

# The causes of maritime accidents in the period 2002-2016



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## Contents

Introduction.....	1
Table 1: Numbers of accident investigation reports by country of origin.....	1
Method of Analysis.....	2
Accident Types.....	2
Table 2: Types of accident .....	2
Immediate and contributory causes of different types of accidents .....	3
Collision, close quarters and contact accidents .....	3
Figure 1: Immediate causes of collision, close quarters and contact accidents.....	4
Figure 2: Contributory causes of collision, close quarters and contact accidents .....	5
Grounding.....	5
Figure 3: Immediate causes of grounding .....	6
Figure 4: Contributory causes of grounding.....	7
Fire and explosion.....	7
Figure 5: Immediate causes of fire and explosion.....	8
Figure 6: Contributory causes of fire and explosion.....	8
Lifeboat accidents.....	9
Figure 7: Contributory causes of lifeboat accidents.....	10
Other accidents .....	10
Figure 8: Immediate causes of other accidents.....	11
Figure 9: Contributory causes of other accidents .....	11
Immediate causes of all types of accidents.....	12
Figure 10: Immediate cases (all accident types).....	12
Contributory causes of all types of accidents.....	12
Figure 11: Contributory causes (all accident types) .....	13
Immediate and contributory causes of all types of accidents combined.....	13
<b>Table 3: Overall causes of all types of accident .....</b>	<b>14</b>
Conclusion .....	14
References.....	15

## Introduction

Maritime safety has undoubtedly improved in the last century as a result of a combination of factors including: technological advancement; better training; and regulatory development (Allianz, 2012). However, despite such improvement seafaring remains a relatively dangerous occupation (Hansen, 1996; Roberts and Marlow, 2005; Borch et al., 2012). One way to improve safety at sea is to ‘learn’ from past accidents. For this purpose, maritime authorities around the world invest a considerable amount of resource in investigating accidents and producing reports. Most reports offer a detailed account of what took place and attempt to identify all the relevant factors and contributory causes. While they frequently provide rich information, meticulous analysis and detailed insight, such accident reports are generally read as isolated documents and therefore fail to shed light on general patterns or trends. To identify patterns, and lessons from accidents, it is helpful therefore to consider such documents ‘en masse’ and to systematically aggregate their findings as far as is reasonable. This is the aim of this report which builds upon an earlier paper which was published as part of the SIRC symposium proceedings in 2013 (Tang et al, 2013).

The report constitutes an analysis of accident investigation reports that have been published on line by the (UK) Marine Accident Investigation Branch (MAIB), the Australian Transport Safety Bureau (ATSB), the (US) National Transportation Safety Board (NTSB), the Federal Bureau of Maritime Casualty Investigation in Germany, and the Danish Maritime Accident Investigation Board (DMAIB) in the period 2002-2016 (inclusive). Accident investigation reports from Maritime New Zealand have only been included for the period 2002-4. This is because their publication was discontinued in 2004.

In preparing this report, a total of 693 accident reports were analysed. An interim paper was published in 2013 outlining the results from the first phase of the study which included 319 accident reports from the period 2002-2011. We subsequently analysed a further 374 reports in Phase 2 which were published in the period 2012-2016 (inclusive). Table 1 gives the breakdown of the accident reports by country of origin.

Table 1: Numbers of accident investigation reports by country of origin

Country of origin	Frequency	%
United Kingdom	203	29.3
Australia	145	20.9
U.S.A.	57	8.2
New Zealand	43	6.2
Germany	137	19.8
Denmark	108	15.6
<b>Total</b>	<b>693</b>	<b>100.0</b>

## Method of Analysis

The reports which were analysed were published online in the period of the study. No sampling was applied. Each report was given a first reading by two different members of the research team (five researchers undertook the analysis in 2002-2011, and two analysed the reports for the period 2012-2016). In the first phase of the research the team was split into two pairs and then cases which caused some concern with regard to classification were discussed with a moderator (the fifth member of the team). The categorisation which was developed in the first phase of the research was then applied consistently throughout the whole period of the analysis. The accident causes were further assigned a status as either the 'immediate cause' or a 'contributory cause' of the accident concerned. Immediate causes refer to those which directly lead to the accidents (at the end of error chains) while contributory causes (which could be multiple) are defined as those that either lead to the immediate cause of an accident, or create the conditions in which the immediate/contributory causes are likely to arise. The respective pairs of researchers individually read accident reports and categorised causation alongside the assignment of causes as 'immediate' or 'contributory'. Having read each report the pair members consulted with each other to check on consistency. Where there were discrepant analyses the pair initially re-read the reports concerned and when disagreement continued or they were uncertain of their interpretation they referred the case to the moderator. The results for these reports were then combined using Microsoft Excel.

## Accident Types

The most common kind of accident was identified as 'collision, close quarters and contact' (35.8%). This was followed by grounding which constituted 17% of the cases. About 9.8% of cases were associated with fire and explosion, 3.3% of cases were related to lifeboats and 34.2% were described by investigators as being other kinds of accidents. These disparate events included, for example, crane failure, man overboard [sic], cargo loss, engine room flooding, trip and fall, parting of mooring lines, and oil spills.

Table 2: Types of accident

Types of Accident	Frequency	%
Collision, close quarters & contact	248	35.8
Grounding	118	17.0
Fire and explosion	66	9.8
Lifeboat	23	3.3
Other	238	34.2
<b>Total</b>	<b>693</b>	<b>100.0</b>

## Immediate and contributory causes of different types of accidents

### Collision, close quarters and contact accidents

The most common immediate cause of collision, close quarters and contact accidents was found to be the maintenance of an 'inadequate lookout' which was identified in 24.6% of cases.

#### Inadequate lookout

[...] the second officer had been in charge of only 10 bridge watches. Therefore, he had not been tested in a variety of shipping situations. As the master had only known the second officer for about 2 weeks, it is astonishing that he was sufficiently confident of the OOW's abilities to entrust him with the bridge watch in the Dover Strait, one of the busiest shipping lanes in the world, at night and without a lookout for support.

*Collision between general cargo vessel Paula C and bulk carrier Darya Gayatri*

'Failure in communication' was identified in 15.3% of cases, 'poor judgment' (14.1%), and 'pilot error/mishandling' (12.9%) also featured as prominent immediate causes of collision, close quarters and contact accidents.

In terms of contributory causes, 'ineffective use of technology' was most commonly identified by investigators. This was found to be a contributory cause in 24.2% of cases. Ineffective use of technology was identified as a cause/contributory cause of an accident when investigators found that technology had not been used to its full potential. An additional category of 'inappropriate use of technology' was applied to misuse of technology and this comprised 6.9% of contributory causes. When ineffective and inappropriate use of technology were aggregated we found that technology was reported to have contributed to accidents in more than a third of the cases (31%).

