Analysis of Maritime Accidents due to Poor Situational Awareness

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ABSTRACT

Many research studies have been carried out over the years to find the main causes of maritime accidents, with human error found to be the prime causative factor, as more than 80 % of accidents are attributed to human errors. By looking closer at these accidents, in some of the reviews, the lack of SA was highlighted as the most important factor in the human error chain (Baker & McCafferty, 2005; Graziano et al., 2016; Popa, 2015). This paper investigates the maritime accidents which were caused by the absence of situational awareness, which affects the performance of the bridge team by looking at what happened before the accident, what kind of action was taken and how the bridge team reacted to the emergency situation.

Keywords: *Bridge Resource Management, Situational Awareness, Accidents Investigation*

1. INTRODUCTION

A review of the accident reports between 2007-2017 from the UK Marine Accident Investigation Branch (MAIB), Australian Transport Safety Bureau (ATSB) and Transportation Safety Board of Canada (TSBC) has been carried out to study the accidents linked to activities on the ship bridge and the underlying reasons linked to the bridge team members (master, an officer of the watch - OOW-, cadet, wheelman, lookout and pilot). The analysis of accident reports included the vessels sailing in the United Kingdom, Australian and Canadian territorial waters, or vessels under the UK, Australian and Canadian flags, to determine the effect of the Bridge Resource Management Course, which became mandatory for officers in 2012.

2. METHODOLOGY

The maritime accident reports from MAIB, ATSB and TSBC were reviewed based on accidents (collision, grounding, contact, ***etc.***) that ocurred due to lack of situational awareness. Then, they were categorised into two parts: those occurring before and after 01/01/2012, when the bridge resource management (BRM) came into force (IMO, 2011), to see whether the BRM course had any positive effect on the performance of bridge team members including reactions and decisions. Each report was reviewed and analysed to find the causes of the accident, which are related to a lack of situational awareness. It was identified that some of the accidents had more than one reason that caused the loss of situational awareness among the bridge team members. The study focuses not only on the time of the accident to identify the cause of the lack of SA but also on how the bridge team acted and their conditions up to a day before the accident to identify if the

fatigue played a part in the lack of SA. In addition, all vessels, which were investigated in this study are above 500 gross tonnages, and the accidents of fishing vessels and pleasure crafts were excluded because mostly they require solo watchkeeping on the bridge.

The study considered the model of situation awareness developed by Endsley when she divided human situation awareness into three levels. Level 1-perception of the element in the current situation, level 2-comprehension of the current situation and level 3-projection of the future situation (Endsley, 1995). Also, the adjustment in this model, which was carried out by (Chauvin et al., 2008), clarified level 1 as the available information from the equipment such as the ARPA/Radar, level 2 as the assessment of the current situation, and level 3 as what the result will be in the future situation. However, this review was done on the basis that:

- level 1 is the available information from any equipment in the bridge, including paper chart, notices, and master's standing order, ***etc***.
- level 2, what is happening in the current situation, and
- level 3 is the prediction of the officer of the watch, or any bridge team member, of what will happen in the future.

3. FINDING

In total, more than 200 marine accidents and near-miss reports have been reviewed over the period of 2007 to 2017, of which 144 of them were from MAIB, 28 of them were from ASTB and 31 of them were from TSBC. A review of the individual reports indicated that more than 58% of OOWs or bridge team members failed to fulfil the level 1 situational awareness, as shown in Figure 1.

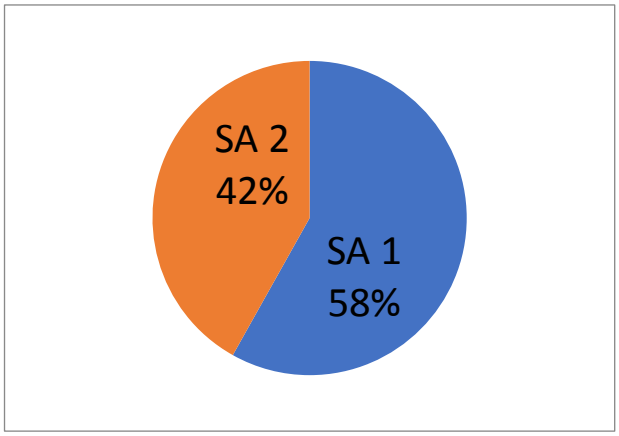

Figure 1 Percentage of failure in situational awareness levels in marine accidents.

