure in communication and misjudgements during navigation in pilot waters, it may be deduced that the coordination among those on the bridge may be improved. On the other hand, crew error on board tugs exceeds 50%. This increase seems to be due to the difficulties of navigation in narrow waterways.

Introduction

According to the Maritime Transportation Research Board of the USA, human error in the maritime domain is "the commission or omission of acts by maritime personnel that cause or contribute to merchant marine casualties or near-casualties" (NAS, 1976). In addition, Lu (20012) remind us that "shipping is one of the most risky service industries. Although shipping companies attempt to assure work safety, they are not completely successful in eliminating human failures". All crews and shipping companies in the world are aware of the influence of the human element in accidents. In 1976, a research board in the U.K. concluded that human error was the cause of 80% of accidents (Goulielmos, 1997). Ever since, most of the published studies on maritime accidents have found that maritime accidents are caused mainly by human errors (Berg et al., 2013a).

In marine accidents, society tends to make an assessment quickly in order to find a scapegoat. In many cases, the Master and the crew are the target of criticism before the investigation starts (Sánchez-Beaskoetxea and Coca, 2015). Human factors are involved in many cases, but the crew is not always to blame.

In recent decades, many researchers have published papers on the causes of maritime accidents, focusing both on technical failures and on the errors of the people working on board ships (crew, pilots, on-shore personnel, inspectors, etc.). Several of these studies found that in many accidents human error was the main cause or an important factor. We can highlight some of them as an example: "Of a total of 880 accidents analysed during the investigations between 2011 and 2015, 62% were attributed to erroneous human action" (EMSA 2016), "Over 80% of marine accidents are caused or influenced by human and organization factors" (Apostol-Mates and

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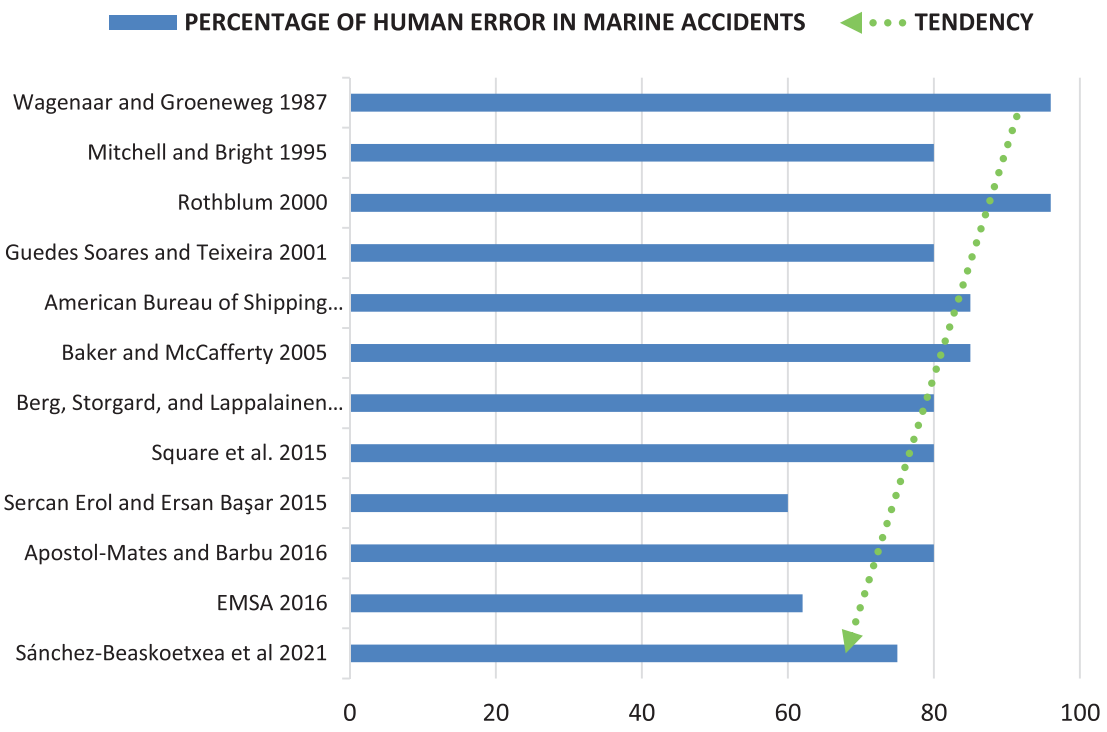

Fig. 1. Percentage of human error in marine accidents according to several authors.

Table 1
Summary of some factors involved in human error.

MTRB	Wang and Zang (2000)	Suraj, Ramanad, and Bina (2013)
Inattention. Ambiguous Pilot-Master relationship. Inefficient bridge design. Poor operational procedures. Poor physical fitness. Poor eyesight. Excessive fatigue. Excessive alcohol use. Excessive personnel turnover. High level of calculated risk. Inadequate lights and markers. Misuse of radar. Uncertain use of sound signals. Inadequate rules of the road.	Lack of knowledge and experience.Overconfidence. Recklessness in responding to commercial pressures. Fatigue (related mainly to collisions). Discomfort, boredom, anger, unhappiness, illness, confusion and lack of adequate communication.	Fatigue. Inadequate communication. Inadequate general technical knowledge. Inadequate knowledge of own ship systems. Lack of situation awareness and complacency. Test of suitability. Decisions based on inadequate information. Faulty standards, policies, or practices. Poor maintenance. Hazardous natural environment. Complacency – a state of mind.