#### Inappropriate use of technology

The recorded AIS data did not permit accurate determination of the scene of collision. There was evidently a GPS error. The officer in charge of the navigational watch on each vessel failed to verify the GPS positions displayed with another system, such as radar, or visual bearings.

*Collision between MV Francisca and MV RMS Bremen*

'Failure in communication' was also identified as a major contributory cause and this was identified in 20.6% of cases. 'Weather/other environmental factors' (19.8%), 'third party deficiency' (14.1%), 'inadequate lookout' (12.5%), 'inadequate risk management' (11.7%) and 'distraction' (10.9%) were also identified by investigators as contributory causes of collision, close quarters and contact accidents.

Figure 1: Immediate causes of collision, close quarters and contact accidents

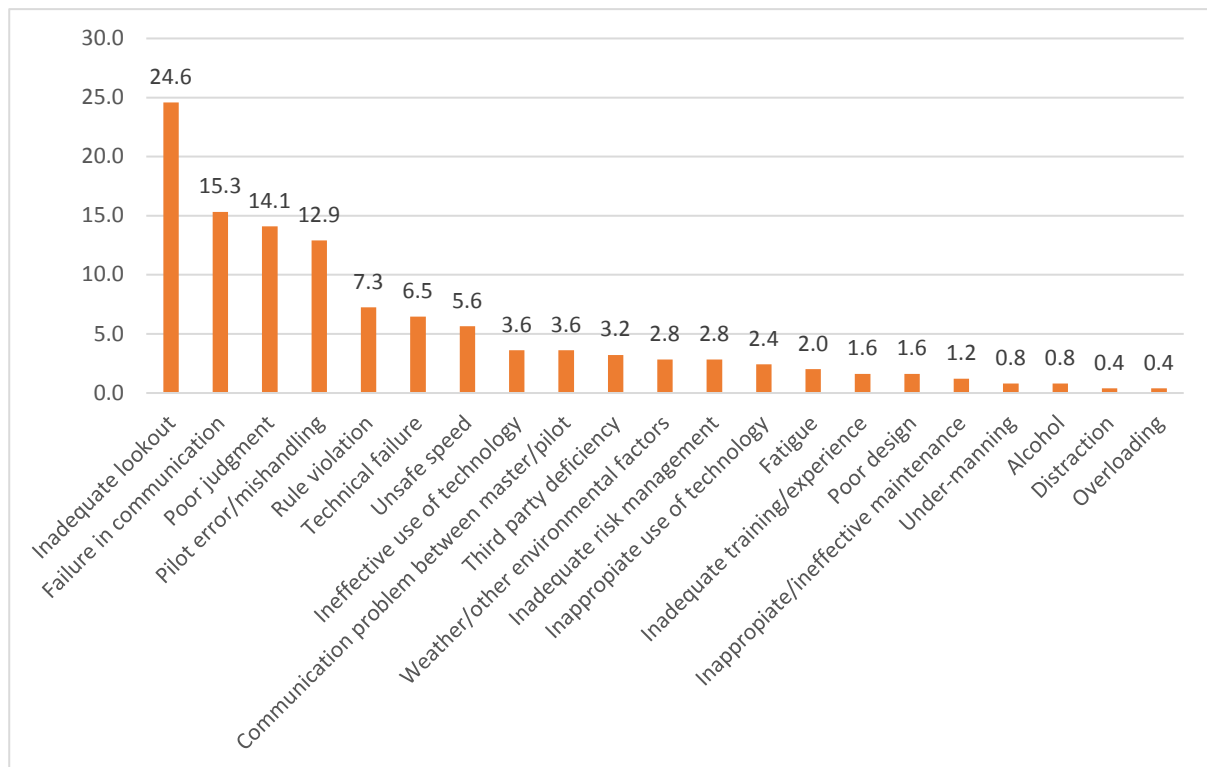
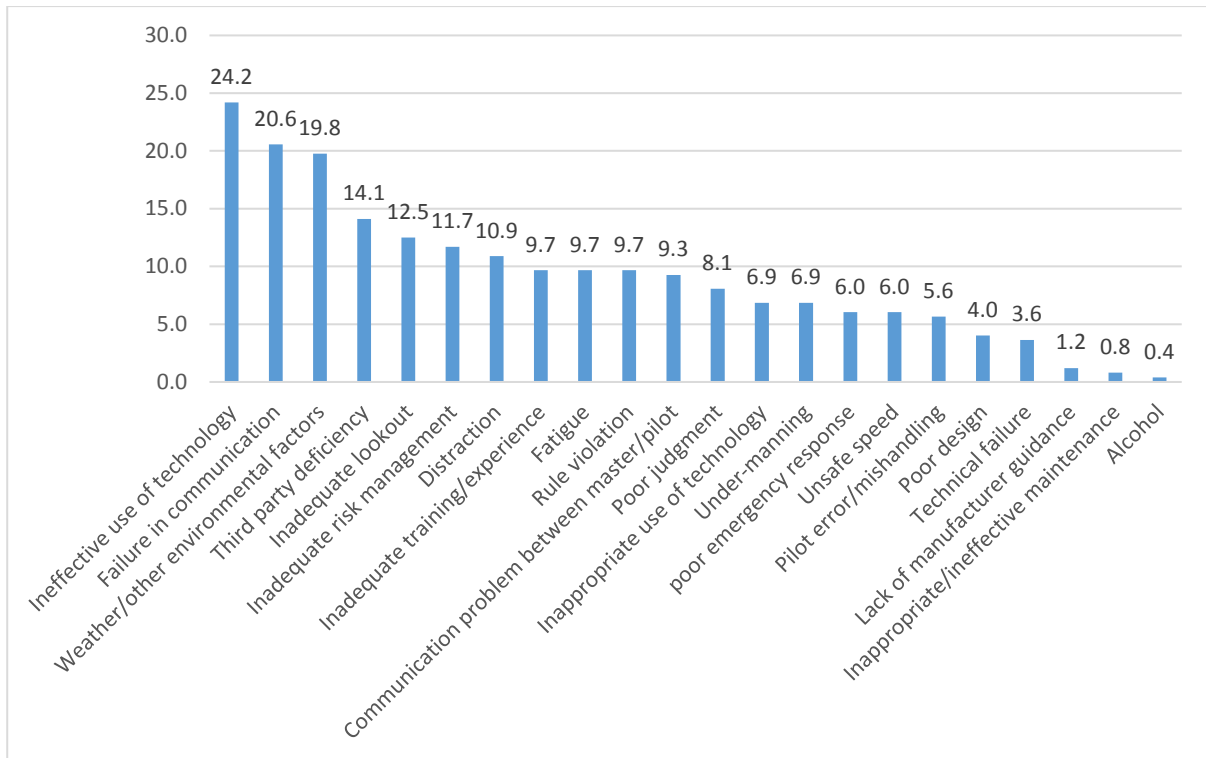


Figure 2: Contributory causes of collision, close quarters and contact accidents



### Grounding

In terms of grounding incidents, ‘failure in communication/coordination’ was found to be an immediate cause in 16.1% of cases. It was also identified as a contributory cause in 24.6% of cases. Other immediate causes of grounding were found to be: ‘inadequate lookout’ (11.9%); ‘poor judgment’ (11%); ‘fatigue’ (9.3%); and ‘technical failure’ (8.5%). Third party causes of grounding such as ‘pilot error/mishandling’ were identified in 6.8% of cases.

