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Behind the Headlines? An Analysis of Accident Investigation Reports

Lijun Tang, Iris Acejo, Neil Ellis, Nelson Turgo & Helen Sampson

Abstract

This paper reports on an analysis of 319 accident investigation reports published over a ten-year period by four maritime authorities. In doing so it highlights the immediate and contributory causes identified by the report authors and aggregates these to create an impression of the major causes of accidents as identified by investigators over a decade. The aggregation and analysis suggest that non-seafarer related factors constitute more than one quarter of all the causes identified in the reports. In particular, third party deficiencies, poor design, and technical failure are prominently identified as causes of ‘fire and explosion’ and ‘lifeboat’ accidents. In ‘grounding’ and ‘collision, close quarter & contact’ accidents, causes such as ‘poor judgement/operation’, ‘failure in communication/coordination’, and ineffective/inappropriate use of technology stand out. Of greatest overall concern to accident investigators was ‘inadequate risk management’ and ‘failure in communication’ despite the implementation of the ISM Code. In addition to the aggregate analysis presented, the paper offers illustrative examples from specific accident investigation reports whilst acknowledging the complexities of accident causation and the dangers of oversimplification in the assignation of accident cause.

Introduction

It is evident that maritime safety has 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. Each report offers a detailed account of what took place and attempts to identify all the relevant factors and contributory causes. While they 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 general patterns and identify more general 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 paper, which reports on an analysis of

319 accident investigation reports published over a ten-year period¹ (from 2002 to 2011). Among these 319 accidents, 148 were investigated by the (UK) Maritime Accident Investigation Branch (MAIB), 110 by the Australian Transportation Safety Board (ATSB), 43 by Maritime New Zealand, and 18 by the (US) National Transportation Safety Board (NTSB)².

Method of analysis

Each report was given a first reading by an individual member of the research team (of five). All elements of the report were read in this initial phase (synopses and findings/conclusions). The synopsis provides an overview of an accident, and the findings/conclusion gives the causes and contributory factors that led to the accident. While reading, the researcher summarised detailed causes and contributory factors into abstract ‘categories’, which were used to code the causes of each accident. In this process, categories were refined and collapsed as required. At the end of the process, twenty-three categories had been arrived at, and these went on to be used throughout the analysis. As such, the categories are fully grounded in data, i.e. the accident investigation reports, rather than being adopted from any existing and pre-defined model. The scheme will be explained in the next section.

In the next stage of the research, four researchers were divided into two groups. Each group was tasked to analyse half of the 319 accident reports and categorise the *immediate causes* and *contributory causes* of each accident using the above mentioned scheme. *Immediate causes* refer to causes that directly lead to the accidents at the end of error chains, while *contributory causes* are defined as those that either lead to the immediate causes or create conditions for immediate/contributory causes to arise. The researchers read the full content of each report and categorised the causes individually. After both the researchers in a pair had finished a number of reports (five or ten), they came together to check each other’s categorisation. If there were differences in their assessment they would discuss these until they arrived at a consensus. A fifth researcher was available to assist in interpretation where agreement could not easily be arrived at. The research pairs would then move on to analyse the next five or ten reports individually. In the end, the two groups combined their results into

¹ Only accidents involving vessels of 1,000 GRT or above are included.

² NTSB published 41 accident reports online during this ten-year period, and only 18 of them involved vessels of 1,000 GRT or above.

one dataset for statistical analysis using the Statistical Package for the Social Sciences (SPSS).

Categorisation scheme and brief explanation

Accident types

The accidents were categorised into five types : 1) collision, close quarter & contact, 2) grounding, 3) fire and explosion, 4) lifeboat accident, and 5) other, such as crane failure, man overboard, cargo loss, engine room flooding, trip and fall, parting of mooring lines, oil spill, etc (see Table 1).

Table 1: Frequencies of different types of accidents

	Frequency	Percent
Collision, close quarter & Contact	99	31.0
Grounding	62	19.4
Fire & explosion	33	10.3
Lifeboat	13	4.1
Other	112	35.1
Total	319	100.0

Accident 'causes' were categorised into the following groups:

1. Alcohol/drug: under the influence of alcohol or drug.
2. Fatigue.
3. Under-manning.
4. Distraction: watch keepers are distracted by phone-calls, paperwork, music, or other activities irrelevant to navigation
5. Inadequate lookout.
6. Unsafe speed.
7. Ineffective use of technology: situations in which technology/equipment is not used to its full potential
8. Inappropriate use of technology: overdependence on, or misuse of, technology/equipment.

9. Failure in communication/coordination: including ineffective bridge/engine room resource management, ineffective co-ordination between crew members during ship operations (Note: communication failure involving a pilot is singled out).
10. Inadequate training/experience.
11. Inappropriate/ineffective maintenance.
12. Inadequate risk management: including inadequate safety management system (SMS) in the company or on-board, no clear procedures, etc. (Note: maintenance issue is singled out).
13. Poor emergency response.
14. Poor judgement/operation: including poor judgements/operations of officers or unexplained mistakes by ship operators.
15. Overloading: cargo or passenger overloading.
16. Rule violation: regulations, rules, or procedures are violated.
17. Ineffective communication between pilot/master.
18. Pilot error/mishandling.
19. Lack of manufacturer guidance: manuals are unclear, not up to date, or contain wrong information.
20. Poor design.
21. Third party deficiency: involving third parties other than pilots and manufacturers. Examples include: regulatory bodies that do not have relevant rules, port authorities that do not provide sufficient navigational aids, erroneous chart information, mistakes by contractors.
22. Weather/other environmental factors: including bad weather, shallow water, strong current, etc.
23. Technical failure

These causes can be further divided into two big groups: causes not directly related to seafarers/ship operators (18-23), and causes directly related to seafarers/ship operators (1-17).

Findings

Overall picture

Looking at the immediate causes, ‘poor judgement/operation’ was the most frequently found cause of accidents (18.2%), followed by ‘technical failure’ and ‘inadequate look out’ which accounted for 12.5% and 11.9% of causes respectively. Two causes were identified that concern communication specifically: ‘failure in communication/coordination’ and ‘communication problem between captain/pilot’. Combined together as a new category of ‘failure in communication’ these constitute the fourth highest immediate cause of accidents at sea (9.4% in total). The frequencies of all causes are summarised in Table 2. Overall, causes which were identified as being directly related to seafarers/ship operators were found 260 times, and causes not directly related to seafarers/ship operators were identified 118 times. This indicates that in the judgement of the accident investigators concerned, non-seafarer related factors directly accounted for around one third of accidents (however note the complexities here as identified by Ghanem, 2009).

Table 2: Immediate causes

Immediate causes	No. of cases	Percentage of cases
Poor judgement/operation	58	18.2
Technical failure	40	12.5
Inadequate lookout	38	11.9
Inadequate risk management	29	9.1
Inappropriate/ineffective maintenance	25	7.8
Inadequate training/experience	24	7.5
Third party deficiency	24	7.5
Failure in communication/coordination	22	6.9
Weather/other environmental factors	20	6.3
Pilot error/mishandling	19	6
Rule violation	16	5
Poor design	13	4.1
Fatigue	12	3.8
Communication problem between captain/pilot	8	2.5
Alcohol/drugs	7	2.2
Unsafe speed	7	2.2
Inappropriate use of technology/equipment	6	1.9
Overloading	4	1.3
Ineffective use of technology/equipment	3	0.9
Lack of manufacturer guidance	2	0.6
Distraction	1	0.3

In terms of contributory factors, ‘inadequate risk management’ was the most prominent contributing factor by quite a margin (36.7%). The next most frequent contributory factor was ‘third party deficiency’ (21.9%), followed by ‘inadequate training/experience’ (19.7%), and ‘failure in communication/coordination’ (18.5%). If we combine ‘failure in communication/coordination’ and ‘communication problem between captain/pilot’ into ‘failure in communication’, then this combined cause constitutes the second highest contributory cause of accidents in this analysis (22.6% in total). Thus ‘failure in communication’ featured prominently both in relation to immediate and contributory causes. All contributory factors are summarised in Table 3. Overall causes directly related to seafarers/ship operators appeared 555 times, and causes not directly related to seafarers/ship operators appeared 186 times. Around one quarter of contributory causes were therefore assessed, by the investigators concerned, to be non-seafarer related.