Barbu 2016), “Many of the ship accidents (60%) result from human error.” (Erol and Başar, 2015), “It is generally stated that 80% of all accidents at sea are as a result of human error. In fact, it is probably more correct to say that all accidents at sea are as a result of human error because, no matter how much automation is introduced into the design or operation of a ship or its systems, there is always a human input.” (Square et al. 2015), “Despite advances in technology, some 80% of all accidents are, according to studies, caused by human errors.” (Berg et al., 2013b), “While the frequency of accidents is declining, human error continues to be a dominant factor in approximately 80 to 85% of maritime accidents.” (Baker and McCafferty 2005), “Marine accidents directly associated with human errors in the MAIB, the ATSB, and the TSB reports total 82%, 85%, and 84%, respectively.” (American Bureau of Shipping 2003), “It is therefore not surprising that it has been estimated that approximately 80% of shipping accidents are caused by human errors in all phases of the process.” (Guedes Soares and Teixeira 2001), “Between 75% and 96% of maritime accidents are caused at least in part by some form of human error.” (Rothblum, 2021) and “80% of maritime accidents are attributable to human error.” (Mitchell and Bright 1995). Only 4 of the 100 cases were not caused by human error (Wagenaar and Groeneweg 1987). Therefore, accidents at sea caused by human mistakes seem account for between 60 and 90% of the total (Håvold, 2000; Macrae, 2009; Schröder-Hinrichs, 2010).

Fig. 1 shows the tendency of human error in marine accidents in some of the studies carried out during the last thirty years.

Regarding human error typology, table 1 shows some of the factors related to the cause of the accident found in different studies. The Maritime Transportation Research Board (MTRB) of the USA provides us with 14 factors as the cause of accidents. Additionally, two other classifications drawn up at different times are included: the article published in October 2000 in “Professional Safety” entitled “Management of Human Errors in Shipping Operations” (Wang and Zhang 2000) and the paper published in 2013 in the

"AMET International Journal of Management" entitled "A Study on Human Errors and Classification of Commonly Prevalent Errors in Shipping Operational Practices" (Suraj, Ramanad, and Bina 2013). In the MTRB classification, the investigators took "workplace factors, procedures, fatigue, health and management into consideration" (Kristiansen 2005).

Table 1 reduces the number of potential causes of maritime accidents, which might be excessive. Textbooks used in navigational education dedicate some lines to the causes of navigational errors. For instance, Chapter 19 of the "Admiralty. Manual of Navigation. Volume 1″ (Peacock 2008) states that more than three-quarters of navigational accidents are attributable to human error, with the following factors involved: poor planning, inadequate bridge organization, unsound bridge procedures and failure to make intelligent use of the information available. Other studies on specific accidents also point to human errors. In this way, Graziano et al. (2016), in a paper about the classification of human errors in grounding and collision accidents, conclude that almost 69% of the errors in these accidents were related to navigation, supervision and traffic monitoring. Similarly, Carl Macrae (Macrae, 2009b), in his paper "Human factors at sea: common patterns of error in grounding and collisions", gives a more concrete analysis of the classification of the mistakes made by the crew of the ships involved in these kind of accidents and the author concludes that the most common mistakes in groundings and collisions are: planning errors, position finding errors and communication errors. Further literature on these types of ship accidents is related to risk management and method of analysis (Moore and Bea 1993; Rasmussen 1997; Harrald et al., 1998; Antão and Guedes Soares, 2006; Kujala et al., 2009; Uğurlu et al., 2015a; Uğurlu et al., 2015b).

Analysing the literature on human error in marine accidents, it may be concluded that a large number of accidents are caused by human error. Furthermore, many of these accidents could be easily avoided if more care were taken in the behavior of individuals and organizations (Hetherington et al., 2006).

Nevertheless, the conclusions in many of these studies do not go beyond that point, and do not explore who the people involved in the cause of the accident are, whether they are members of the crew or other parties. Therefore, it is interesting to study whether these errors were made by members of the crews of the damaged ships or by other people such as the pilot (if there was one), company staff, another ship's crew, shore and port personnel, etc. This paper, based on a large number of accidents, tries to determine what percentage of human errors were attributable to the crew or to other people, and also presents a detailed classification of the type of human errors. The category of the cause provides us with additional information on the integration between the bridge team and other people assisting the ship.

Another important factor in marine accidents is the scenario in which the ship is sailing. Most of the accidents occur in narrow waterways due to the difficulties of ship maneuverability (Drouin and Heath, 2009), (Nuutinen and Norros 2009). Additionally, the concentration of marine traffic provides pilots and crew with more challenging and complex navigation (Van Erve and Bonnor 2006).

Methodology

This article presents the conclusions obtained from the analysis of 225 accident reports, involving 264 ships, submitted to the National Transportation Safety Board (NTSB) from 1975 to 2017. Only the accidents in which the ship was directly affected have been analysed. Consequently, those accidents in which there were only personal injuries have been excluded. Nevertheless, it must be taken into account that most accidents with crew or passenger injuries are also due to human factors (Talley et al., 2005), (Talley et al., 2006) and (Zheng et al., 2016). A typology of human errors has been created to classify the different types of errors that play a decisive role in the cause or causes of these accidents. In addition, these errors are analysed to see which the most common ones are.

In the first stage of the analysis, the reports were classified by type of vessel: merchant ships, tugboats, fishing vessels, recreational boats and other ships. Later, they were classified according to whether or not there was human error in the cause, or causes, of the accident. The accidents involving human error were classified in three groups depending on those involved: crew error, non-crew error and both. When the accident was caused exclusively by the crew of the ship investigated, the error is catalogued as "Crew error only". If there was only a fault coming from another person (pilot, other ship's crew, company or others), the error is classified as "Other people's error only" and, in the case of the mistake being made jointly by the crew of the ship investigated and another person, the error is classified as "Error by both". Fig. 2 shows a self-explanatory drawing regarding the methodology.

Finally, the types of human error were separated into 29 errors. These were classified into 10 groups related to the different types of errors (Table 2), from physical problems of the crew to fear, which can paralyze a person. In Group B, the section "Damaging substances" includes adverse effects of medication, alcohol and drugs The typology classification was related exclusively to people on board the ships and, therefore, was classified depending on the error that was made by the crew of the ship investigated, by other ships' crew or by the pilots.

The International Maritime Organization (IMO) is responsible for the international regulation applicable to ships. The study of the causes of marine accidents and near misses is the basis of a large part of marine legislation (Karahalios 2017), (Schröder-Hinrichs et al., 2012). Similarly, the human factor is one of the priorities for IMO, which established the Human Element Working Group in 1991 to provide guidelines for the application of human element analysing processes (IMO 1998). For instance, the accident of the "Herald of Free Enterprise" prompted the IMO to prepare the International Safety Management Code (ISM Code) which was aimed at preventing human error on board ships (Gill and Wahner 2012). Whereas this was a reaction to the aforementioned accident, it would be convenient for the maritime industry to have rules available before the incident occurs (Schröder-Hinrichs et al., 2013). This research presents an analysis of marine accidents in order to give a guide towards developing a proactive stance regarding marine accidents caused by people on board ships. In this respect, Bridge resource management/Bridge team management (BRM/BTM) is one of the tools used to avoid nautical errors.