‘Ineffective use of technology’ (31.4%) and ‘inadequate risk management’ (28.8%) were most frequently identified as contributory causes in cases of grounding. ‘Inappropriate use of technology’ was identified as a contributory cause in 7.6% of cases and ‘ineffective use of technology’ was reported by investigators to have contributed to 31.4% of groundings amounting to a total of 39% of cases in which technology played a contributory role.

Inadequate risk management was also commonly identified as a contributory cause and was found to play a part in 28.8% of cases.



**Inadequate risk management**

[...] there had been insufficient passage planning for the voyage; in particular, for the transit through the Little Russel, the extremely low tide and effect of squat were not properly considered. This resulted in the bridge team being unaware of the limits of safe water available and thus, despite their good positional awareness, they headed into danger without appreciation of the risk.

*Grounding and flooding of ro-ro ferry Commodore Clipper*

The next most common contributory causes of grounding were ‘failure in communication’ (24.6%) and ‘third party deficiency’ (17.8%). ‘Fatigue’ (12.7%), ‘weather/other environmental factors’ (12.7%) and ‘rule violation’ (12.7%) were also identified as common contributory factors in grounding reports.

Figure 3: Immediate causes of grounding

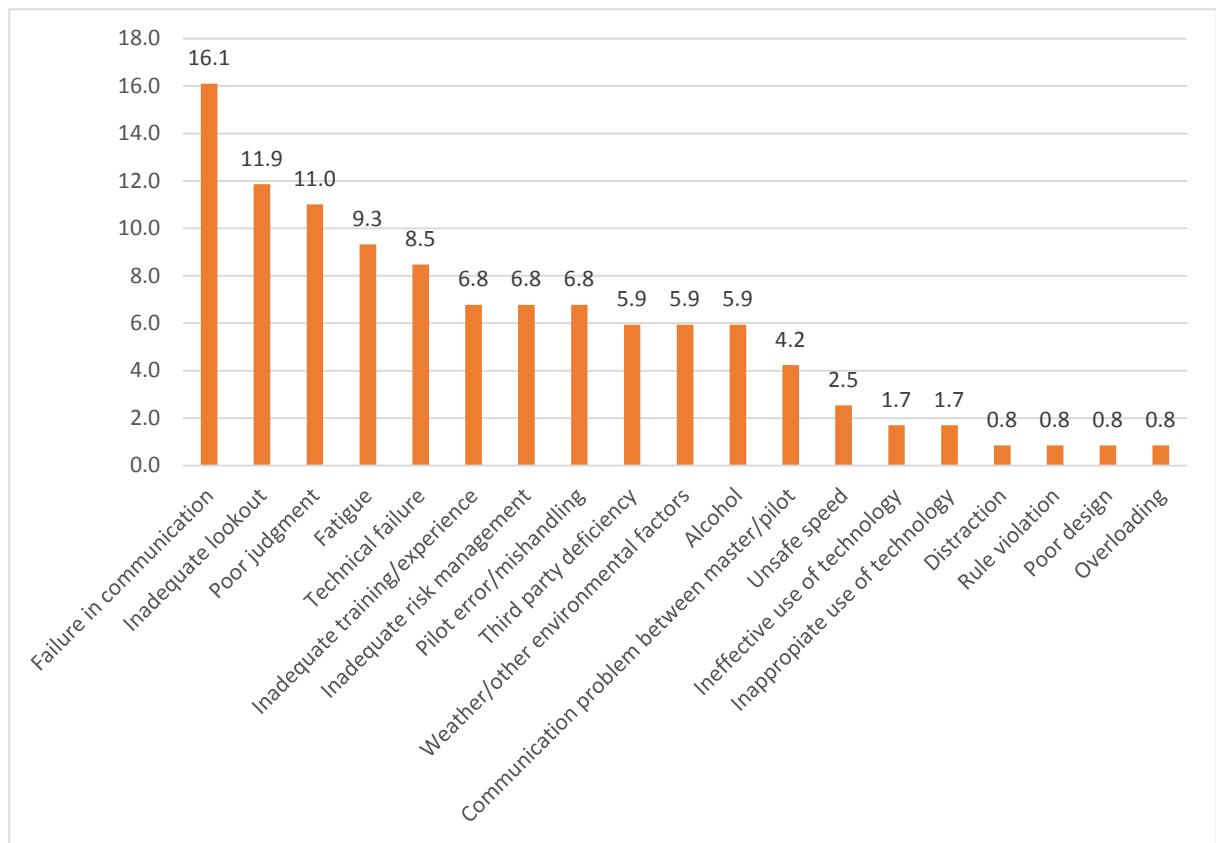
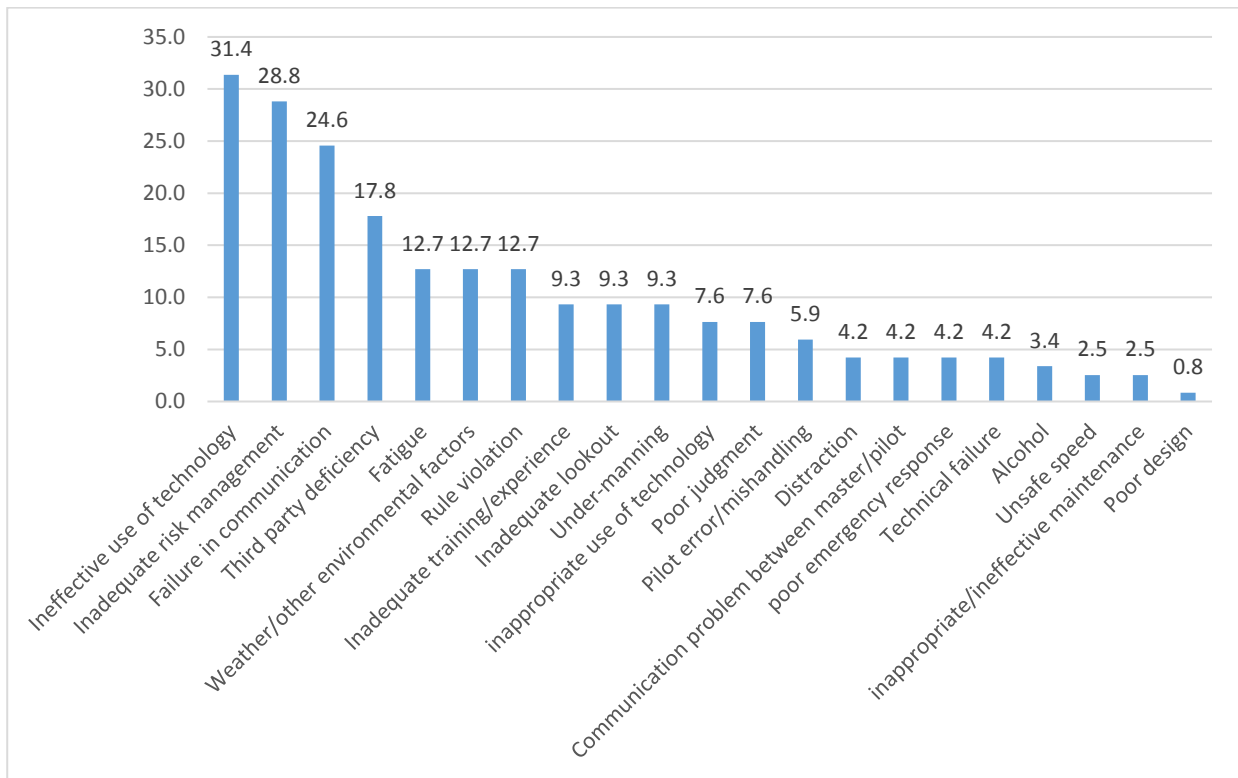