Figure 2 and Figure 3, which show the percentage of the accidents that occurred due to lack of communication before and after 2012, indicate that wrong/misuse of the available information and manning decreases after 2012. This indicates that BRM is found to be useful in some of its elements. However, the interaction between the bridge team members, poor decision-making, and poor navigational practice still cause significant impact on maritime accidents even after 2012, indicating the gaps with BRM overall.

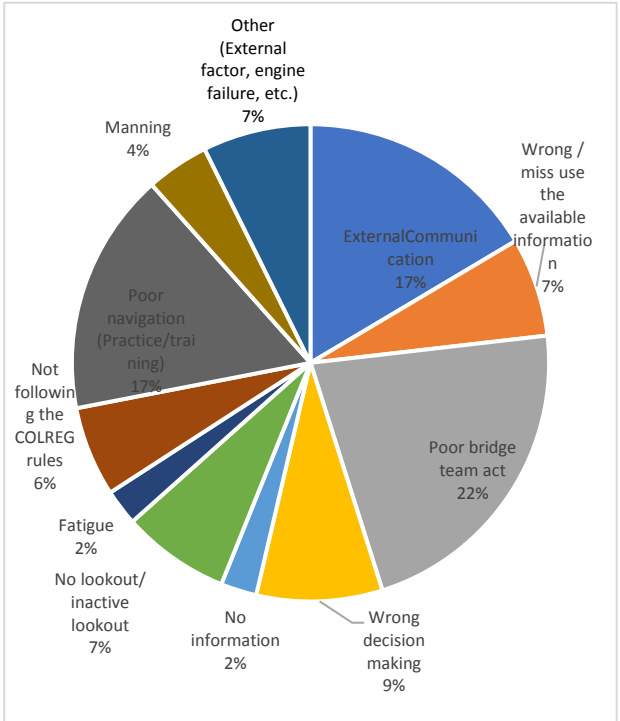

Figure 2 Overall factors that lead to a lack of situational awareness before 2012.

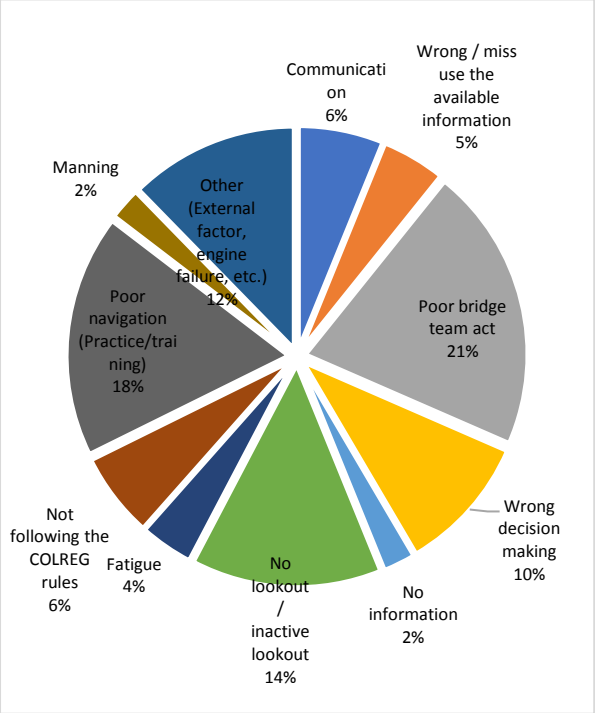

Figure 3 Overall factors that lead to a lack of situational awareness after 2012.