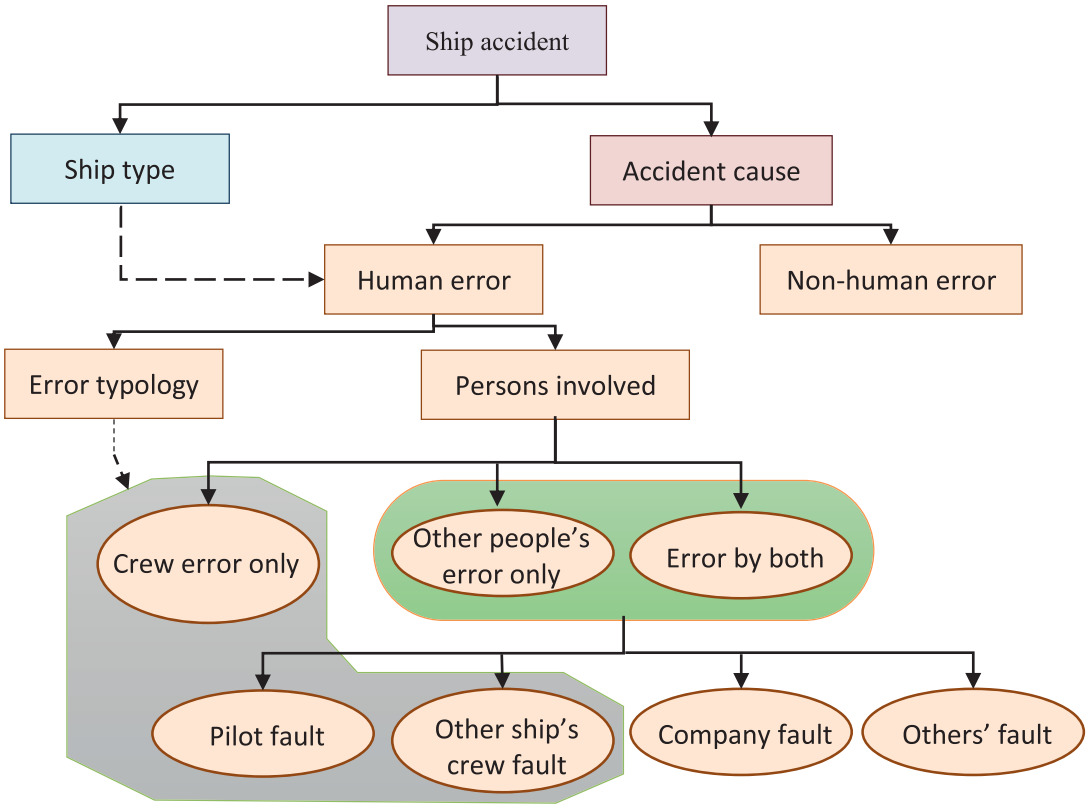

Fig. 2. Methodology diagram.

Table 2
Groups related to error typology.

GROUP (Type of error)	*N°*	*ERROR*
A (Physical problems)	1	Physical problems due to marine environment (storms, cold, etc.)
	2	Fatigue due to lack of sleep / Physical problems
	3	Fatigue due to excessive workload
B (Damaging substances)	4	Adverse effects of medication
	5	Alcohol
	6	Drugs
C (Communication error)	7	Failure to communicate among crew members (misunderstanding, inappropriately expressed orders, language, ...)
	8	Failure to communicate with the pilot (language, etc.)
	9	Communication error among crew members due to personal problems
	10	Communication error with other ships
	11	Communication error with ground personnel
D (Distractions)	12	Distraction during the watch caused by performing several tasks at the same time
	13	Distraction during the watch caused by non-work tasks (telephone, etc.)
	14	Lack of proper monitoring of navigation
E (Navigation error)	15	Navigation error due to misjudgement
	16	Navigation error due to poor technical training or inexperience
	17	Navigation error due to overconfidence
	18	Navigation error due to misuse of vessel equipment
F (Inadequate planning)	19	Lack of trip planning or maneuver planning
	20	Failure to follow trip plan or maneuver plan
	21	Not following the procedures
G (Lack of training)	22	Ignorance of the procedures
	23	Ignorance of the use of ship equipment
	24	Ignorance of regulations
	25	Ignorance of working language
H (Lack of leadership)	26	Error in the exercise of command
I (Maintenance)	27	Poor maintenance of the ship known by crew
	28	Failure to take adequate corrective measures against a known mechanical failure
J (Fear)	29	Fear