Figure 4: Contributory causes of grounding



Fire and explosion

‘Inadequate risk management’ prominently featured both as an immediate (27.3%) and contributory (43.9%) cause of fire/explosion. Other immediate causes such as ‘third party deficiency’ (18.2%), ‘technical failure’ (18.2%), and ‘inappropriate/ineffective maintenance (16.7%) were also commonly found by investigators to have resulted in fire/explosion.

**Technical Failure**

The water mist system should have started automatically but because of inappropriate placement of smoke and heat detectors it did not. Furthermore it could not be engaged immediately by using the control panel by the engine room entrance. It has not been possible to establish why the system did not start when the CE pushed the buttons on the panel.

Engine room fire *Maersk Master*

In terms of contributory causes, 'poor emergency response' was identified as a factor in more than a quarter of cases (27.3%). 'third party deficiency' (18.2%) and 'inappropriate/ineffective maintenance' (16.7%) were also identified by investigators as important contributory causes of fires and explosions. Both 'inadequate training/experience' and 'poor design' were identified as immediate and contributory causes of fire and explosion accidents.

Figure 5: Immediate causes of fire and explosion

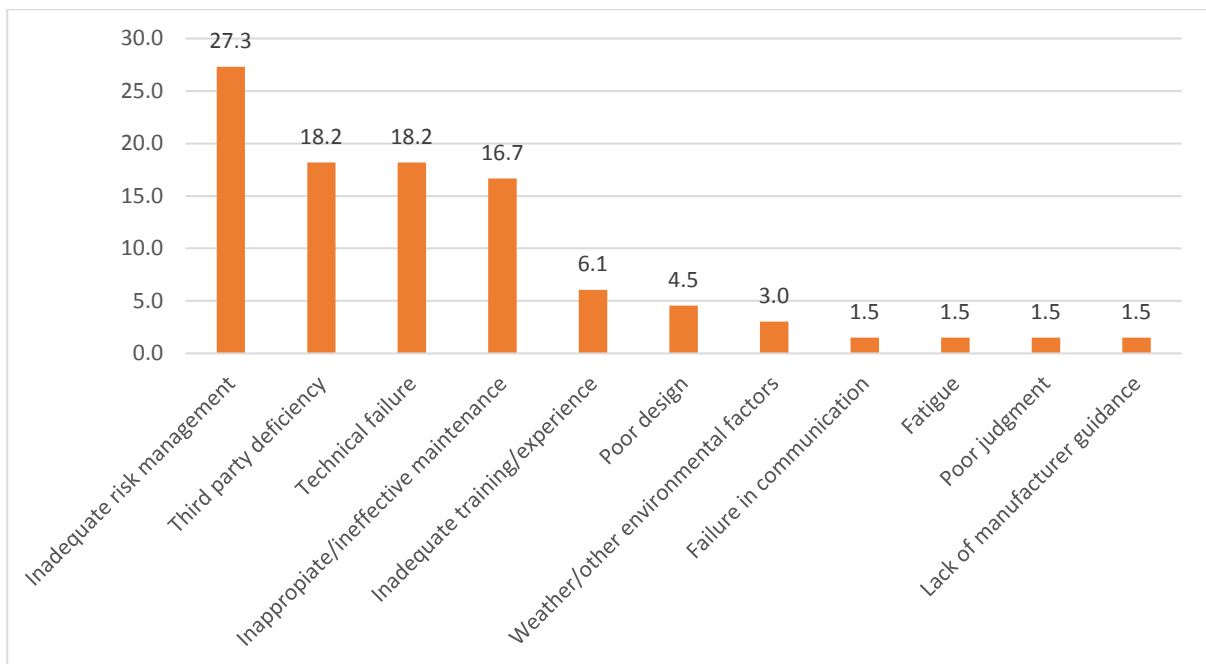
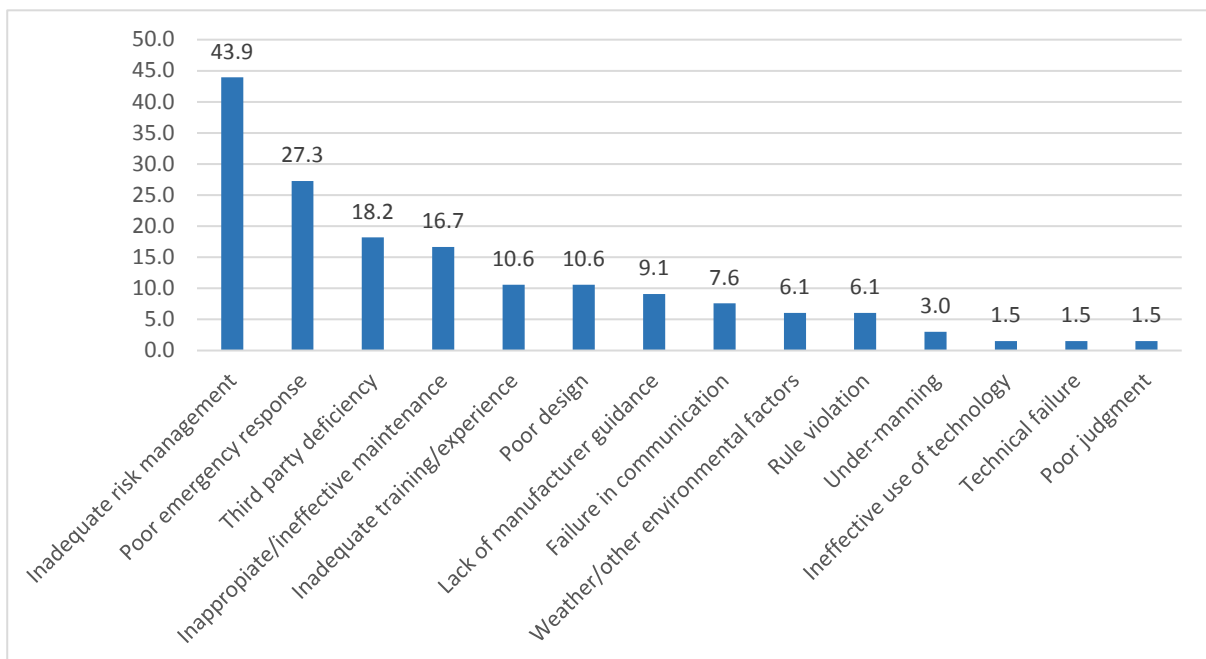


