Insights Of Safety Practices In The Shipping Industry – A Qualitative Assessment

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Abstract: This paper assesses the insights of safety practices in the shipping industry using secondary data from shipping accident report from MAIB and primary evidence from responses to interviews on safety practice completed by ten shipping personnel (shipping company managers and seafarers). Human Factor Analysis and Classification System (HFACS) framework has been used to analyse the reports to identify the root causes of accidents and group them into four levels of human error. NVivo was used to group the responses from the interviews into relevant themes based on safety practice aspects. Based on the HFACS framework, human error from Level 1-unsafe acts and Level 2-preconditions for unsafe acts has been identified as the most accident contributed factors. Based on the interviews, six themes of safety practice have been identified as most contributed aspects towards an improved on-board safety culture.

Index Terms: HFACS, Human error, Human factor, Ship accidents, MAIB, Accident reports, Interviews.

1. INTRODUCTION

Shipping accident has been the main concern in the maritime industry as it leaves negative impact to many parties. Specifically, shipping accidents potentially harmful as it may cause loss of life, loss of property and marine pollution (Ceyhun, 2014). It is vital to identify the root causes of accidents in order to find a solution or prevention method to reduce its impact. There are several potential causes of shipping accidents such as natural or environmental factors, technical failures, route conditions, ship-related factors, human errors and cargo-related factors (Akten, 2006). However, most studies have identified human error as the primary factor of shipping accidents (MAIB, 2000; Rothblum, 2000; O'Neil, 2003; Darbra and Casal, 2004; Toffoli et al., 2005; Allianz, 2018). Studies show several steps have been taken to combat human errors (Apostol-Mates and Barbu, 2015). As such, advanced technology were developed to reduce human reliance and adapt people to technology (Apostol-Mates and Barbu, 2015) . However, despite of capable and multi-tasking systems, they are still need human assistance. Studies have also highlighted that even well trained and experienced seafarers could make mistakes and therefore, any human operating systems on-board are considered ineffective to reduce human errors (Apostol-Mates and Barbu, 2015).

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Besides that, maritime authorities such as Maritime and Coastguard Agency (MCA) and Marine Accident Investigation Branch (MAIB) have also highlighted many useful methods and recommendations to prevent accidents in their investigation reports. However, lack of awareness in learning from previous accidents has become a threat to maritime safety. Previously, Skjong and Soares (2008) have claimed that enhancements in methods used to study and improve maritime safety are vital. Moreover, Celik and Cebi (2009) has also stressed that it is crucial to develop a specific analytical framework to identify human errors and has used Human Factors Analysis and Classification System (HFACS) in his research to investigate shipping accidents. Thus, research on the root causes of human errors and safety parameters is significance. While the HFACS framework can enhance the research by identifying the levels of human error based on shipping accidents reports by MAIB. In this respect, the perception and views of shipping company managers and seafarers working on board ship can provide useful insight about the causes of accidents and the safety parameters that contribute towards an improved safety culture. This paper undertakes a qualitative study for example document analysis based on accident reports from MAIB and semi-structured interviews. The main aim of this study is to explore the causes of shipping accidents based on HFACS and the perception of shipping personnel through two related objectives: 1) to identify the most accident contributed levels of human errors and 2) to identify the safety parameters (themes) that shipping personnel believes contribute most towards an improved on-board safety culture.

2. HFACS AND HUMAN ERROR

2.1 HFACS

HFACS framework was originally developed for the United States Navy and Marine Corps as an accident investigation and data analysis tool (Shappell and Wiegmann, 1997). HFACS which was developed based on Reason's (1990) model of active (human errors) and latent failures (causes of human errors) has been very relevant for investigating human error in accidents (Celik and Cebi, 2009). HFACS was cited as most relevant tool to study about human error in accident (Xi et al., 2010) and it has been used in various fields such shipping, civil aviation, mining, railway and