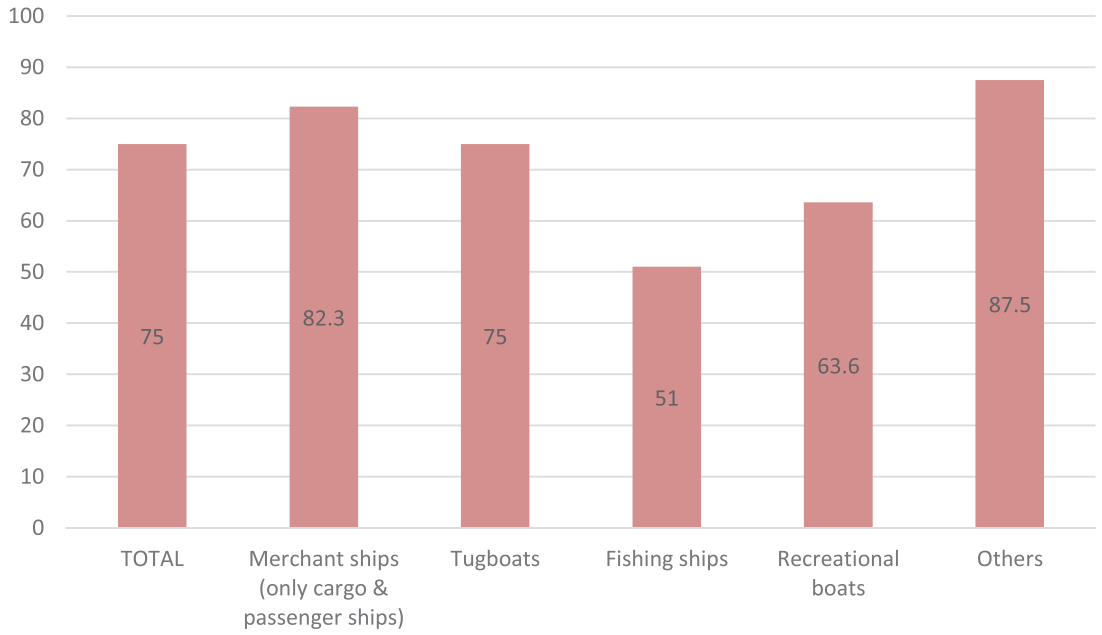

Fig. 3. Percentage of human error in marine accidents depending on the type of ship.

Data and analysis

The data obtained from the reports analysed is classified by type of vessel involved in the accidents. Table 9 (see Appendix) shows the numbers of reports in which a specific type of vessel was involved and, at the same time, this classification is broken down according to who was responsible. Of course, there are some reports in which there was no human error. Table 10 (see Appendix) shows the number of reports in which there was an error attributable to pilots, another ship's crew, company or another person different from the crew on board the damaged ship.

Moreover, the reports are carefully analysed in order to determine exactly the typology of the human error. Tables 11 to 15 (see Appendix) show data related to human error typology which is classified separately for the crew, the other ship's crew, cargo and passenger ships, tugboats and fishing vessels.

The analysis of the results tries to discern exactly who is responsible when a human error is the cause of the marine accident, depending on the type of ship involved. Therefore, the percentage of human error is separated depending on whether the cause of the accident arose from the crew of the ship investigated (ship's crew) or from other people. Taking into account that the crew on board ships other than the ship being investigated may be involved in the accident, the percentage of error coming from the crew of all ships involved (including other crews) in the accident is also calculated. Additionally, other people's error is analysed depending on whether the accident is caused by pilot error, another ship's crew, company or others.

On the other hand, the types of human errors are also analysed to find out whether there are any differences with respect to other investigation carried out previously. Additionally, the typology is related to those who made the error.

The results obtained after the analysis of the data related to the person involved in the cause of the accident are as follows:

- Percentage of accidents with human error depending on the type of ship is shown in Fig. 3.
- Percentage of accidents with crew error only: there was exclusively crew error in the cause or causes of the accident in 32.2% of the total number of vessels (264). In Fig. 4 this percentage is shown depending on the type of ship.
- Percentage of accidents with other people's error only: there were exclusively errors of people other than the crew in the cause or causes of the accident in 26.9% of ships. In Fig. 4 this percentage is shown depending on the type of ship.
- Percentage of accidents with other people's error and crew error: errors made jointly by crew members and other people are the cause or causes of the accident in 15.9% of ships. In Fig. 4 this percentage is shown depending on the type of ship.

Table 3 shows the percentage of errors made by other people in relation to the ship type (cargo & passenger ships, tugboats and fishing vessels). The main groups are pilots, the shipping company and the crew on board a ship other than the one being investigated (i.e. in the case of two or more ships involved in a collision). The column 'Others' includes port personnel, stevedores, etcetera.

The crew error is mainly related to navigation. An inadequate passage planning and communication problems are the secondary source of crew error. Distractions and physical problems among the crew are also related to marine accidents; however, fatigue is more frequent in fishing vessels where the crew needs a high level of attention and the work is physically harder. Errors due to lack

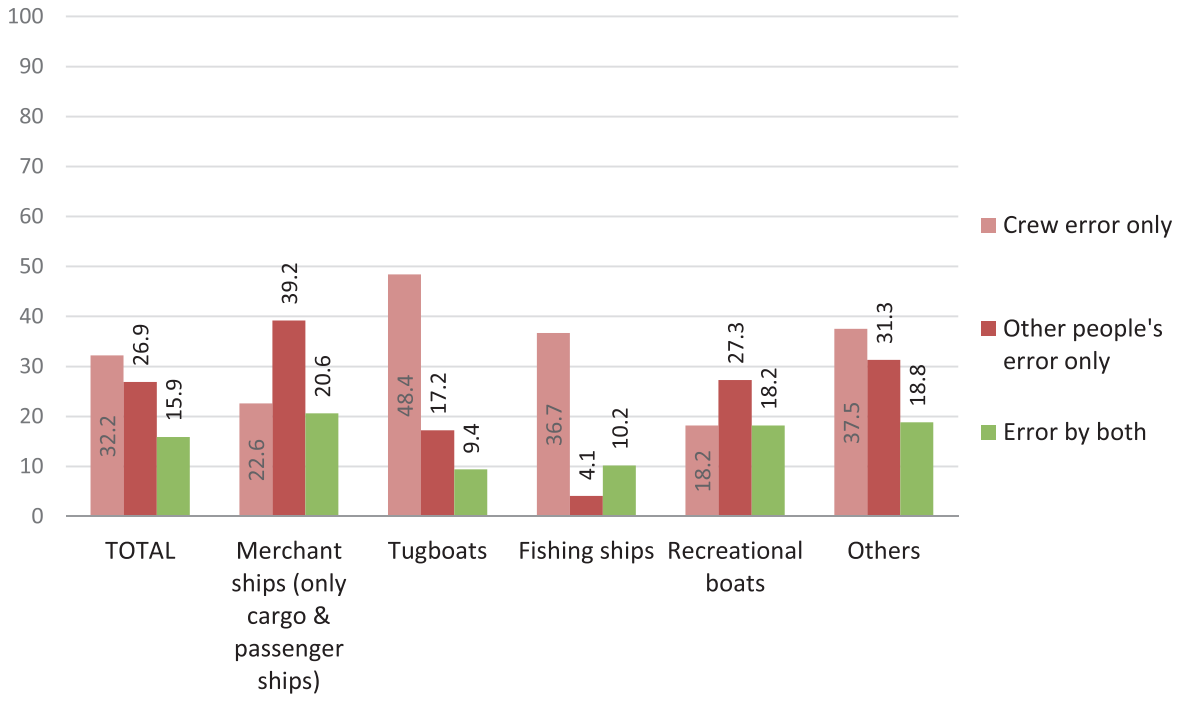

Fig. 4. Percentage of accidents with human error depending on the type of ship.