Figure 6: Contributory causes of fire and explosion



## Lifeboat accidents

In relation to accidents associated with lifeboats investigators most commonly identified the immediate causes as 'inappropriate/ineffective maintenance' (26.1%) and 'inadequate training/experience' (21.7%). 'poor design' and 'poor judgment' were identified as immediate causes in 17.4% and 13% of lifeboat accidents respectively.

While 'inadequate risk management' was identified in 8.7% of cases as an immediate cause of lifeboat accidents, it was more frequently regarded as a contributory cause and was cited as such in 60.9% of cases. Inadequate training/experience (30.4%), third party deficiency (21.7%), and lack of manufacturers' guidance (21.7%) were also frequently identified as contributing to lifeboat accidents. Poor design (17.4%), inappropriate/ineffective maintenance (17.4%), failure in communication (8.7%), rule violation (8.7%), and technical failure (8.7%) were also identified as significant contributory causes.

Figure 6: Immediate causes of lifeboat accidents

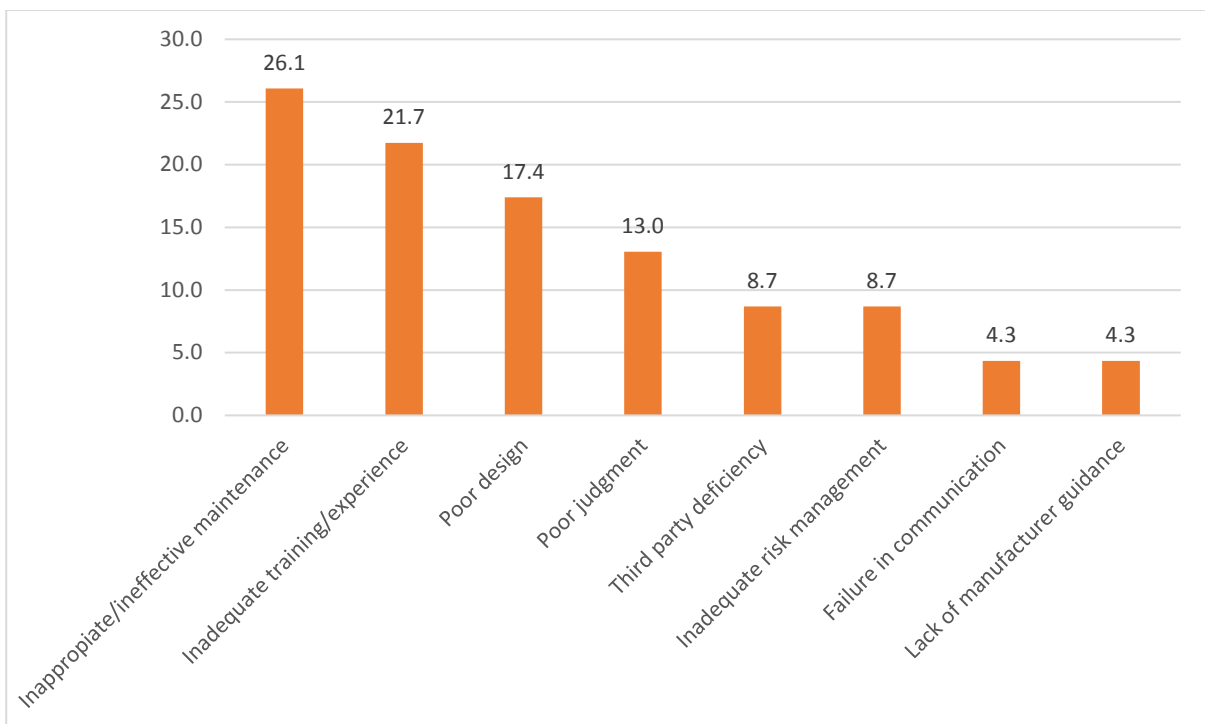
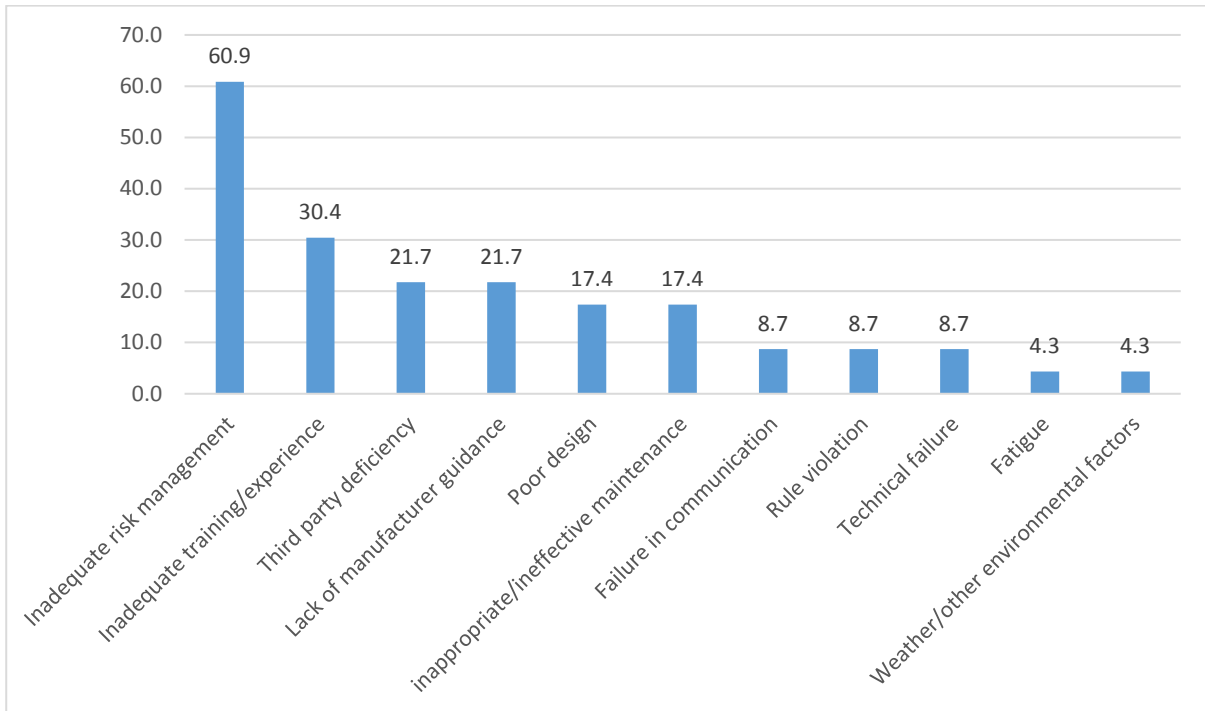