Table 3: Contributory causes

Contributory causes	No. of cases	Percentage of cases
Inadequate risk management	117	36.7
Third party deficiency	70	21.9
Inadequate training/experience	63	19.7
Failure in communication/coordination	59	18.5
Ineffective use of technology/equipment	49	15.4
Weather/other environmental factors	44	13.8
Rule violation	41	12.9
Poor design	33	10.3
Fatigue	32	10
Poor judgement/operation	31	9.7
Inappropriate/ineffective maintenance	28	8.8
Under- manning	27	8.5
Poor emergency response	25	7.8
Distraction	22	6.9
Inappropriate use of technology/equipment	20	6.3
Inadequate lookout	17	5.3
Lack of manufacturer guidance	16	5
Technical failure	15	4.7
Communication problem between captain/pilot	13	4.1
Unsafe speed	8	2.5
Pilot error/mishandling	8	2.5
Overloading	3	0.9

Immediate and contributory causes of different types of accidents

It is likely that different types of accidents (for example grounding and fire) are associated with different perceived causes. We therefore gave consideration to the different types of accidents to identify any such patterns.

Collision, close quarter & contact accidents

In relation to collision close quarter & contact accidents, 'inadequate lookout' and 'poor judgement/operation' were the two most common immediate causes identified by accident investigators: while the former was featured in 35.4 per cent of cases, the latter was identified in 26.3 per cent. Two other prominent immediate causes emerged: 'pilot error/mishandling' (13.1%) and 'rule violation' (12.1%) (see Figure 1a).

'Failure in communication/co-ordination' was also identified as an immediate cause of collision, close quarter & contact accidents. Not only was this identified as directly leading to such accidents (in 10.1% of cases see Figure 1a), it also featured as a contributory cause that was identified in a high number of cases (26.3% see Figure 1b).

Use of technology/equipment featured prominently in the accounts of accident investigators as a contributory cause. 'Ineffective use of technology' and 'inappropriate use of technology' were identified in 31.3 per cent and 11.1 per cent cases respectively. In such cases technology had generally not been used to its full potential or had been misused in ways which negatively affected watchkeeping and/or ship operations and resulted in collisions, close quarters, or contacts with fixed objects (see Figure 1b). 'Inadequate training/experience' and 'third party deficiency' were also highlighted by accident investigators and each of these causes feature in 20 per cent of all cases (see Figure 1b).

Figure 1a: Immediate causes of collision, close quarter & contact accidents

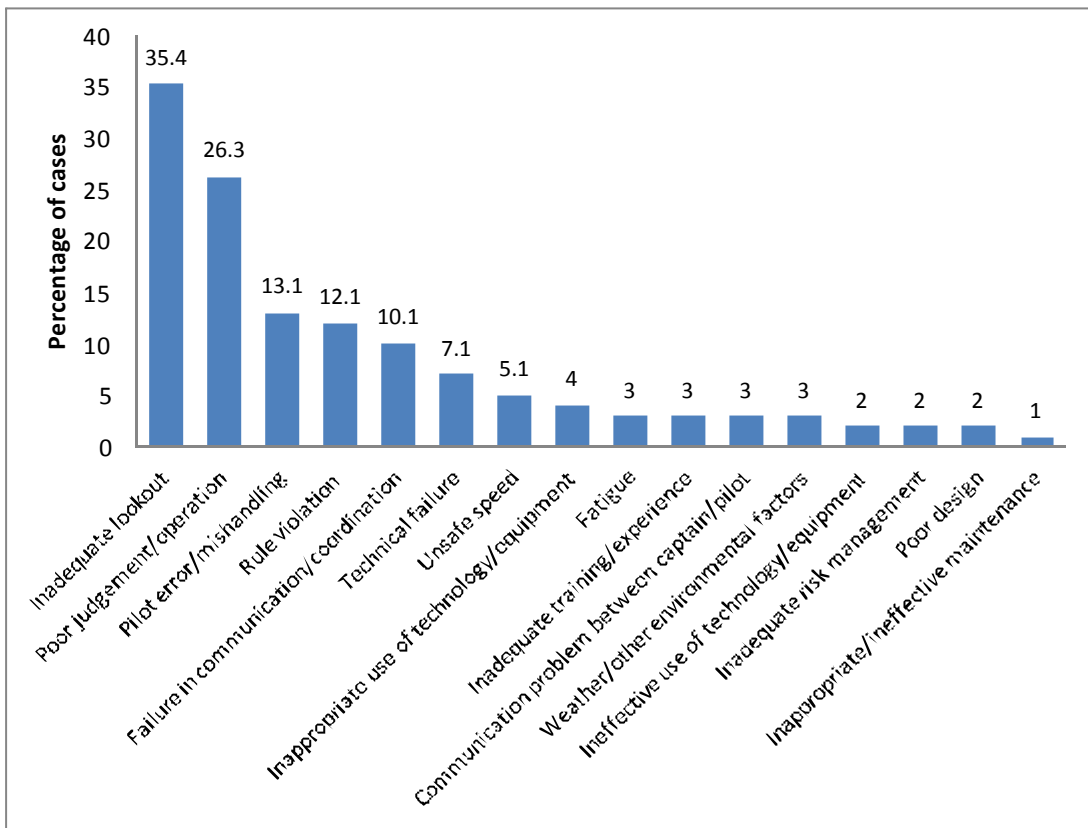
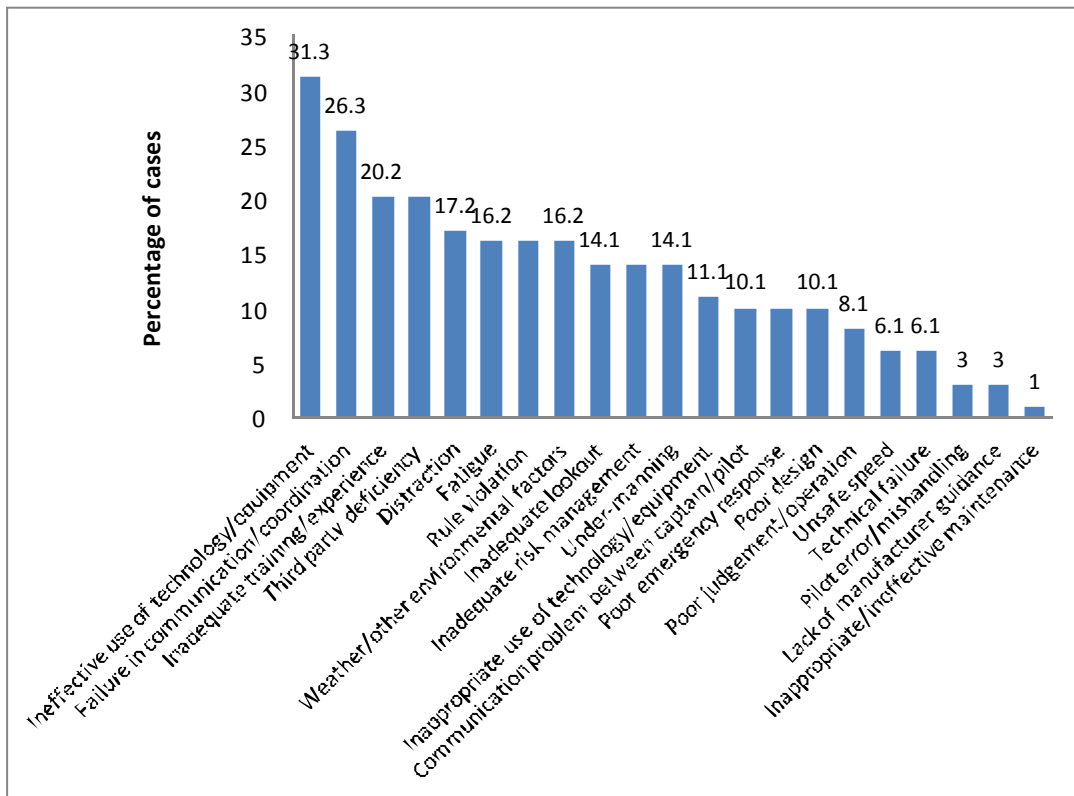