Table 3
Other people's human error with respect to the type of ship (cargo & passenger ships, tugboats and fishing vessels).

	Pilot	Other crew	Company	Others
Cargo & passenger ships	42.62%	19.67%	21.31%	16.39%
Tugboats	17.65%	35.29%	29.41%	17.65%
Total merchant ships (cargo, passenger ships & tugs)	*37.18%*	*23.08%*	*23.08%*	*16.67%*
Fishing vessels	0%	28.57%	57.14%	14.29%
TOTAL	**34.12%**	**23.53%**	**25.88%**	**16.47%**

Table 4
Most frequent errors among the crew (overall).

Error category	Cases
Navigation error due to misjudgement	36
Navigation error due to overconfidence	30
Lack of trip planning or maneuver planning	24
Navigation error due to misuse of vessel equipment	20
Navigation error due to poor technical training or inexperience	20
Not following the procedures	16
Fatigue due to lack of sleep / Physical problems	18
Failure to communicate with the pilot (language, etc.)	13
Failure to communicate among crew members	11
Lack of proper monitoring of navigation	10
Communication error with other ships	9

of technical training and inexperience are higher in cargo/passenger ships than in tugs, probably due to a larger frequency of crew replacements.

A deeper analysis of error categories is shown in Tables 4 to 8, where the most frequent causes of human error are provided, divided into different categories. Only on fishing vessels does error due to physical problems, such as fatigue, occupy first place. Navigation errors are related to misjudgement and overconfidence as well as misuse of ship equipment and poor technical training and inexperience of the crew. Another source of error is the lack of passage planning and monitoring as well of the lack of follow-up

Table 5
Most frequent errors among the crew (on cargo and passenger ships).

Error category	Cases
Navigation error due to misjudgement	12
Lack of trip planning or maneuver planning	12
Failure to communicate with the pilot (language, etc.)	10
Navigation error due to overconfidence	10
Navigation error due to misuse of vessel equipment	10
Navigation error due to poor technical training or inexperience	7
Communication error with other ships	6

Table 6
Most frequent errors among the crew on other ships.

Error category	Cases
Navigation error due to overconfidence	11
Communication error with other ships	11
Navigation error due to misjudgement	10
Lack of proper monitoring of navigation	8
Not following the procedures	7

Table 7
Most frequent errors among the crew (on tugboats).

Error category	Cases
Navigation error due to misjudgement	20
Navigation error due to overconfidence	17
Navigation error due to misuse of vessel equipment	8
Navigation error due to poor technical training or inexperience	5

Table 8
Most frequent errors among the crew (on fishing vessels).

Error category	Cases
Fatigue due to lack of sleep / Physical problems	10
Lack of trip planning or maneuver planning	6
Fatigue due to excessive workload	5
Failure to communicate between crew members	3
Navigation error due to misjudgement	3
Navigation error due to poor technical training or inexperience	3
Not following the procedures	3

procedures. Communication errors are found between different ships, between pilot and officers and between crew members on board the same ship.

Conclusions

The total percentage of accidents attributable to human error, adding up the errors of crews plus those not attributable to the crew, is 75% (82.3% in the case of cargo/passenger ships), which is a similar figure to that found in the literature reviewed. Additionally, it should be noted that if we add the cases of accidents caused by the crew of the ship investigated (85 out of 264 cases) with the cases of error made by the crew of another ship (36 out of 264 cases), the percentage of human error caused by the crew is 45.83% of all accidents analysed. This percentage also includes the crew of a different ship from the one being investigated in the case that there is more than one ship involved in the incident. Therefore, human error in ship accidents is not always a crew error. The crew is responsible for less than fifty percent of human error.

As is known, maritime transport in the United States tends to be extended to rivers and lakes where the use of tugs is common, and the long coastline also supports fisheries. Consequently, almost 25% of the ships analysed are tugs, 20% fishing vessels and only 40% cargo and passenger ships. Therefore, some interesting conclusions have been found when crew error is focused on the type of ship. For instance, human error in cargo/passenger ships is around 82%, but crew error is only 43%. Pilot error is responsible for 43% of total cases with other people's error in this type of vessel. Human error is extended mainly to the pilots due to the fact that the ship is exposed to higher risk when navigating in narrow channels or during berthing/unberthing (Uğurlu et al., 2012). Navigation is not the exclusive cause of marine accidents according to Park et al. (2019). Another influential factor in the joint error of pilot and crew tends to be improper integration in the bridge team due to ineffective bridge resources management. Taking into consideration that the results show that pilot error is commonly related to poor communication and navigation, it may be deduced that passage

planning in pilot waters should be discussed before the pilot takes action. In the event of the pilot not being present at the bridge team briefing before the river, port or canal passage, a common plan for pilot waters should be agreed, if possible, by electronic means before pilot boarding. Therefore, IMO recommendations on the exchange of information between the pilot and the bridge team may not be enough for a safe transit (IMO, 2004).

On the other hand, taking into account that human error on fishing ships is around 51% and crew error is almost 47% of total cases, the conclusion seems no different to that reached for the cargo and passenger fleet with regard to the maintenance of high standards. The percentage of crew error in fishing vessels is a little higher than in cargo/passenger ships. The International Convention on Standards of Training, Certification and Watchkeeping for fishing vessel personnel is not applied to ships of less than 24 m and, moreover, is not in force in the USA (IMO 2019). On the other hand, crew error on tugs increases up to almost 58%. This high percentage is not attributed to a lack of training, according to the results found after the analysis, although the percentage of navigation error is high. Therefore, it appears that the tug master and crew have to face a high risk in the fluvial towage, just the same as pilots during ship manoeuvres.