Figure 7: Contributory causes of lifeboat accidents



### Other accidents

The category ‘other accidents’ consisted of all other accidents deemed worthy of investigation but not related to collision, grounding, fire and explosion and lifeboats. For example accidents associated with crane operations or resulting in oil spills were counted as ‘other accidents’. In these kinds of accidents, ‘inadequate risk management’ was frequently identified as both as an immediate and contributory cause (in 34.9 and 34.5% of cases, respectively). Other immediate causes included ‘third party deficiency’ (12.2%) and ‘poor judgment’ (11.3%) alongside inappropriate/ineffective maintenance’ ‘poor design’ ‘technical failure’ and ‘weather/other environmental factors’.

**Weather/other environmental factors**

The two crew members had proceeded onto the aft mooring deck (Figure 1) to secure a coiled mooring rope that had loosened in its stowed position. They were struck by a large wave, which washed them overboard, causing their respective lifelines, which were secured to the vessel, to part.

*Persons washed overboard during heavy weather with loss of two lives **Timberland***

Third party deficiencies featured as a contributory cause in 17.6% of cases. Weather/other environmental factors (16%), inadequate training/experience (12.6%), poor judgment (10.1%), and inappropriate/ineffective maintenance (9.7%), were also regarded as contributory causes of 'other accidents'.

Figure 8: Immediate causes of other accidents

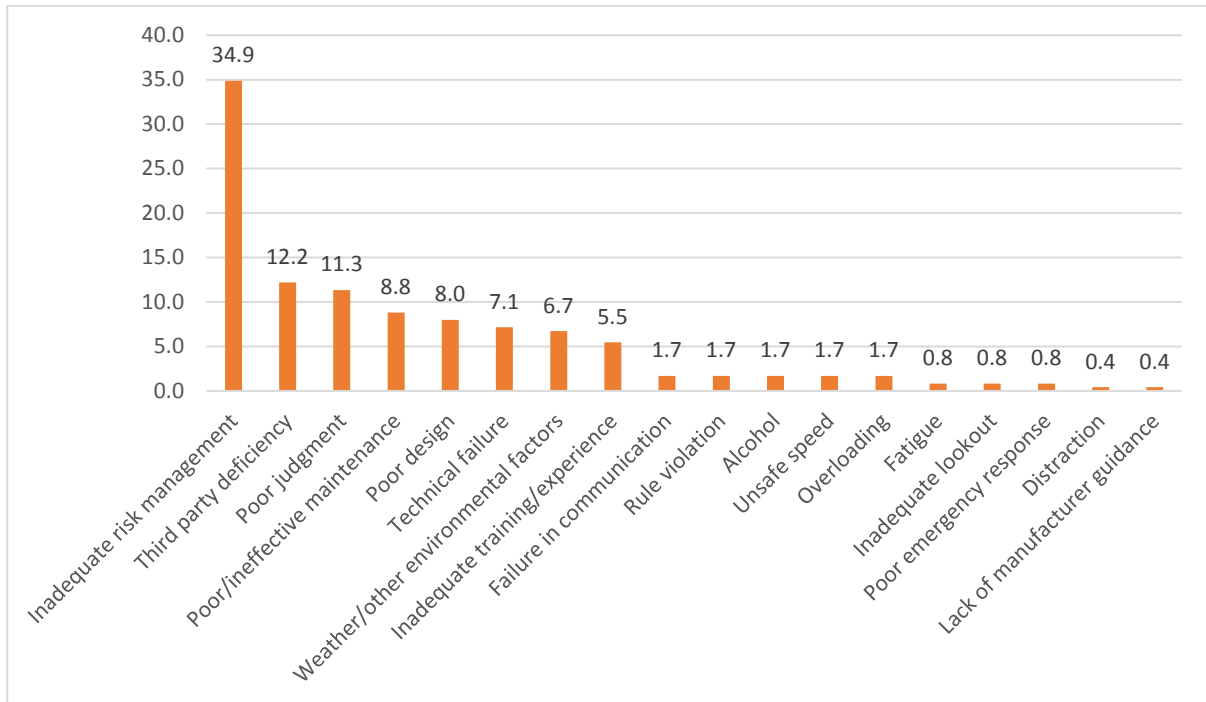
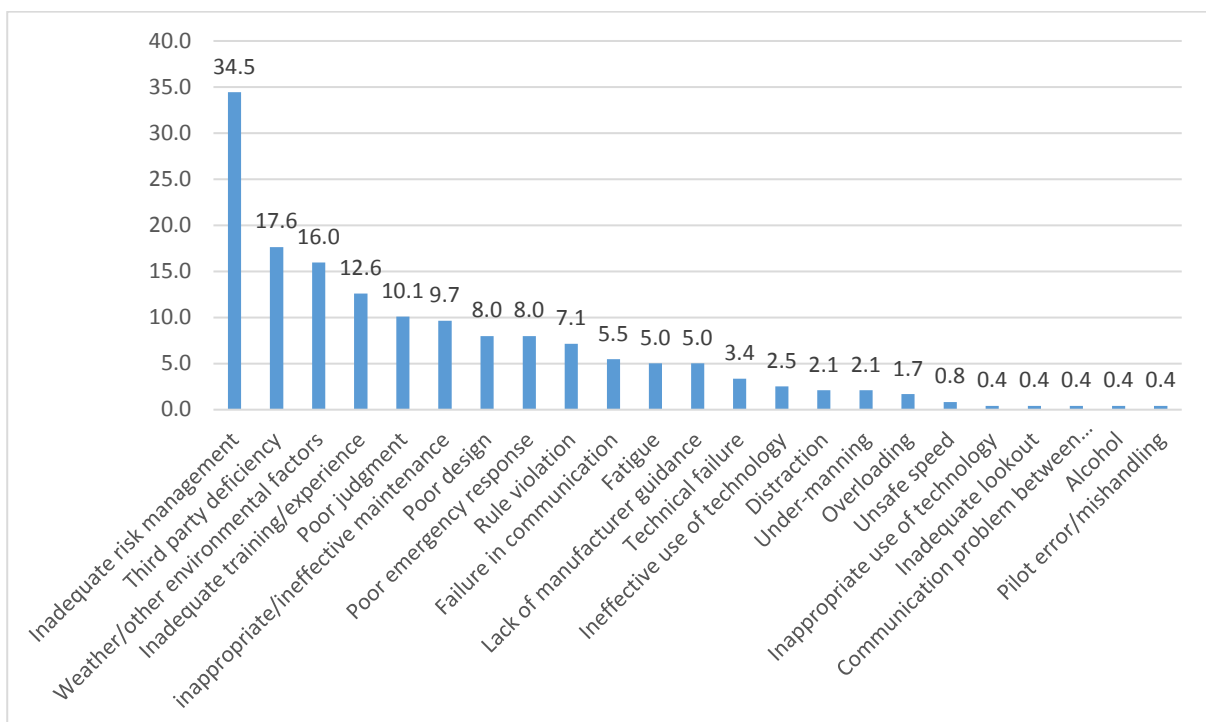