3.1 Missing SA factors

3.1.1 External Communication

Lack of communication always affects team behaviour, particularly in critical situations. MAIB accident reports reveal the bridge team's communication problems (especially between master and external pilot) before the accidents occurred. The ratio of accidents that occurred due to the lack of communication decreased from 1:4.9 before 2012 to 1:8.7 after 2012. The reduction in accident rates possibly indicates that BRM improved communication among the team members on the ship bridge but has not eliminated the communication problem completely. In addition, poor communication including, misunderstanding between two bridge teams or failing to reach an agreement about the avoidance manoeuvring, are factors that affect the situational awareness for the bridge team members.

Some researchers found that forgetfulness and exhaustion influenced efficient communication adversely (Ziarati et al., 2010). Furthermore, the fear of being blamed by higher-ranked officers, assuming that another team member knows the communication failures, or doubting if the transferred information is correct or not all contributed to the maritime accidents considerably (Vrbnjak et al., 2016)

3.1.2 Wrong/miss use of the available information.

With the tremendous amount of information available on the bridge, some accidents are related to OOWs who are not utilising all the information, are not following the rules or are using the information only from one or two sources all the time, e.g. the ship's position. Even if the OOW have the correct information, he/she misuses it (e.g. change the ship's speed or heading) to avoid the accident or got confused between true and relative bearings. This had occurred regularly depending on the equipment preference by the OOWs. The rate of this type of accidents had decreased from 1:14.9 before 2012 to 1:21.6 after 2012. If the bridge team lacks the knowledge or skills to understand information or do not know how to respond to them, maritime accident risk increases substantially. These numbers indicate that there is still room for improvement through BRM courses with the provision of training to ratings on the bridge.

3.1.3 The information is not there.

All accidents that occurred due to unavailable information were small because of the new technology, and the overall ratio scored 1:41 and 1:43 before and after 2012. However, some of the bridge equipment needs to be upgraded/updated or corrected from time to time, such as ECDIS, paper chart, ***etc.,*** to have the correct information available to use. For example, many ships ran aground due to the OOW losing his situational awareness because he did not know the object was there. All information must be made available to the bridge team in time to use it in the correct way to avoid accidents.

3.1.4 Poor bridge team act (BTA).

Communication is an essential element in bridge resource management, but some other elements must also be addressed. Failing to share information and situational awareness, decision making, teamwork, including master/ pilot exchange are key underlying reasons for maritime accidents. The lack of communication and situational awareness among the bridge team and other ship bridge's team increases the potential of misinformation such as the ship's position speed or heading, thereby reduces the efficiency/effectiveness of the team to respond timely to avoid accidents. Even after the STCW forcing the BRM certificate to be held by OOW, some errors/deficiencies have not been addressed entirely yet. The bridge team is required to use all the resources, including human resources, that are available on the bridge. In fact, it has been cited that every year there is an accident caused by a lack of BTA (excluding Australia). Surprisingly, accidents that occurred because of poor BTA after 2012 remained high, and the ratio is the same (1:4.8) as before 2012. Such a high value shows the gaps in BRM courses and highlights that an intermediate improvement is required to enhance bridge team interaction to minimise these accidents.

3.1.5 Lookout

For all the accidents that occurred under this category, the OOW was alone on the bridge, or there was no-lookout on the bridge, even though rule no. 5 of the COLREG convention states that all ships should keep a proper lookout out at all times (IMO, 1972). In many MAIB accident investigation reports, it was mentioned that the bridge teams in vessel A and vessel B were not aware of each other until just before the collision. Some of the vessels ran aground because the OOW slept on the bridge or he/she went to his/her room due to fatigue, and there was no lookout with him, despite the regulatory requirements. This evidence clearly indicates the scale of the problem with overall minimum manning standards and available minimum crew on duty. This is detrimental to the team situational awareness on the bridge, and the accident reports are clear evidence supporting this conclusion. Even with IMO regulations that require an active lookout, the number of accidents due to inactive lookout has increased considerably from 1:13.6 before 2012 to 1:7.2 after 2012.

3.1.6 Wrong decision-making

All the factors, which were mentioned earlier, contribute to the decision-making and naturally leads to good/poor navigational practices. When a bridge team member loses his/her Level 1 SA or Level 2 SA and is not consulting or sharing his ideas with other team members, this influences his decision making and leads to a potential accident. The BRM course covers decision-making, which should be placed in every situation that the bridge team member faces. However, the number of accidents did not change, and the ratio of the accidents due to poor decision making increased from 1:11.7 before 2012 to 1:10 after 2012. Again this indicates the gaps with the BRM course with regards to decision making.