With regard to typology, navigation errors are the most frequent. However, they are caused mainly by misjudgements and overconfidence rather than poor technical training, inexperience and misuse of ship equipment. Training for officers on watch to try to reduce overconfidence is necessary. Other errors, ordered by frequency, are inadequate planning, poor communication, physical problems and distractions.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Table 9, Table 10, Table 11, Table 12, Table 13, Table 14 and Table 15.

Table 9
Classification by type of vessel (in italics only cargo and passenger ships).

Classification by type of vessel								
	Total accidents investigated		**Cases and percentage with human error**					
			Crew error only		**Others error only**		**Error by both**	
Merchant ship (including tugboats and others)	*Tanker:*	*20*	*4*	*20.00%*	*10*	*50.00%*	*4*	*20.00%*
	Bulk carrier:	*19*	*4*	*21.05%*	*9*	*47.37%*	*4*	*21.05%*
	Container ship:	*11*	*1*	*9.09%*	*6*	*54.55%*	*2*	*18.18%*
	Other cargo ships:	*13*	*3*	*25.00%*	*2*	*16.67%*	*6*	*50.00%*
	Passenger ship:	*39*	*11*	*28.21%*	*13*	*33.33%*	*5*	*12.82%*
	SUBTOTAL (only cargo and passenger ships)	*102*	*23*	*22.55%*	*40*	*39.22%*	*21*	*20.59%*
	Tugboats	64	31	48.44%	11	17.19%	6	9.38%
	Ferry:	5	2	40.00%	1	20.00%	2	40.00%
	Offshore / supply / lift boat:	13	3	23.08%	5	38.46%	3	23.08%
	Dredges:	1	0	0.00%	1	100.00%	0	0.00%
	Barges:	3	0	0.00%	3	100.00%	0	0.00%
	SUBTOTAL	188	59	31.38%	61	32.45%	32	17.02%
Fishing vessels	**SUBTOTAL**	49	18	36.73%	2	4.08%	5	10.20%
Recreational boats	**SUBTOTAL**	11	2	18.18%	3	27.27%	2	18.18%
	Coastguard:	11	4	36.36%	3	27.27%	3	27.27%
Other ships	Navy:	2	1	50.00%	1	50.00%	0	0.00%
	Diving boat:	1	0	0.00%	0	0.00%	0	0.00%
	Oceanographic:	1	0	0.00%	1	100.00%	0	0.00%
	Sailboat:	1	1	100.00%	0	0.00%	0	0.00%
	SUBTOTAL	16	6	37.50%	5	31.25%	3	18.75%
	TOTAL SHIPS	**264**	**85**	**32.20%**	**71**	**26.89%**	**42**	**15.91%**

Table 10
Classification by type of vessel (other people's error) (in italics only cargo and passenger ships).

Classification by type of vessel (other people's error)									
		Pilot fault		Other ship's crew error		Company fault		Others' fault	
Merchant ship (including tugboats and others)	*Tanker:*	*8*	*57.14%*	*2*	*14.29%*	*2*	*14.29%*	*2*	*14.29%*
	Bulk carrier:	*7*	*53.85%*	*3*	*23.08%*	*1*	*7.69%*	*2*	*15.38%*
	Container ship:	*6*	*75.00%*	*2*	*25.00%*	*0*	*0.00%*	*0*	*0.00%*
	Other cargo ships:	*4*	*50.00%*	*2*	*25.00%*	*2*	*25.00%*	*0*	*0.00%*
	Passenger ship:	*1*	*5.56%*	*3*	*16.67%*	*8*	*44.44%*	*6*	*33.33%*
	SUBTOTAL (only cargo and passenger ships)	*26*	*42.62%*	*12*	*19.67%*	*13*	*21.31%*	*10*	*16.39%*
	Tugboats	3	17.65%	6	35.29%	5	29.41%	3	17.65%
	Ferry:	0	0.00%	2	66.67%	0	0.00%	1	33.33%
	Offshore / supply / lift boat:	0	0.00%	3	37.50%	5	62.50%	0	0.00%
	Dredges:	0	0.00%	1	100.00%	0	0.00%	0	0.00%
	Barges:	0	0.00%	1	33.33%	2	66.67%	0	0.00%
	SUBTOTAL	29	31.18%	25	26.88%	25	26.88%	14	15.05%
Fishing vessels	SUBTOTAL	0	0.00%	2	28.57%	4	57.14%	1	14.29%
Recreational boats	SUBTOTAL	0	0.00%	4	80.00%	0	0.00%	1	20.00%
Other ships	SUBTOTAL	1	12.50%	5	62.50%	1	12.50%	1	12.50%
	TOTAL	30	26.55%	36	31.86%	30	26.55%	17	15.04%

Table 11
Types of human error among the crew of ship investigated.

TYPES OF HUMAN ERROR AMONG THE CREW OF SHIPS INVESTIGATED (127 ships)				
GROUP	*N°*	*ERROR*	*Q*	*% cases*
A (Physical problems)	1	Physical problems due to marine environment (storms, cold, etc.)	1	3.70%
	2	Fatigue due to lack of sleep / Physical problems	18	66.67%
	3	Fatigue due to excessive workload	8	29.63%
		TOTAL GROUP A:	27	21.26%
B (Damaging substances)	4	Adverse reaction to medication	4	40.00%
	5	Alcohol	3	30.00%
	6	Drugs	3	30.00%
		TOTAL GROUP B:	10	7.87%
C (Communication error)	7	Failure to communicate among crew members (misunderstanding, inappropriately expressed orders, language, ...)	11	30.56%
	8	Failure to communicate with the pilot (language, etc.)	13	36.11%
	9	Communication error among crew members due to personal problems	0	0.00%
	10	Communication error with other ships	9	25.00%
	11	Communication error with ground personnel	3	8.33%
		TOTAL GROUP C:	36	28.35%
D (Distractions)	12	Distraction in the watch by performing several tasks of the watch at the same time	3	15.00%
	13	Distraction during the watch caused by non-work tasks (telephone, etc.)	7	35.00%
	14	Lack of proper monitoring of navigation	10	50.00%
		TOTAL GROUP D:	20	15.75%
E (Navigation error)	15	Navigation error due to misjudgement	36	33.96%
	16	Navigation error due to poor technical training or inexperience	20	18.87%
	17	Navigation error due to overconfidence	30	28.30%
	18	Navigation error due to misuse of vessel equipment	20	18.87%
		TOTAL GROUP E:	106	83.46%
F (Inadequate planning)	19	Lack of trip planning or maneuver planning	24	54.55%
	20	Failure to follow trip plan or maneuver plan	4	9.09%
	21	Not following the procedures	16	36.36%
		TOTAL GROUP F:	44	34.65%
G (Lack of training)	22	Ignorance of the procedures	4	28.57%
	23	Ignorance of the use of ship equipment	5	35.71%
	24	Ignorance of regulations	3	21.43%
	25	Ignorance of working language	2	14.29%
		TOTAL GROUP G:	14	11.02%
H (Lack of leadership)	26	Error in the exercise of command	4	100.00%
		TOTAL GROUP H:	4	3.15%
I (Maintenance)	27	Poor maintenance of the ship known by crew	8	72.73%
	28	Failure to take adequate corrective measures against a known mechanical failure	3	27.27%
		TOTAL GROUP I:	11	8.66%
J (Fear)	29	Fear	1	100.00%
		TOTAL GROUP J:	1	0.79%