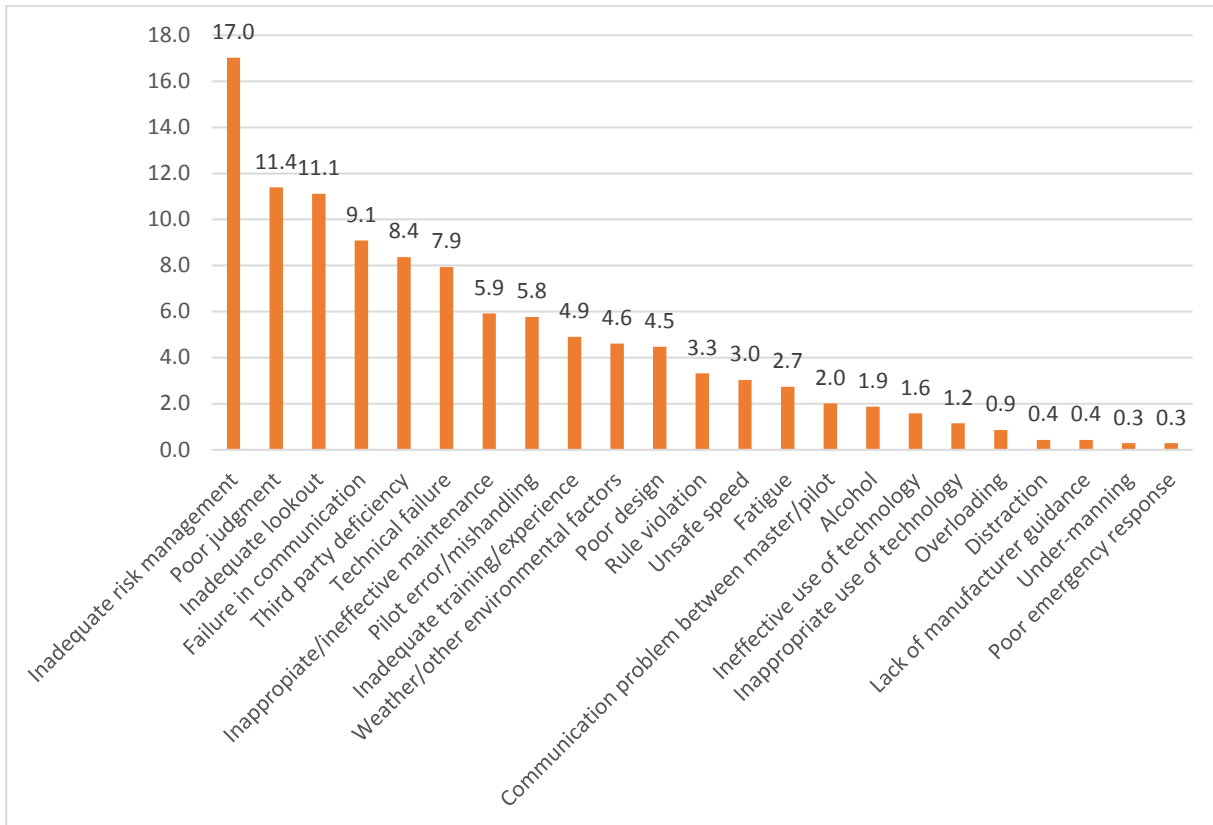
Figure 9: Contributory causes of other accidents



## Immediate causes of all types of accidents

For all accident types, the immediate causes most frequently identified by investigators were as follows: inadequate risk management (17%), poor judgment (11.4%), inadequate lookout (11.1%), failure in communication (9.1%), third party deficiency (8.4%), technical failure (7.9%), inappropriate and ineffective maintenance (5.9%).