3.1.7 Not following the regulations

The review of accident reports indicated that the factors such as misunderstanding, confusion and not awareness of which rules to follow are highlighted as one of the main underlying reasons in each accident of this category. The number of accidents due to not following regulations decreased after 2012, but the ratio remained exactly the same (1:16). The OOWs sometimes get confused about which ship is the give-way vessel and the stand-on vessel. Is it a crossing situation or overtaking? These kinds of questions, which are linked to the lack of competence of the crew, affect the decision making of the crew (Abdushkour et al., 2018). It highlights the importance of following regulations should be an essential part of the BRM course.

3.1.8 Poor navigation (Practice/training)

Safe navigational practice and handling of the ship heavily relies on the standard of knowledge and skills of the bridge team rather than relying on the sophistication of the bridge's equipment. The bridge teams' knowledge, skills, and proper training are the contributory factors to ensure the safety of the vessel, crew, cargo and the marine environment. Taking late actions, not considering the consequences of the action taken, who has control on the bridge, or not having the proper training are the key factors in this category. The overall number of accidents that occurred due to poor navigation is high, and there is only a slight decrease in the number of accidents after 2012. However, considering the number of accidents, the ratio after 2012 is 1:5.65 compared to 1:6.05 before 2012. This clearly indicates that BRM has not emphasised enough the importance of good navigation through teamwork.

3.1.9 Manning/Other

This section includes the poor manning of the bridge, which means either the bridge is manned with fewer people than required, including a solo watchkeeper, or there is nobody on the bridge. Also, it includes external factors such as wind, anchor dredging, current and waves effect on the ship and led to accidents without being noticed by the bridge team member or hard to notice by solo watchkeeper in the bridge. The number of accidents that occurred due to the manning group decreased after 2012 as a ratio of 1:43 after 2012 comparing to 1:23 before 2012 were observed. Also, the external factors, which led to the accidents, had increased after 2012 (1:8.1) compared to before 2012 (1:13.6).

3.2 Period before 2012 - MAIB

After analysing 104 accident reports, the results indicated that nearly 60% of the OOWs were unsuccessful in maintaining level 1 SA, and 43% failed to comply with level 2 SA, as shown in Figure 4. Lack of situational awareness occurred due to many factors are presented in Figure 5

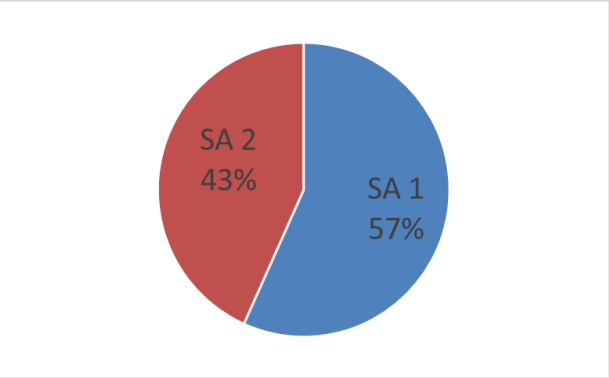

Figure 4 Percentage of failure in situational awareness levels in MAIB marine accidents before 01/01/2012

As shown in Figure 5, communication failures among bridge team members, ship to ship, and ship to shore, along with poor bridge team management and poor navigation practice, had a significant impact on maritime accidents that occurred before 2012. Almost 60% of these accidents occurred due to failure of the physical interaction between the bridge team members or as solo watchkeeper such as communication, teamwork or poor navigational watchkeeping. It is not surprising that accidents occurred because of the absence of a bridge team act, which scored 21% because of BRM, which was not mandatory. However, failing to communicate or not performing proper watchkeeping was evident due to the lack of fundamental training and education that the seafarers should gain before working onboard vessels. It seems that lack of SA contributed to cognition and decision errors, which lead to poor risk-taking and ultimately affected the decision making. The reports regularly stated that the bridge team members needed more training to enhance their communication and teamwork skills. It may be the case that more robust onboard procedures should be designed to complement the training.