Figure 1b: Contributory causes of collision, close quarter & contact accidents



The case of the collision between the *Atlantic Mermaid* and *Hampoel* in June 2001 illustrates some of these findings. In this incident the overtaking vessel, *Atlantic Mermaid*, failed to stay clear of the slower vessel *Hampoel* which similarly failed to take action to avoid a collision once it was apparent that a high risk of such collision existed. At the time of the collision *Atlantic Mermaid* was ballasting the forepeak and the trim and vessel's ballast condition produced a blind spot from the bridge of around 50-70 metres. The second officer and helmsman who were on the bridge with the Master were attending to non-watchkeeping duties. This rendered the Master, who had a headache, was new to the company, had only recently joined the vessel, and may have been fatigued, the sole watchkeeper and lookout. In addition the radars on the vessel were reported to be substandard. The report notes that:

The pilot who had recently been on the vessel described the radars as “appalling” and “difficult to use”. He said that the overall quality of radar picture was “poor” and that he had to work on longer ranges than he normally would to obtain a clear picture. (MAIB 2002a:20)

In relation to *Atlantic Mermaid* the MAIB made the following recommendations to Elmira Shipping and Trading:

1. Ensure that all of its vessels are fitted with radars which are in good working order, such that a proper radar watch can be kept.
2. Ensure that identified deficiencies to navigational equipment on its vessels are promptly and effectively rectified.
3. Ensure that there are sufficient bridge watchkeepers on its vessels at all times.
4. Ensure that the ability to keep a proper watch is not constrained by:
 - Additional tasks to watchkeeping
 - Lack of movement for all round visibility
 - Fatigue
 - Reduced vigilance (MAIB 2002a:28)

Grounding

‘Failure in communication/co-ordination’ was the most prominent cause identified by accident investigators in grounding incidents. This was suggested to have immediately led to groundings in 14.5 per cent of cases, and it was said to have contributed to the grounding of vessels in 33.9 per cent of cases (see Figure 2a and 2b). Other immediate causes of

groundings were found to be ‘fatigue’ (an immediate cause in 11.3% of cases), ‘poor judgement/operation’ (11.3%), weather conditions (11.3%) and technical failure (11.3%). While ‘inadequate risk management’ was the most visible contributory cause of grounding incidents, failure in communication/co-ordination (33.9%), and use of technology/equipment also appeared as a noteworthy contributory factors here. ‘Ineffective use of technology’ and ‘inappropriate use of technology’ were identified in 25.8 per cent and 12.9 per cent of cases respectively.

In terms of ‘third party’ causes of groundings pilots were most prominent in collision, close quarter & contact accidents and also in groundings. ‘Pilot error/mishandling’ directly led to 13.1 per cent of the first type of accidents (see Figure 1a) and slightly less than ten per cent of grounding incidents. Further to this, ‘communication problem between captain/pilot’ was considered by accident investigators to be directly responsible for just over eight per cent of groundings and three per cent of collisions.

Figure 2a: Immediate causes of groundings

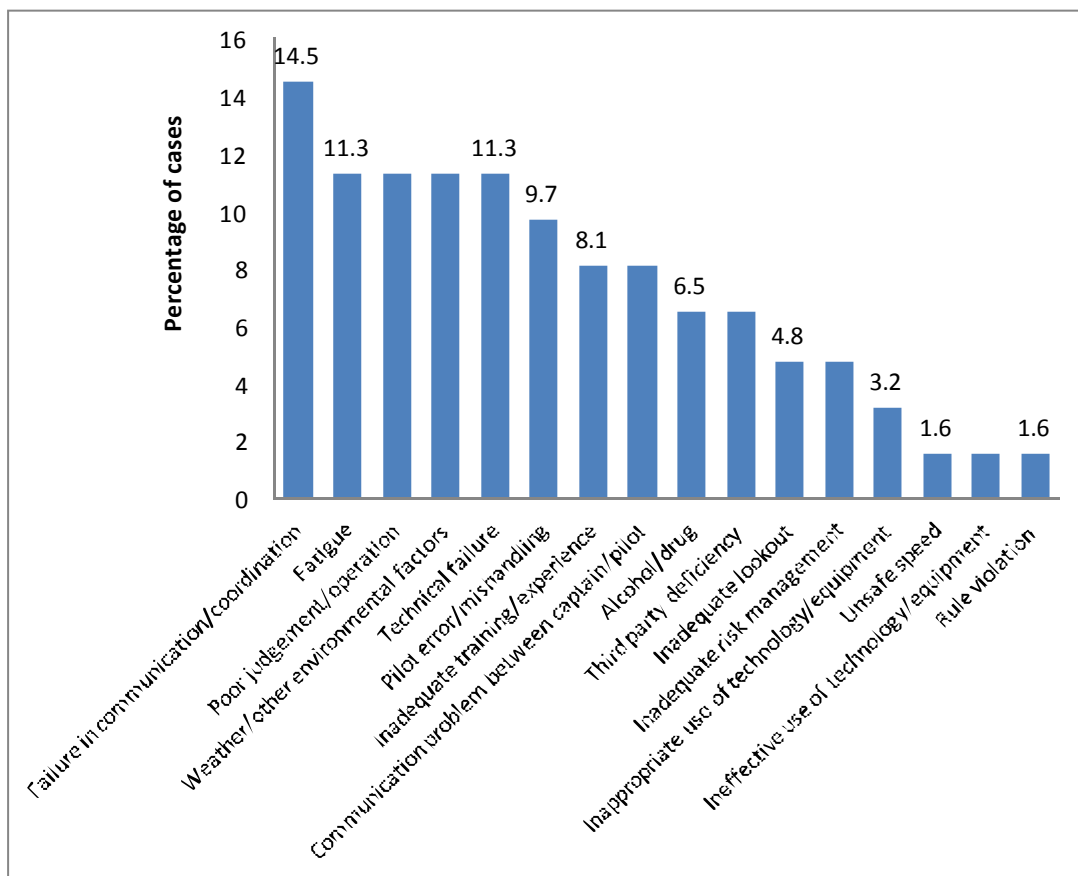
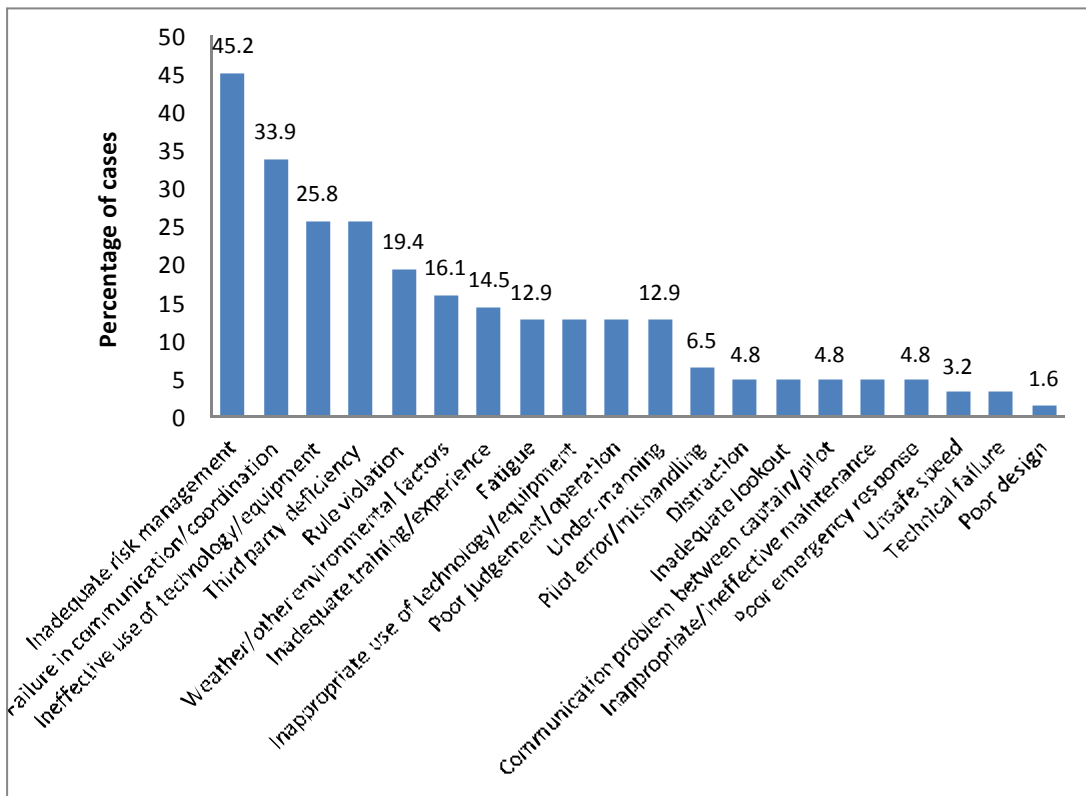