Table 12
Types of human errors among the crew on cargo and passenger ships.

TYPES OF HUMAN ERROR AMONG THE CREW ON CARGO & PASSENGER SHIPS (44 ships)				
GROUP	*N°*	*ERROR*	*Q*	*% cases*
A (Physical problems)	1	Physical problems due to marine environment (storms, cold, etc.)	1	50.00%
	2	Fatigue due to lack of sleep / Physical problems	1	50.00%
	3	Fatigue due to excessive workload	0	0.00%
		TOTAL GROUP A:	2	4.55%
B (Damaging substances)	4	Adverse reaction to medication	1	50.00%
	5	Alcohol	0	0.00%
	6	Drugs	1	50.00%
		TOTAL GROUP B:	2	4.55%
C (Communication error)	7	Failure to communicate among crew members (misunderstanding, inappropriately expressed orders, language. ...)	4	19.05%
	8	Failure to communicate with the pilot (language, etc.)	10	47.62%
	9	Communication error among crew members due to personal problems	0	0.00%
	10	Communication error with other ships	6	28.57%
	11	Communication error with ground personnel	1	4.76%
		TOTAL GROUP C:	21	47.73%
D (Distractions)	12	Distraction during the watch caused by performing several tasks at the same time	1	16.67%
	13	Distraction during the watch caused by non-work tasks (telephone, etc.)	2	33.33%
	14	Lack of proper monitoring of navigation	3	50.00%
		TOTAL GROUP D:	6	13.64%
E (Navigation error)	15	Navigation error due to misjudgement	12	30.77%
	16	Navigation error due to poor technical training or inexperience	7	17.95%
	17	Navigation error due to overconfidence	10	25.64%
	18	Navigation error due to misuse of vessel equipment	10	25.64%
		TOTAL GROUP E:	39	88.64%
F (Inadequate planning)	19	Lack of trip planning or maneuver planning	12	70.59%
	20	Failure to follow trip plan or maneuver plan	0	0.00%
	21	Not following the procedures	5	29.41%
		TOTAL GROUP F:	17	36.96%
G (Lack of training)	22	Ignorance of the procedures	2	40.00%
	23	Ignorance of the use of ship equipment	1	20.00%
	24	Ignorance of regulations	2	40.00%
	25	Ignorance of working language	0	0.00%
		TOTAL GROUP G:	5	11.36%
H (Lack of leadership)	26	Error in the exercise of command	3	100.00%
		TOTAL GROUP H:	3	6.52%
I (Maintenance)	27	Poor maintenance of the ship known by crew	3	100.00%
	28	Failure to take adequate corrective measures against a known mechanical failure	0	0.00%
		TOTAL GROUP I:	3	6.82%
J (Fear)	29	Fear	0	0.00%
		TOTAL GROUP J:	0	0.00%

Table 13
Types of human error among another ship's crew.

TYPES OF HUMAN ERROR AMONG ANOTHER SHIP'S CREW (39 ships)				
GROUP	*N°*	*ERROR*	*Q*	*% cases*
A (Physical problems)	1	Physical problems due to marine environment (storms, cold, etc.)	0	0.00%
	2	Fatigue due to lack of sleep / Physical problems	2	50.00%
	3	Fatigue due to excessive workload	2	50.00%
		TOTAL GROUP A:	4	10.26%
B (Damaging substances)	4	Adverse reaction to medication	0	0.00%
	5	Alcohol	3	75.00%
	6	Drugs	1	25.00%
		TOTAL GROUP B:	4	10.26%
C (Communication error)	7	Failure to communicate among crew members (misunderstanding, inappropriately expressed orders, language. ...)	2	11.76%
	8	Failure to communicate with the pilot (language, etc.)	3	17.65%
	9	Communication error among crew members due to personal problems	0	0.00%
	10	Communication error with other ships	11	64.71%
	11	Communication error with ground personnel	1	5.88%
		TOTAL GROUP C:	17	43.59%
D (Distractions)	12	Distraction during the watch caused by performing several tasks at the same time	3	23.08%
	13	Distraction during the watch caused by non-work tasks (telephone, etc.)	2	15.38%
	14	Lack of proper monitoring of navigation	8	61.54%
		TOTAL GROUP D:	13	33.33%
E (Navigation error)	15	Navigation error due to misjudgement	10	30.30%
	16	Navigation error due to poor technical training or inexperience	4	12.12%
	17	Navigation error due to overconfidence	11	33.33%
	18	Navigation error due to misuse of vessel equipment	8	24.24%
		TOTAL GROUP E:	33	84.62%
F (Inadequate planning)	19	Lack of trip planning or maneuver planning	3	30.00%
	20	Failure to follow trip plan or maneuver plan	0	0.00%
	21	Not following the procedures	7	70.00%
		TOTAL GROUP F:	10	25.64%
G (Lack of training)	22	Ignorance of the procedures	0	0.00%
	23	Ignorance of the use of ship equipment	0	0.00%
	24	Ignorance of regulations	0	0.00%
	25	Ignorance of working language	1	100.00%
		TOTAL GROUP G:	1	2.56%
H (Lack of leadership)	26	Error in the exercise of command	0	0.00%
		TOTAL GROUP H:	0	0.00%
I (Maintenance)	27	Poor maintenance of the ship known by crew	0	0.00%
	28	Failure to take adequate corrective measures against a known mechanical failure	0	0.00%
		TOTAL GROUP I:	0	0.00%
J (Fear)	29	Fear	0	0.00%
		TOTAL GROUP J:	0	0.00%

Table 14
Types of human error among the crew of tugboats.