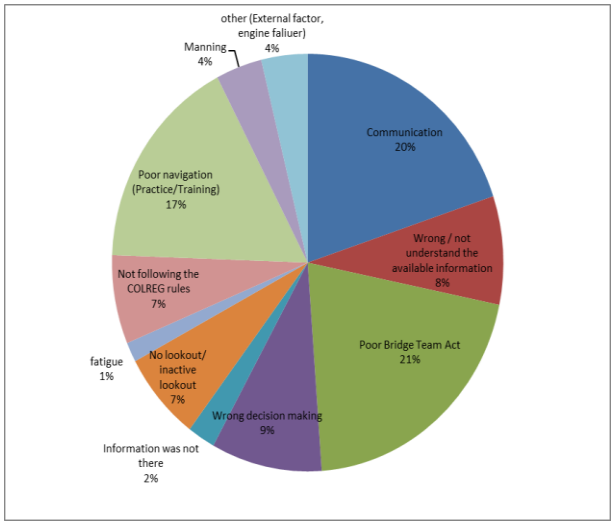

Figure 5 Percentage of factors that lead to lack of situational awareness before 01/01/2012 MAIB.

3.3 Period after 2012 - MAIB

This period showed significant improvement in some of the factors that affect SA. However, despite the overall improvements, 40 accident reports showed that more OOWs failed to meet their SA level 1 compared to the period before 2012, as displayed in Figure 6 and Figure 7.

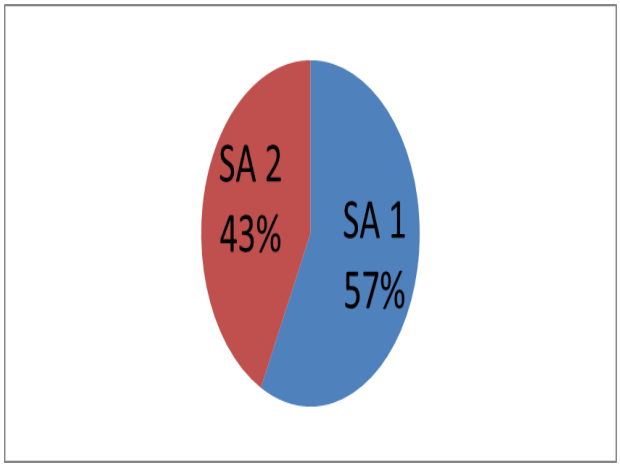

Figure 6 Percentage of failure in situational awareness levels in MAIB marine accidents after 01/01/2012.

On the other hand, the BRM course showed some improvement in individual skills, but it failed in the main idea, which is to improve the bridge team management. There is no doubt that bridge teams are facing more issues other than communication. Lack of sharing the knowledge and SA, absence of teamwork, and misreporting near misses side by side with applying poor navigational practice are main factors contributing to the loss of the bridge team's SA. This made some companies take action by running a BRM course onboard the ships. Also, they sent their seafarers to nautical institutes to enhance their skills.

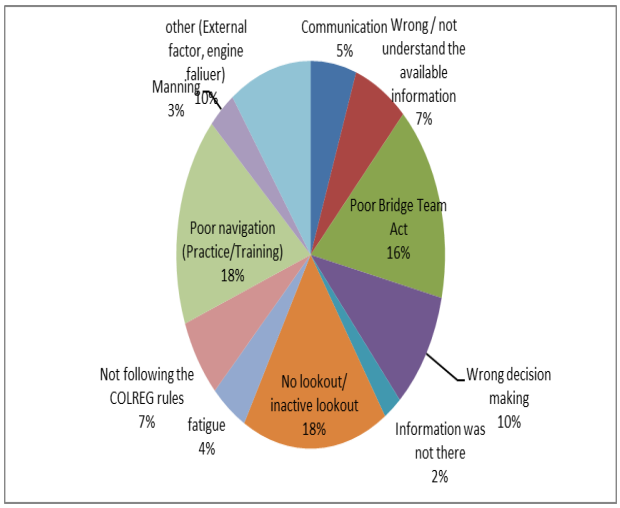

Figure 7. Percentage of factors that lead to lack of situational awareness after 01/01/2012 MAIB.