Figure 2b: Contributory causes of groundings



The case of the British-flagged general cargo vessel *MV Lerrix* which grounded in the Baltic Sea in October 2005, illustrates some of the factors which were commonly identified by inspectors when reporting on groundings. In this case several factors were identified by inspectors to have contributed to the incident. The master was fatigued as a consequence of the 6-on/6-off watchkeeping system that was in place, the watch alarm was not functioning and the master was alone on the bridge. The accident investigation report made reference to a study commissioned by the Chief Inspector of Marine Accidents in 2003. This study considered 23 vessels involved in groundings and concluded that:

Nearly 50% (11 cases) occurred between 0000 and 0600 of which fatigue was considered a contributory factor in nine of the cases.

In eight of those nine fatigue related accidents, the vessels:

- Carried only two watchkeeping officers.
- Had not posted a lookout.
- Were steering by autopilot.
- Were not fitted with, or were not using a watch alarm.
- Had an unaccompanied watchkeeper who had fallen asleep. (MAIB 2006:28)

Lifeboats

In relation to lifeboat incidents, ‘inappropriate/ineffective maintenance’ (38.5%), ‘inadequate training/experience’ (23.1%), and poor judgement/operation (23.1%) were identified most frequently by accident investigators as immediate causes of accidents, and ‘inadequate training/experience’ (38.5%) was noteworthy as a contributory cause (see Figure 3a and 3b respectively). Furthermore, ‘poor design’ and ‘third party deficiency’ were also identified relatively frequently by accident investigators as contributing to accidents involving lifeboats as both an immediate and a contributory cause.

Figure 3a: Immediate causes of lifeboat accidents

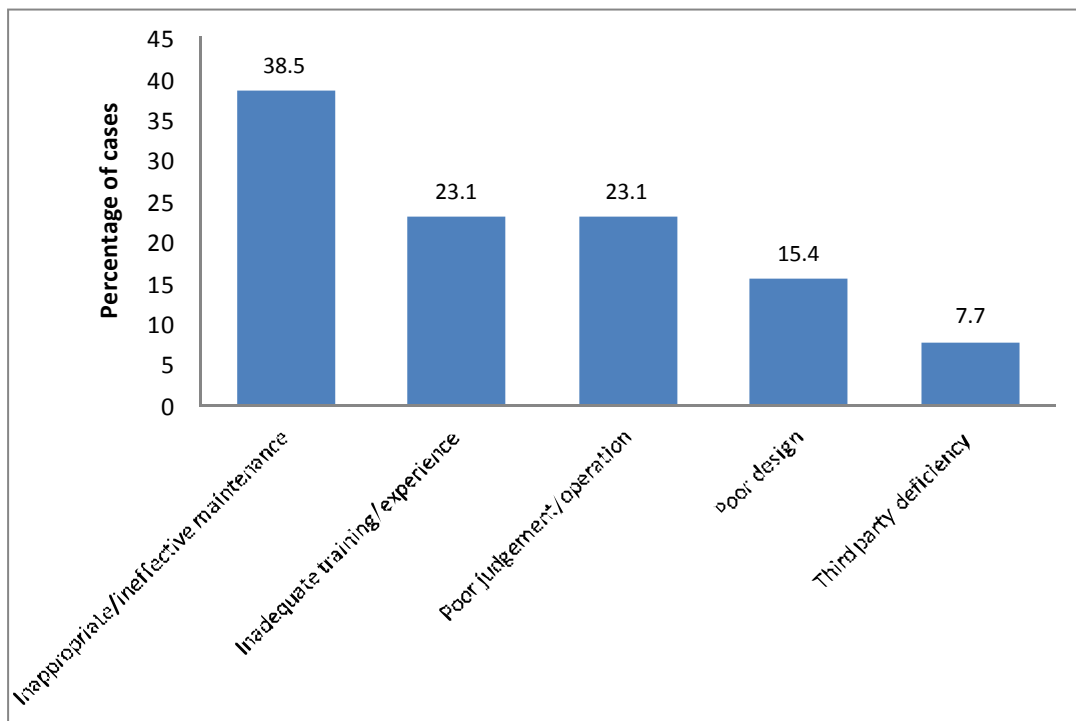
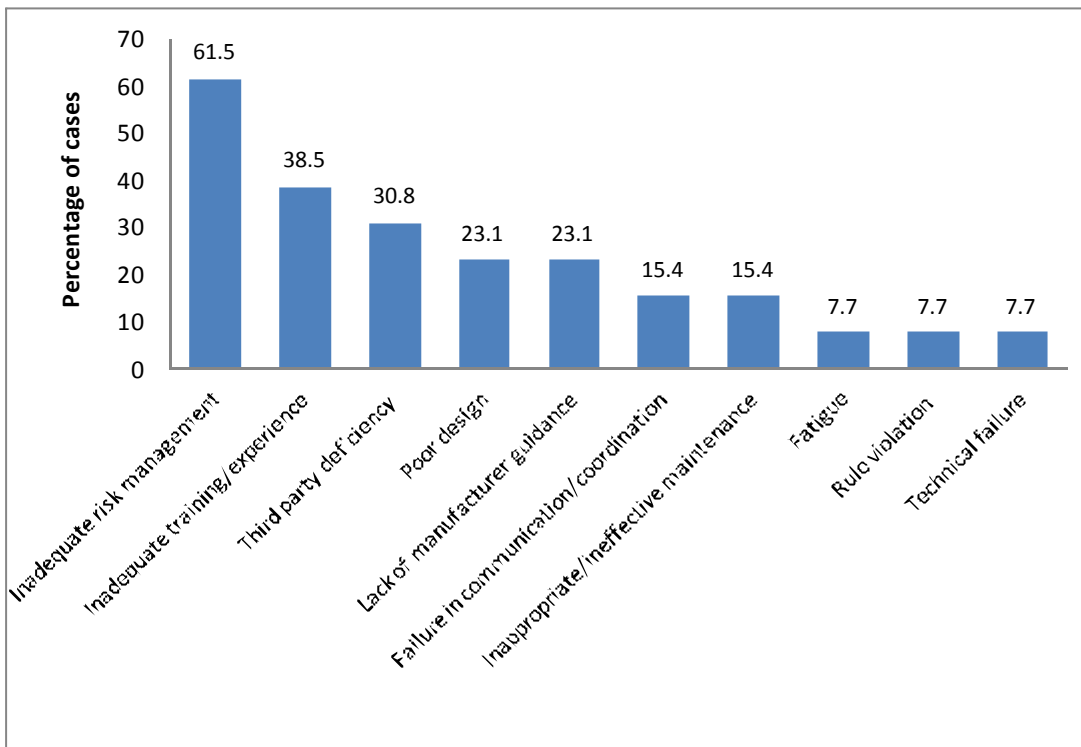


Figure 3b: Contributory causes of lifeboat accidents



The case of the Turkish bulk carrier *Gulser Ana* is illustrative of the kinds of issues which were most frequently identified by accident investigators in relation to lifeboat accidents. In October 2001, the *Gulser Ana* was detained in Belfast harbour by MCA inspectors and following the detention two members of the crew engaged in efforts to rectify poor maintenance of the starboard lifeboat whilst it was on the water. Once satisfied that their task was complete the boat was hoisted to embarkation level where it remained suspended by its falls. The chief officer of the vessel boarded the lifeboat, joining the two crewmembers already on-board, to inspect the work. Within less than a minute the forward hook released dropping the forward end of the lifeboat and throwing the three seafarers into the water. The chief officer was rendered unconscious and was not wearing a lifejacket, however, his fellow crewmen (who were in lifejackets) were able to pull him to the surface of the water and keep him afloat until they were picked up by the pilot launch.