TYPES OF HUMAN ERROR AMONG THE CREW OF TUGBOATS (37 ships)				
GROUP	*N°*	*ERROR*	*Q*	*% cases*
A (Physical problems)	1	Physical problems due to marine environment (storms, cold, etc.)	0	0.00%
	2	Fatigue due to lack of sleep / Physical problems	3	50.00%
	3	Fatigue due to excessive workload	3	50.00%
		TOTAL GROUP A:	6	16.22%
B (Damaging substances)	4	Adverse reaction to medication	1	100.00%
	5	Alcohol	0	0.00%
	6	Drugs	0	0.00%
		TOTAL GROUP B:	1	2.70%
C (Communication error)	7	Failure to communicate among crew members (misunderstanding, inappropriately expressed orders, language…)	1	12.50%
	8	Failure to communicate with the pilot (language, etc.)	2	25.00%
	9	Communication error among crew members due to personal problems	0	0.00%
	10	Communication error with other ships	3	37.50%
	11	Communication error with ground personnel	2	25.00%
		TOTAL GROUP C:	8	21.62%
D (Distractions)	12	Distraction during the watch caused by performing several tasks at the same time	1	16.67%
	13	Distraction during the watch caused by non-work tasks (telephone, etc.)	2	33.33%
	14	Lack of proper monitoring of navigation	3	50.00%
		TOTAL GROUP D:	6	16.22%
E (Navigation error)	15	Navigation error due to misjudgement	20	40.00%
	16	Navigation error due to poor technical training or inexperience	5	10.00%
	17	Navigation error due to overconfidence	17	34.00%
	18	Navigation error due to misuse of vessel equipment	8	16.00%
		TOTAL GROUP E:	50	135.14%
F (Inadequate planning)	19	Lack of trip planning or maneuver planning	1	12.50%
	20	Failure to follow trip plan or maneuver plan	2	25.00%
	21	Not following the procedures	5	62.50%
		TOTAL GROUP F:	8	21.62%
G (Lack of training)	22	Ignorance of the procedures	0	0.00%
	23	Ignorance of the use of ship equipment	0	0.00%
	24	Ignorance of regulations	0	0.00%
	25	Ignorance of working language	0	0.00%
		TOTAL GROUP G:	0	0.00%
H (Lack of leadership)	26	Error in the exercise of command	0	0.00%
		TOTAL GROUP H:	0	0.00%
I (Maintenance)	27	Poor maintenance of the ship known by crew	1	50.00%
	28	Failure to take adequate corrective measures against a known mechanical failure	1	50.00%
		TOTAL GROUP I:	2	5.41%
J (Fear)	29	Fear	0	0.00%
		TOTAL GROUP J:	0	0.00%

Table 15
Types of human errors among the crew of fishing vessels.

TYPES OF HUMAN ERROR AMONG THE CREW OF FISHING VESSELS (23 ships)				
GROUP	*N°*	*ERROR*	*Q*	*% cases*
A (Physical problems)	1	Physical problems due to marine environment (storms, cold, etc.)	0	0.00%
	2	Fatigue due to lack of sleep / Physical problems	10	66.67%
	3	Fatigue due to excessive workload	5	33.33%
		TOTAL GROUP A:	15	65.22%
B (Damaging substances)	4	Adverse reaction to medication	2	66.67%
	5	Alcohol	0	0.00%
	6	Drugs	1	33.33%
		TOTAL GROUP B:	3	13.04%
C (Communication error)	7	Failure to communicate among crew members (misunderstanding, inappropriately expressed orders, language…)	3	100.00%
	8	Failure to communicate with the pilot (language, etc.)	0	0.00%
	9	Communication error among crew members due to personal problems	0	0.00%
	10	Communication error with other ships	0	0.00%
	11	Communication error with ground personnel	0	0.00%
		TOTAL GROUP C:	3	13.04%
D (Distractions)	12	Distraction during the watch caused by performing several tasks at the same time	2	50.00%
	13	Distraction during the watch caused by non-work tasks (telephone, etc.)	0	0.00%
	14	Lack of proper monitoring of navigation	2	50.00%
		TOTAL GROUP D:	4	17.39%
E (Navigation error)	15	Navigation error due to misjudgement	3	33.33%
	16	Navigation error due to poor technical training or inexperience	3	33.33%
	17	Navigation error due to overconfidence	1	11.11%
	18	Navigation error due to misuse of vessel equipment	2	22.22%
		TOTAL GROUP E:	9	39.13%
F (Inadequate planning)	19	Lack of trip planning or maneuver planning	6	60.00%
	20	Failure to follow trip plan or maneuver plan	1	10.00%
	21	Not following the procedures	3	30.00%
		TOTAL GROUP F:	10	43.48%
G (Lack of training)	22	Ignorance of the procedures	0	0.00%
	23	Ignorance of the use of ship equipment	1	33.33%
	24	Ignorance of regulations	1	33.33%
	25	Ignorance of working language	1	33.33%
		TOTAL GROUP G:	3	13.04%
H (Lack of leadership)	26	Error in the exercise of command	0	0.00%
		TOTAL GROUP H:	0	0.00%
I (Maintenance)	27	Poor maintenance of the ship known by crew	4	80.00%
	28	Failure to take adequate corrective measures against a known mechanical failure	1	20.00%
		TOTAL GROUP I:	5	21.74%
J (Fear)	29	Fear	1	100.00%
		TOTAL GROUP J:	1	4.35%

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