3.4 Period before 2012 - ATSB

A total of 19 accident reports showed that more than 60% of the marine accidents occurred due to low SA level 1, and 37% failed to obtain SA level 2, as presented in Figure 8.

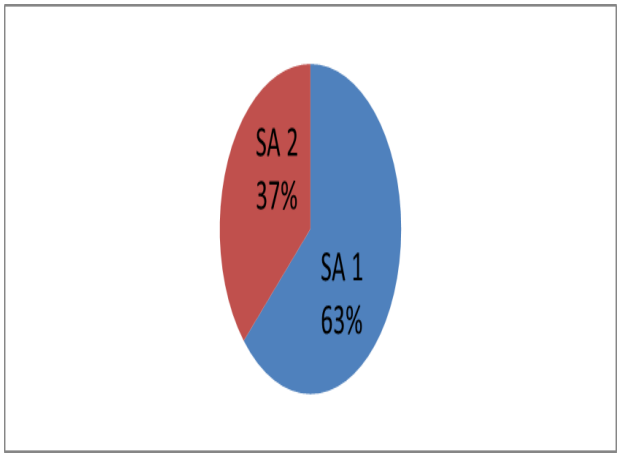

Figure 8 Percentage of failure in situational awareness levels in ATSB marine accidents before 01/01/2012.

This percentage illustrates that OOWs failed to utilise all useful resources available at the time of the accidents, as displayed in Figure 10. As it is clear from the figure, the poor of BTM/BRM was the main cause of the maritime accidents in Australia, which were identified almost in each report.

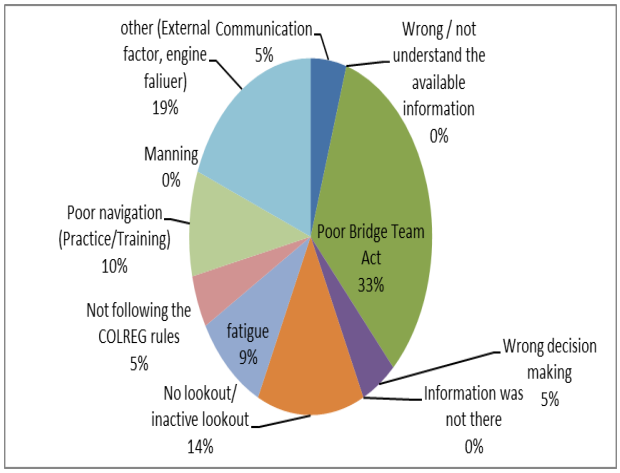

Figure 10 Percentage of factors that lead to lack of situational awareness before 01/01/2012 ATSB.

3.5 Period after2012 - ATSB

Only nine accident reports were linked to the SA issues after 2012. The analysis of those nine reports showed that nearly 70% of the maritime accidents happened due to lack of level 1 SA, and about 33% of the accidents occurred due to lack of level 2 of SA, as shown in Figure 9.

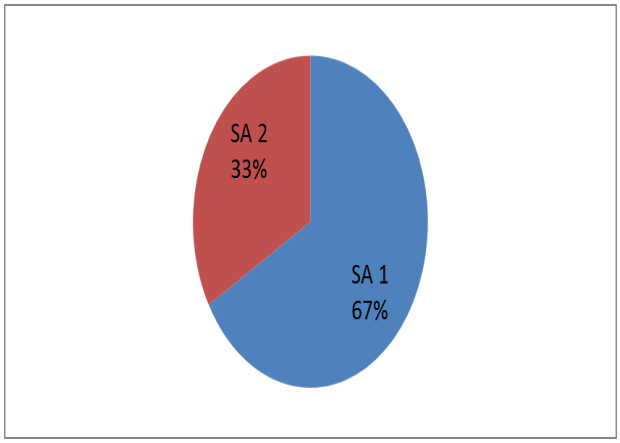

Figure 11 Percentage of failure in situational awareness levels in ATSB marine accidents after 01/01/2012.