The report describes failures in maintenance, understanding, and risk management, and states that:

The following evidence, found on-board, indicated that the vessel's operator had shied away from its responsibilities to ensure that *Gulser Ana*'s crew maintained and operated the lifeboat hook release mechanism safely:

- Nobody on-board had been trained in its use.
- The manufacturer's manual was written in poor English, which was difficult even for a native speaker of English to understand.
- None of the manuals were written in the working language of the crew.
- There were no written procedures or plans to ensure that repairs were undertaken safely.
- No formal risk assessment had been carried out on the work to be done, and there was no procedure in place to require such an assessment to be completed. (MAIB 2002b:15)

In relation to the manual the report further adds that the manual was not simply deficient but was in fact highly misleading. The investigators state that:

Much of that described in the manual was unclear or misleading. For example, it read "but the releasing handling does not operate other than after the boat was waterborne". On the contrary, this handle did operate the release mechanism with the lifeboat out of the water. (MAIB 2002b:15)

Fire and Explosion

Investigators seeking to understand the causes of fire and explosion raised concern with 'technical failure' and 'third party deficiency' as the most frequent immediate causes in terms of these kinds of incidents (see Figure 4a). Inadequate risk management was the most frequently found contributory cause in terms of fire and explosion and this was identified in a large number of cases (51.5%, see Figure 4b). In addition, maintenance and training and emergency response were also issues reflected in fire and explosion accident reports. 'Inappropriate/ineffective maintenance' was identified as an immediate cause in 12.1 per cent of cases and as a contributory cause in 24.2 per cent of cases. 'Inadequate training/experience' was identified as an immediate cause in just over nine per cent of cases and as a contributory cause in 21.2 per cent of cases. Poor emergency response was as a contributory factor in nearly a quarter of all incidents (24.2%).

Figure 4a: Immediate causes of fires and explosions

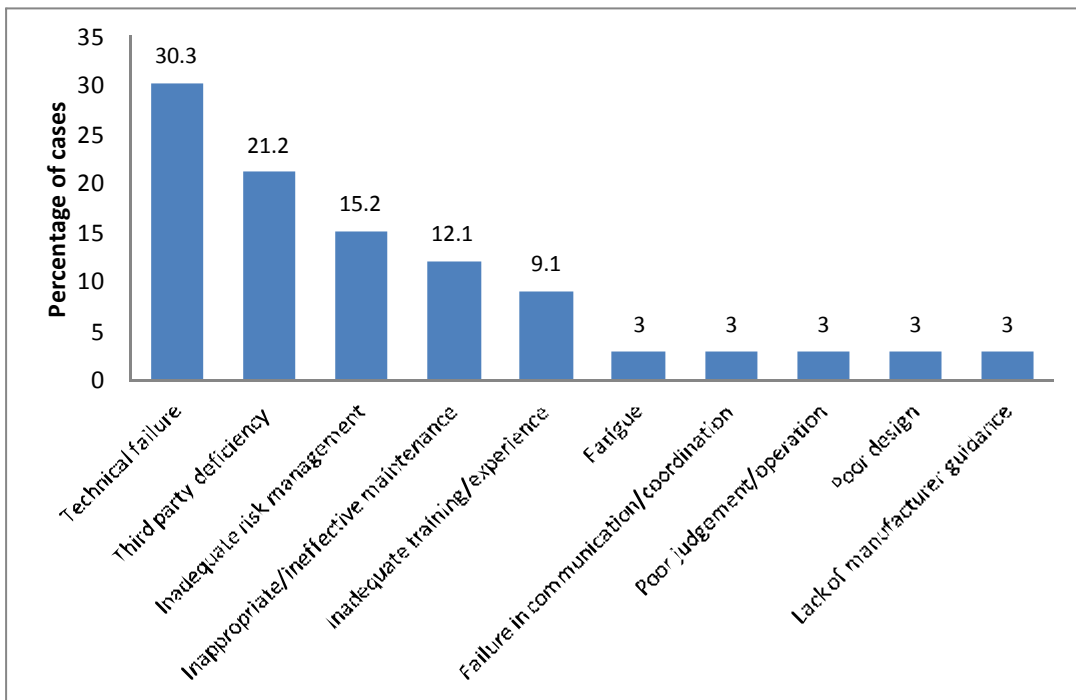
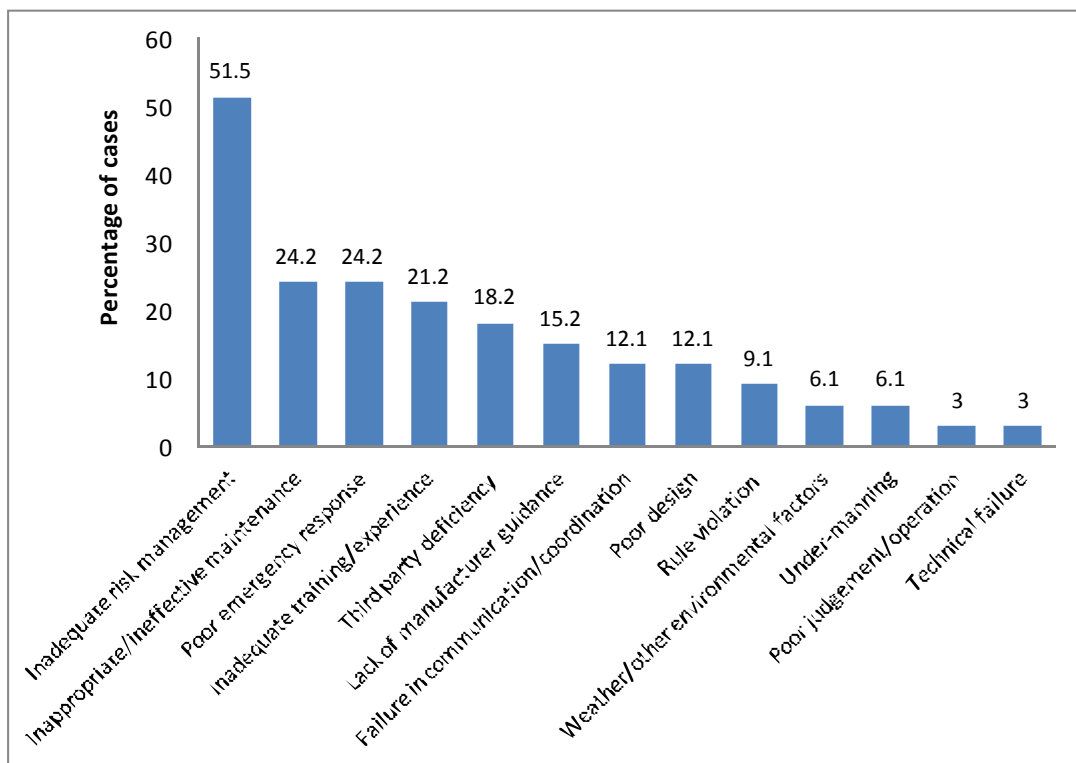


Figure 4b: Contributory causes of fires and explosions



The case of a fire in the engine room of the Cypriot-registered cruise vessel *Calypso* highlights some of these factors. The fire was caused by the failure of a low pressure fuel pipe flange which in the absence of a guard sprayed fuel onto the adjacent turbocharger (and possibly exhaust piping) immediately resulting in the fire. The engine manufacturer had become aware of the weakness in the flange design and had issued a technical bulletin recommending modifications to such flanges. However, aboard *Calypso* these modifications had never been made. Subsequent attempts to fight the fire were deeply flawed and the report suggests that it was fortunate that fatalities did not occur:

The fire was intense, and the subsequent fire-fighting response highlighted flaws in the knowledge, experience and training of some of the ship's senior officers. Those on-board believed that the fire had been successfully extinguished by the quick use of the fixed CO₂ fire smothering system. The fire had, in fact, died down mainly as a result of fuel starvation due to the quick action of the watchkeeping engineer officer. Those in charge of the fire-fighting response did not appear to follow recognised good practice. The attempt to release CO₂ was made from the CO₂ room, and not from the appropriate remote operating station, from where mistakes were less likely to have occurred. The person tasked to release the CO₂ was not the person designated on the muster list. On a number of separate occasions soon after they thought CO₂ had been released, senior officers re-entered the engine room without the proper equipment or back-up and with the consequent risk of allowing air to feed the fire.