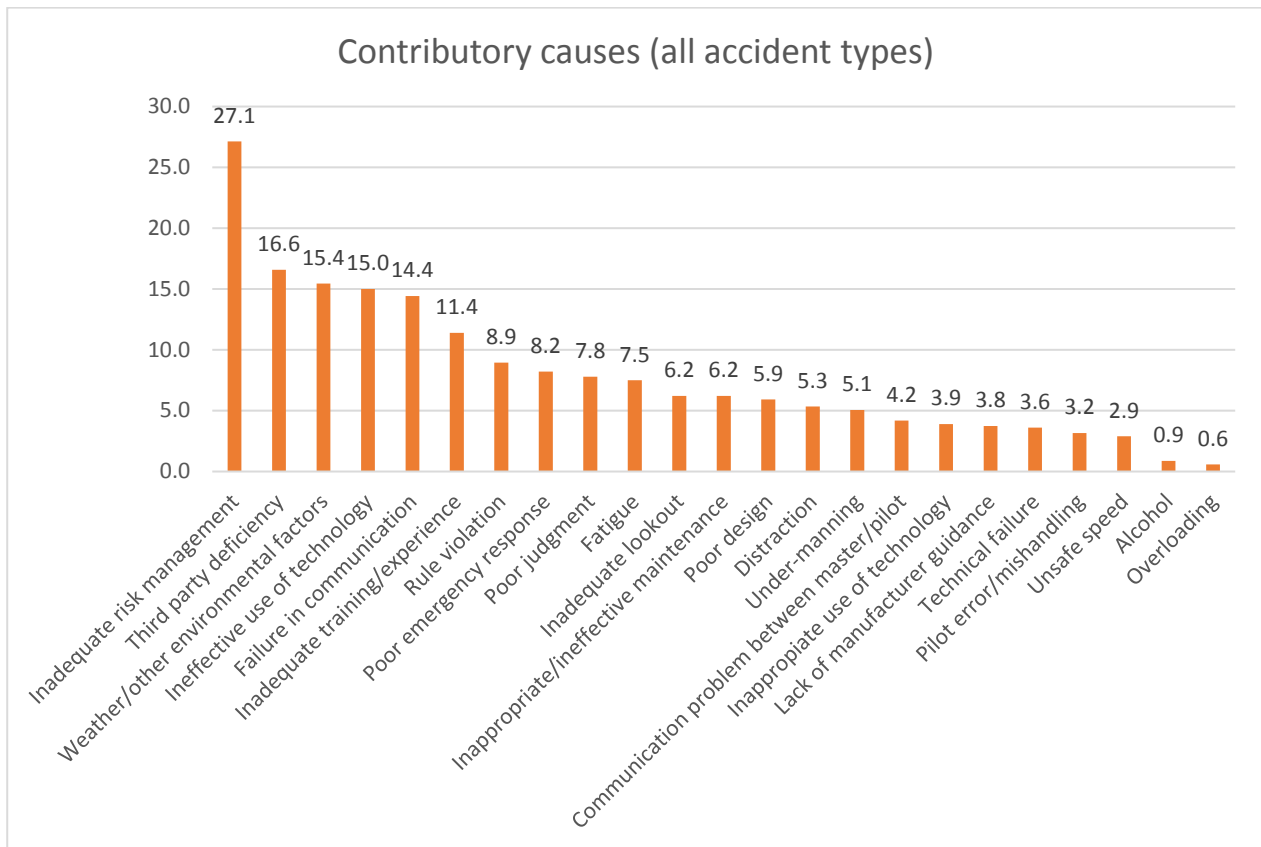
Figure 10: Immediate cases (all accident types)



## Contributory causes of all types of accidents

In terms of the contributory causes identified by accident investigators across all accident types, the most common were found to be: inadequate risk management (27.1%); third party deficiency (16.6%); weather/other environmental factors (15.4%); and ineffective use of technology (15%). Failure in communication (14.4%), inadequate training/experience (11.4%), rule violation (8.9%), and poor emergency response (8.2%) were also noteworthy contributory causes.

Figure 11: Contributory causes (all accident types)



### Immediate and contributory causes of all types of accidents combined

To look at the overall picture, the immediate and contributory causes for all types of accidents were combined and then ranked in descending order. The following were identified by accident investigators most frequently (see Table 3): inadequate risk management; third party deficiency; failure in communication; weather/other environmental factors; poor judgement; inadequate lookout; ineffective use of technology; inadequate training/experience; rule violation; inappropriate/ineffective maintenance; technical failure; poor design; fatigue, pilot error/mishandling; poor emergency response; communication problem between master and pilot; unsafe speed, distraction; under-manning; inappropriate use of technology; lack of manufacturer guidance; alcohol; overloading.



Table 3: Overall causes of all types of accident

	No. of Cases	%age of cases
Inadequate risk management	306	44.2
Third party deficiency	173	25.0
Failure in communication	163	23.5
Weather/other environmental factors	139	20.1
Poor judgment	133	19.2
Inadequate lookout	120	17.3
Ineffective use of technology	115	16.6
Inadequate training/experience	113	16.3
Rule violation	85	12.3
Inappropriate/ineffective maintenance	84	12.1
Technical failure	80	11.5
Poor design	72	10.4
Fatigue	71	10.2
Pilot error/mishandling	62	8.9
Poor emergency response	59	8.5
Communication problem between master/pilot	43	6.2
Unsafe speed	41	5.9
Distraction	40	5.8
Under-manning	37	5.3
Inappropriate use of technology	35	5.1
Lack of manufacturer guidance	29	4.2
Alcohol	19	2.7
Overloading	10	1.4

## Conclusion

‘*Inadequate risk management*’ was most commonly identified as both an immediate and a contributory cause of accidents when all types were aggregated. In some respects this is unhelpful as in relation to very many accidents it is inevitably the case that inadequate risk management can be identified as part of the overall picture and this does not shed a great deal of light on how accidents might be avoided in the future. However, inadequate risk management was identified as the **immediate** cause of 17% of all accidents and this may indicate that there is an underlying problem of poor training or recruitment practice.

Overall, ‘*third party deficiency*’ is the second most common accident cause identified by investigators. It is the second most common **immediate** cause of fire/explosion and of ‘other’ accidents. This indicates that there is a pressing need to look beyond the operational staff within a company (on board and ashore) when considering appropriate strategies for accident mitigation. It is arguably the case that the focus by

regulators and enforcement agents on third party deficiencies has been inadequate, to date, and that this needs urgent rectification.

'*Failure in communication*' is the third most commonly identified cause of accidents. It is the most frequently identified **immediate** cause of groundings and the second most common **immediate** cause of collision, contact and close quarters incidents. It is often not possible to discern the underlying causes of communication failure. In some incidents information is simply not passed on and in others there may be language or hierarchical barriers at play. This is an area where better training and recruitment practices would be expected to have a positive impact providing the industry with a constructive way forward with regard to accident mitigation.

There are further areas where improved recruitment strategies and training practices could prove effective in accident prevention. For example, in relation to incidents where poor judgement is identified as a factor, better training or more careful selection procedures could serve to reduce accidents in the future. Similarly, in this report, there are various factors identified as causing accidents which could be addressed via better training including: ineffective use of technology; inadequate training/experience; rule violation; inappropriate/ineffective maintenance; poor emergency response; unsafe speed; inappropriate use of technology and overloading.

Finally the analysis also clearly indicates areas where management practices need to be addressed and where it can be inferred that shore-based managers need to place greater priority on safety and less emphasis on commercial considerations (e.g. with regard to weather routing, crewing, loading, and ensuring that equipment manuals are readily available in appropriate languages on board).

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