All the bridge activities were the main causes of the accidents that included lack of BTM/BRM, inactive lookout and incapable of executing good navigational practices, as presented in Figure 11.

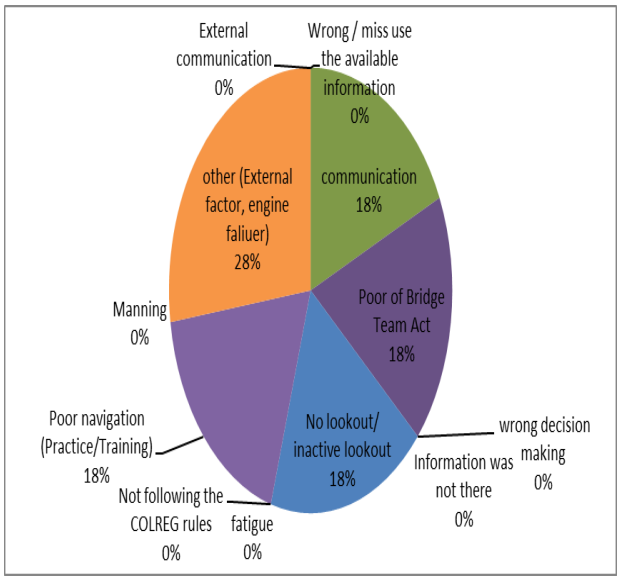

Figure 9 Percentage of factors that lead to lack of situational awareness after 01/01/2012 ATSB.

3.6 Period before 2012 - TSBC

Ten accident reports show that most of the marine accidents investigated by the Canadian board took place because of the human element. For 60% of the accidents, OOWs were unsuccessful in gaining level 1 SA, while 40% failed to obtain level 2 SA, as shown in Figure 12.

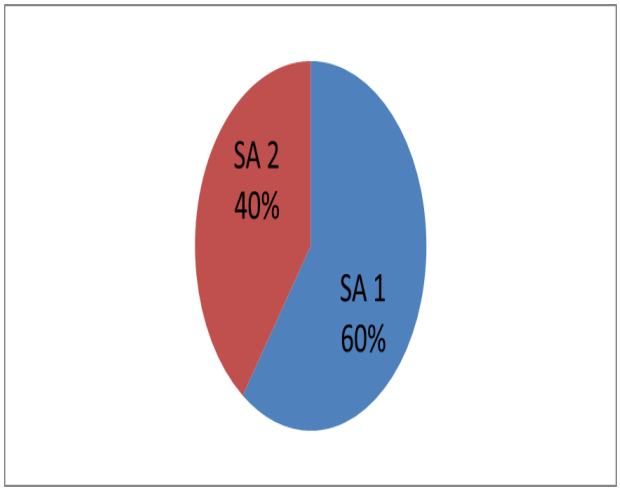

Figure 12 Percentage of failure in situational awareness levels in TSBC marine accidents before 01/01/2012.

Poor work practice as a team and poor use of all resources on the bridge, and a lack of navigational practices and training were the major factors contributing to the absence of SA. Nearly 40% of the accidents occurred due to different reasons, as displayed in Figure 13.

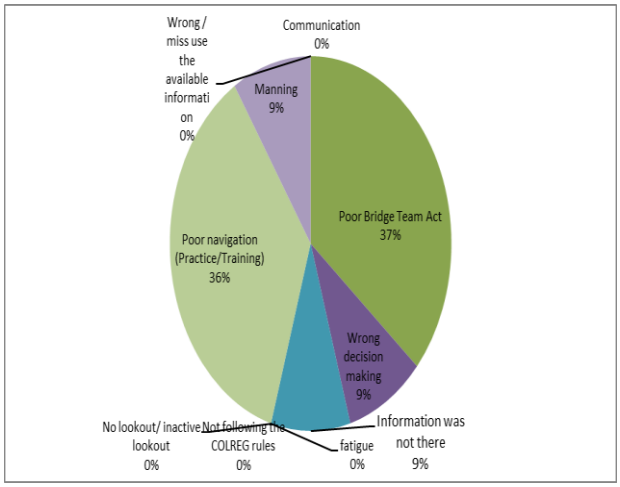

Figure 15 Percentage of factors that lead to lack of situational awareness before 01/01/2012 TSBC.