The officer, who had attempted to release the CO₂, had mistaken timer bottles for pilot cylinders and it subsequently transpired that, unbeknown to anyone on-board, no CO₂ had been released in the immediate aftermath of the fire. The CO₂ system was not checked and made secure after the fire, and it had been left in a dangerous condition with distribution and other valves open and all the cylinders still full. During the investigation into the cause of the fire, after the vessel's arrival in Southampton, CO₂ from a bank of cylinders was accidentally released into the engine room. In the event, three crew were lucky to escape without loss of life or serious injury. (MAIB 2007:1).

Other accidents

Whilst it may not make sense to attempt to identify patterns in relation to the varied category 'other accidents' poor judgement/operation and inadequate risk management were frequently identified by investigators as an immediate cause (inadequate risk management was identified in 17.0% of cases as an immediate cause, and in 44.6% as a contributory cause). The causes are shown in Figure 5a and 5b).

Figure 5a: Immediate causes of other accidents

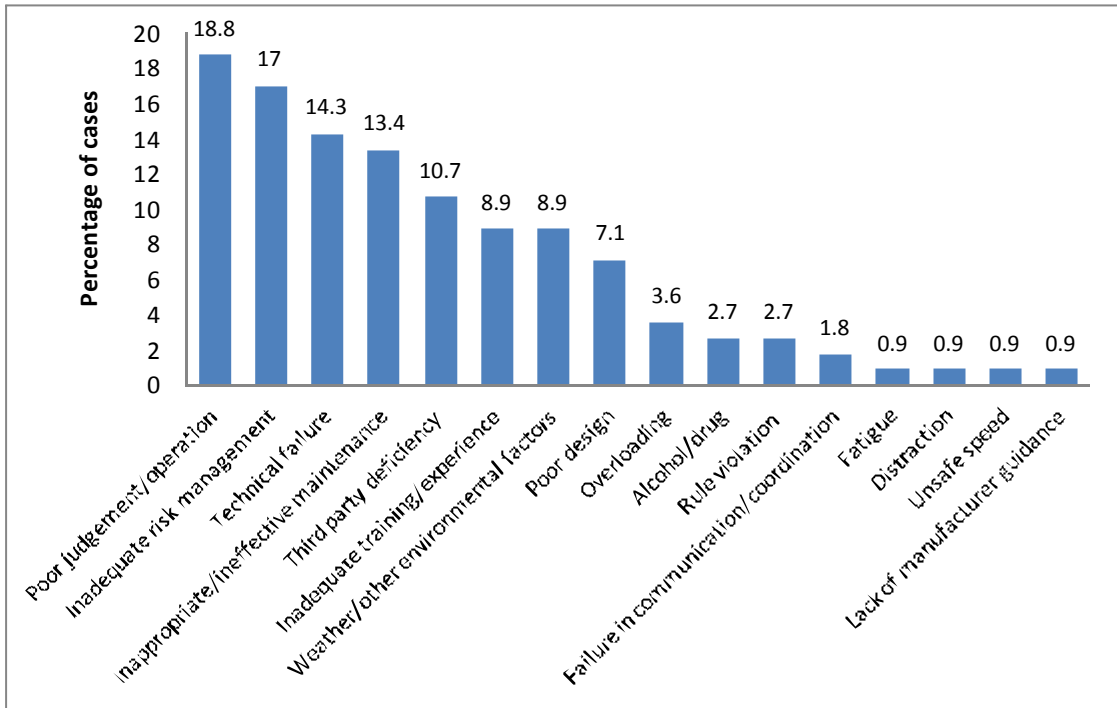
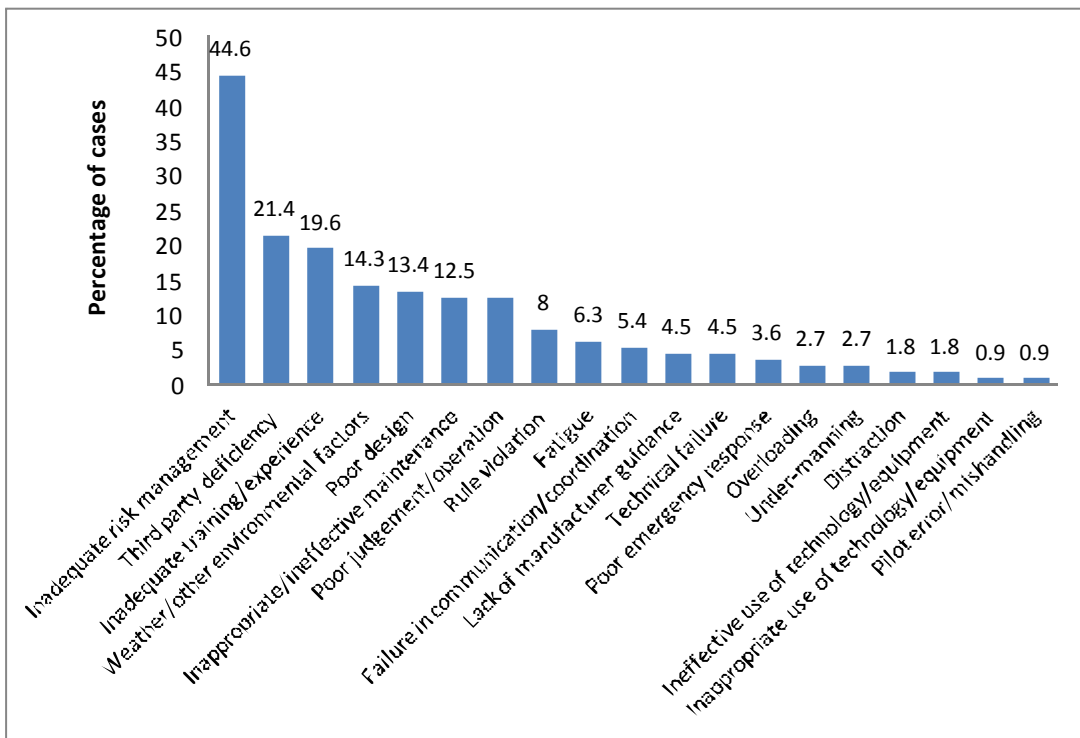


Figure 5b: Contributory causes of other accidents



Combined causes of accidents

In combining the immediate and contributory causes together the overall picture (see Table 4) that emerges suggests that in descending order the following factors were identified by accident investigators most frequently: inadequate risk management; third party deficiencies; poor judgement/operation; inadequate training/experience; failure in communication/coordination; weather/environmental factors; rule violations; inadequate lookout; technical failure; inappropriate/ineffective maintenance; ineffective use of technology/equipment; poor design; and fatigue.

Table 4: Overall Picture (all causes combined)

Causes	No. of cases	Percentage of cases
Inadequate risk management	146	45.8
Third party deficiency	93	29.2
Poor judgement/operation	89	27.9
Inadequate training/experience	85	26.6
Failure in communication/coordination	81	25.4
Weather/other environmental factors	64	20.1
Rule violation	57	17.9
Inadequate lookout	55	17.2
Technical failure	55	17.2
Inappropriate/ineffective maintenance	53	16.6
Ineffective use of technology/equipment	52	16.3
Poor design	46	14.4
Fatigue	44	13.8
Pilot error/mishandling	27	8.5
Under-manning	27	8.5
Inappropriate use of technology/equipment	26	8.2
Poor emergency response	25	7.8
Distraction	23	7.2
Communication problem between captain/pilot	21	6.6
Lack of manufacturer guidance	18	5.6
Unsafe speed	15	4.7
Alcohol/drugs	7	2.2
Overloading	7	2.2

Again, examining the five types of accidents individually in terms of combined causes (the graphs of combined causes of each type of accidents are provided in the Appendix), we observe the following patterns :

- ‘Inadequate risk management’ was identified as the most frequent cause in relation to four types of accidents: fire and explosion (66.7%), other accidents (61.6%), lifeboat accidents (61.5%), and grounding (50%).
- ‘Third party deficiency’ was more prominent in fire and explosion (39.4%), lifeboat accidents (38.5%), groundings (32.3%), and other accidents (31.3%).
- ‘Poor judgement/operation’ was a more commonly identified feature of collision, close quarter & contact accidents (34.3%), and other accidents (31.3%).
- ‘Inadequate training/experience’ was identified as a cause of lifeboat accidents (61.5%) and fire and explosion (30.3%).
- ‘Failure in communication/coordination’ was identified by accident investigators more frequently in relation to groundings (48.4%) and collision, close quarter & contact accidents (36.4%).
- ‘Weather/environmental factors’ were seen by investigators to have contributed more often to groundings (27.4%) and other accidents (23.2%).
- ‘Rule violations’ were regarded as more prominent in collision, close quarter & contact accidents (28.3%), and groundings (21%).
- ‘Inadequate lookout’ was understandably identified as a major cause of collision, close quarter & contact accidents (49.5%).
- ‘Technical failure’ was identified in fire and explosion (33.3%).
- ‘Inappropriate/ineffective maintenance’ was frequently identified as a cause in relation to lifeboat accidents (53.8%), and fire and explosion (36.4%).
- ‘Ineffective use of technology/equipment’ was identified as a problem in collision, close quarter & contact accidents (33.3%), and groundings (27.4%).
- ‘Poor design’ was a factor identified by investigators in relation to lifeboat accidents (38.5%).
- ‘Fatigue’ featured more frequently as an explanation for groundings in accident investigation reports (24.2%).

Conclusions

Despite the positive improvements in maritime safety over the years, the safety of shipping is still an area giving rise to concern. This paper has attempted to offer insight into past accidents by analysing and aggregating the findings of 319 accident investigation reports

produced by four maritime authorities over a ten-year period. While all such reports are social constructions and as a result, in their production, they are subject to a number of influences, they nevertheless provide us with valuable information about the kinds of factors which have been previously seen by accident investigators as underpinning accidents at sea. The findings indicate that in many cases the factors that are identified by investigators as underlying accidents at sea fall outside the influence of seafarers (a third of incidents could be considered in this analysis to be 'non-seafarer related'). For example, 'third party deficiency', 'poor design', and 'technical failure' were prominent causes identified in relation to fire and explosion and lifeboat accidents. In the judgement of accident investigators seafarers were implicated more frequently in relation to groundings and collision and close quarter & contact accidents, where 'poor judgement/operation', 'failure in communication/coordination', and ineffective/inappropriate use of technology were identified more frequently. In the light of the ISM code and the implementation of safety management systems on-board it is perhaps unsurprising to find many accidents being identified as involving 'inadequate risk management'. What may be a greater surprise to the non-maritime world, in the light of high-profile cases such as the 2012 incident involving the *Union Moon*³ (where a Polish Master on-board *Union Moon* was found to be under the influence of alcohol), is the very small number of cases which featured alcohol or substance abuse as explanatory factors in relation to accidents at sea.

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³ This incident is not included in the numeric analysis presented herein as it was only reported in 2012 i.e. after the cut off date of 2011.

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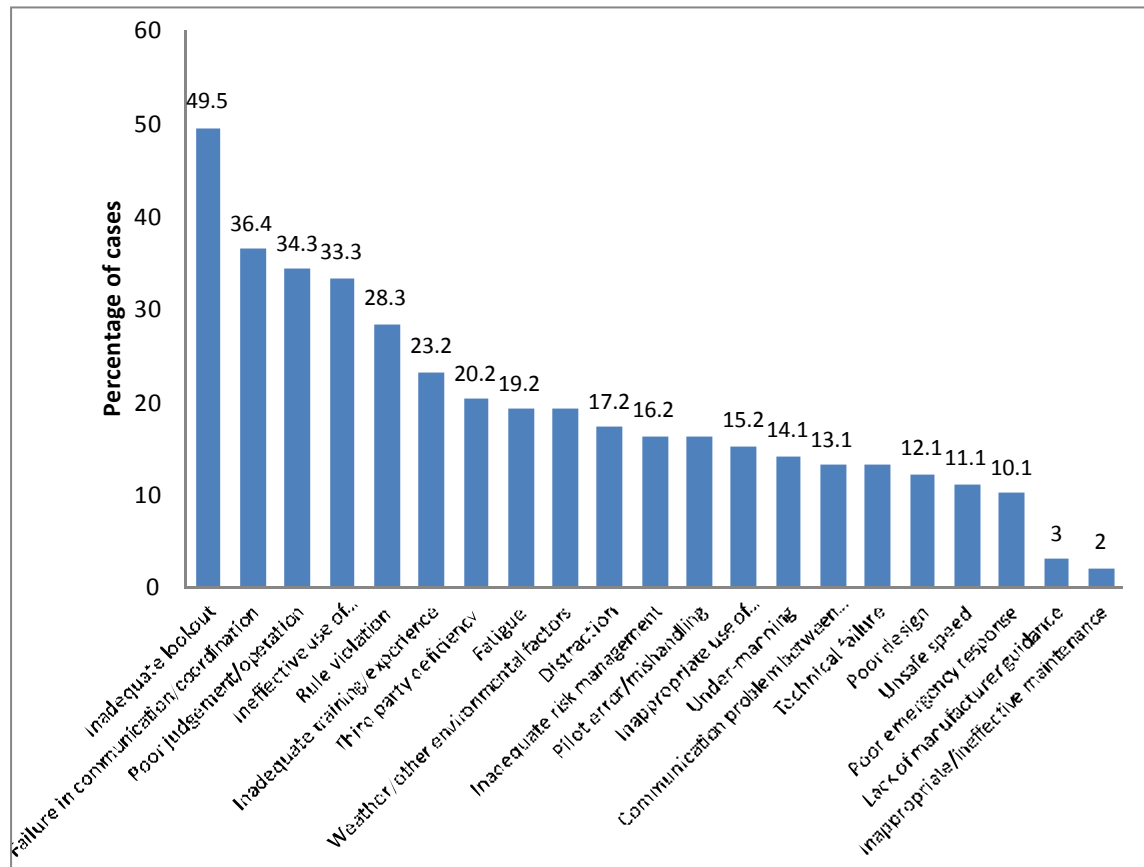
MAIB (2006) Report on the investigation into the grounding of *MV Lerrix* off the Darss peninsular, Baltic Sea Germany 10 October 2005. http://www.maib.gov.uk/cms_resources.cfm?file=/Lerrix.pdf

MAIB (2007) Report on the investigation of the engine room fire on-board the passenger cruise vessel *The Calypso* 16 miles south of Beachy Head 6 May 2006. http://www.maib.gov.uk/cms_resources.cfm?file=/The%20Calypso.pdf