3.7 Period after 2012 TSBC

In this period, 21 accident reports were analysed; 57% of the OOWs failed to gain level 1 SA and 43% level 2 SA, as shown in Figure 14. The prime cause of these accidents was the bridge performance; it was observed that BTM/BRM was inefficient with 34% and been reported almost in half of the accident cases. This issue affects directly the other aspects presented in Figure 15.

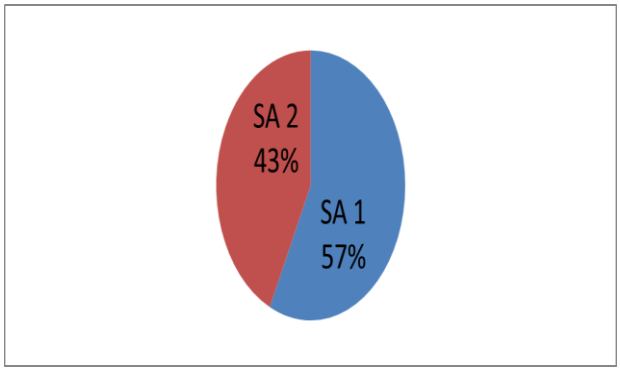

Figure 14 Percentage of failure in situational awareness levels in TSBC marine accidents after 01/01/2012.

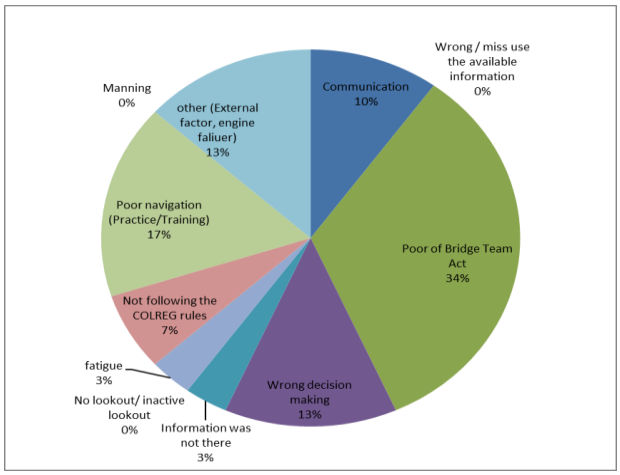

Figure 13. Percentage of factors that lead to lack of situational awareness after 01/01/2012 TSBC.

CONCLUSIONS

The human element was a major factor influencing ship accidents which have been reviewed; the main two components are situational awareness and assessment (SA) and teamwork. The misunderstanding of the situation, lack of knowledge about the capabilities of the navigational equipment, and the misuse of it increased the risk of accidents. Moreover, poor application of bridge team management (BTM) increased this risk to a higher level.

As it is clearly presented above, most OOWs are not achieving level 1 SA because they rely on one or two navigational equipment rather than utilising all the equipment on the bridge to create Situational Awareness. Also, the benefits of using another opinion to improve the decision have not been used regularly. Surprisingly, many accidents had occurred because of a lack of BTM/BRM even after the course has come into force. The reason could be that because of other team members such as cadets, wheelmen, lookouts, and pilots, who do not have to attend the BRM course, as it is mandatory for only the OOWs and masters. Besides, the officer does not report/share any useful information due to the assumption that another member knows about it, or he/she is afraid that this information does not belong to the situation or is wrong or afraid of another team member's reaction. Many of these

accidents could be eliminated, and level 3 of SA can be maintained if OOWs used all the available resources along with their experience. Moreover, accidents are related to lack of bridge team management, including different factors such as communication, decision-making, leadership and teamwork.

In the end, accidents will continue to occur in the future if the same circumstances still exist. Therefore, those circumstances should be reviewed and addressed to maintain the highest level of Situational Awareness through better BRM training and implementation of better onboard procedures.

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