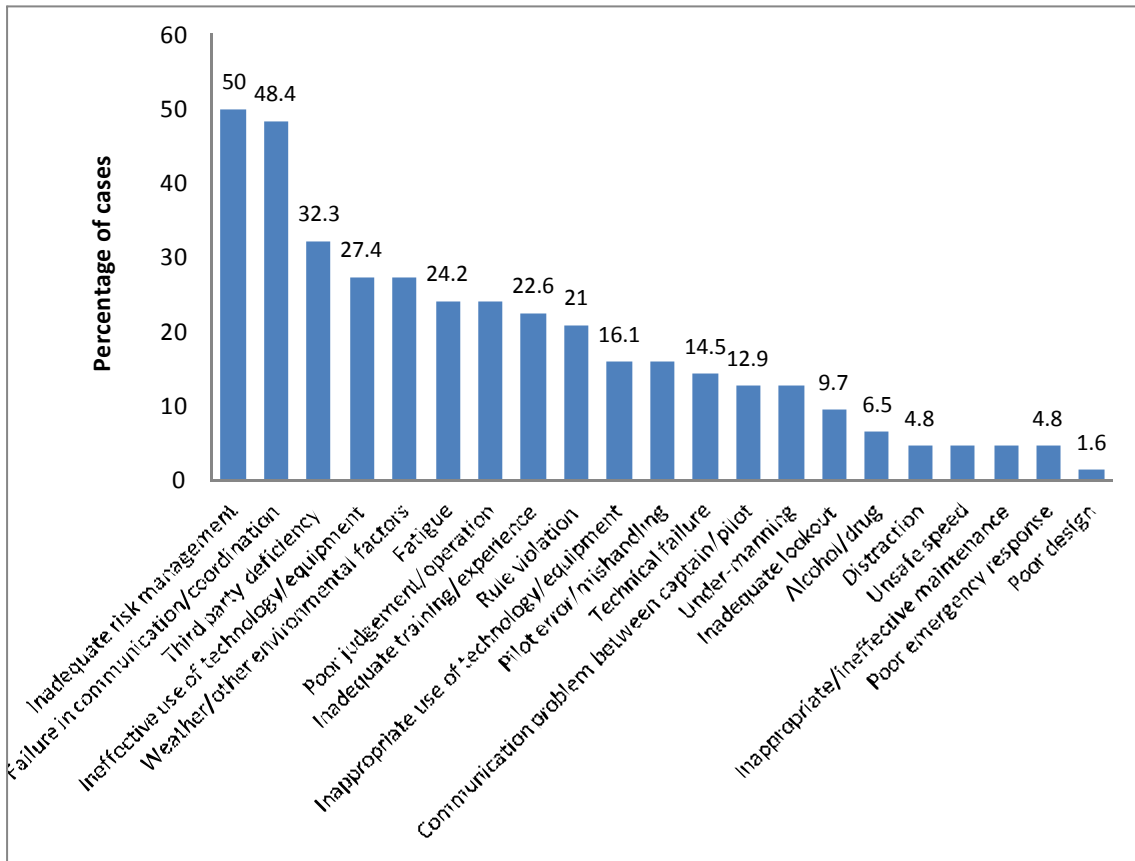
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Appendix: combined causes of each type of accidents

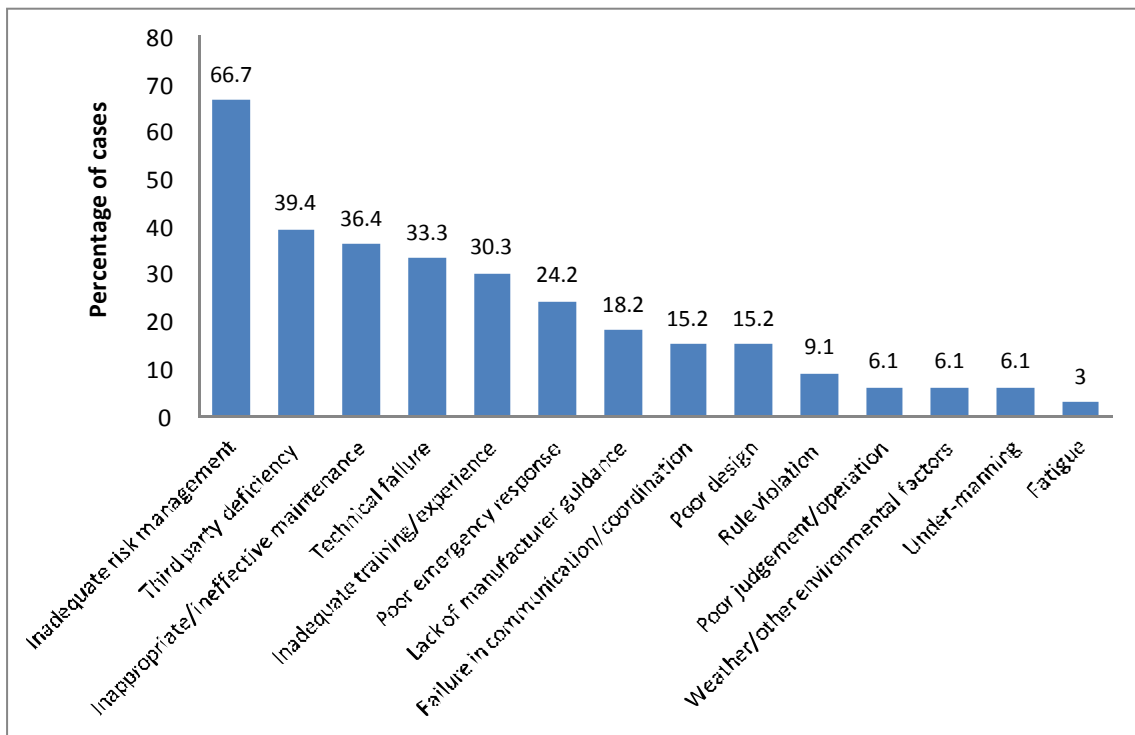
Collision, close quarter & contact



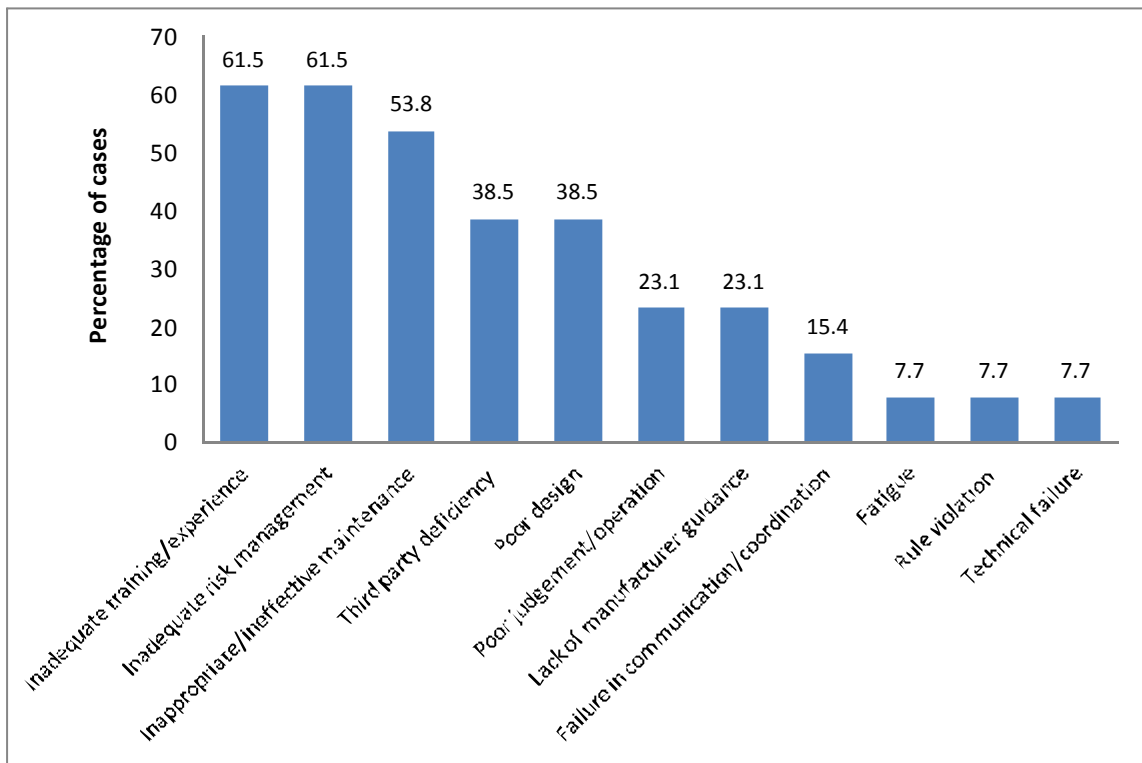
Grounding



Fire and explosion



Lifeboat



Other