healthcare (Diller et al., 2014). In shipping sector, HFACS has been utilised by Schröder-Hinrichs et al. (2011) in his study on human error related accident investigation. Interestingly, it was one of the first applications of HFACS in the maritime field particularly for accident investigation. According to the author, HFACS was appropriate for his study and abled to identify 368 human error causal factors from 41 accident reports. HFACS has also been implied in another study on accident investigation in passenger ship accidents by Singh (2014). The author has claimed that the classification framework has provided a comprehensive perspective to accident investigation and has identified 649 human error causal factors only from 15 accident reports. These findings have shown how effective the HFACS is in identifying the causal factors and also supports Celik and Cebi (2009) and Xi et al. (2009) statement claiming that this framework is appropriate to investigate, collect and quantify human error in shipping accidents.

2.2 Human Error

Generally, when it comes to marine casualties, human errors are frequently linked as the main contributing factors (Rothblum, 2000; O'Neil, 2003; Darbra and Casal, 2004; Toffoli et al., 2005). Although, it is impossible to directly observe human errors, it is possible to indirectly observe through human behaviour (Hollnagel, 1998). Human behaviour is defined as the actions or reactions of a person influenced by culture, tradition and human physiology (Schiffer, 2002). Human error is described as making an incorrect decision, an improperly performed action, or an improper lack of action (Rothblum, 2002). Gil de Egea (2003) stated that human errors developed from the management deficiencies, the personnel's physical and mental conditions, and qualifications. There are several other aspects of psychological processes such as perception, attention, memory, thinking, problem solving and decision making that are believed to be among the main causes of human error (Senders and Moray, 1991). Table 1 shows different perceptions of researchers on human error. Human error can be classified into three categories namely: system-induced error; design-induced error; and human-induced error (Meister, 1971; Baker et al., 2002). System-induced errors indicate deficiency in the way a system was implemented. This includes mistakes in designating the numbers and types of personnel, in system operating policies, training, data resources, logistics, organizational responsibilities, and maintenance requirements and support. Design-induced errors are developed consequently from human incompatibilities with the design of equipment. The operators are challenged with the equipment design characteristics that substantially increase the risk of error. These include inadequate workspace for maintenance, poor colour/contrast of displays screens, inadequate labeling of controls and difficulties to reach valve location (Meister, 1971). Human-induced errors are defined as characteristics of people that influence the risk of errors (Meister, 1971). There are several types of human-induced errors such as fatigue, disorientation, distraction, impaired attention, lack of motivation, forgetfulness, complacency, confusion, incorrect expectancy, excessive stress, boredom, inadequate skills and knowledge, and inadequate perceptual or cognitive ability. Such factors pose high risk towards occurrence of errors and even likely to cause errors or accidents (Meister, 1971). Caridis (1999) has mentioned that the number of worldwide maritime accident has not reduced even in the presence of advanced marine technologies. The highest proportion of maritime casualties is relates to human factors, this comprises of 75% - 96% of overall maritime accidents (Wagenaar and Groeneweg, 1987; Rothblum, 2000; Anderson, 2003).

3. METHODOLOGY

In this study, the researcher has adopted qualitative research method. This method is appropriate to understand the changing aspects of a workplace and draw out the causations (Whitfield and Strauss, 1998). The ability to provide complex textual descriptions on how people experience a given research issue is the main strength of qualitative research. This method is also effective in identifying intangible factors such as social norms, socio economic status and gender roles, in which, whose role and impact may not be readily apparent (Mack et al., 2005). There are five main qualitative methods: phenomenological, ethnographic, grounded theory, case study and narrative (Hancock et al., 1998). In this study, phenomenological and case study have been utilised for the qualitative data collection.

3.1 Case study

A case study is the exploration of an individual, group or phenomenon (Starman, 2013). It is also often used for an in-depth exploration from multiple perspectives of the complexity and uniqueness of a specific event, policy or system (Simons, 2009). Document study is a method of data collection of case study technique that does not require participation of the subjects or the person involved (Oltedal, 2011). It is also intended to explain the causes of system failures and they are evidence of various team of experts and are the results of lengthy investigation process (Johnson, 2001).The purpose of choosing this approach is to address one of the objectives, which is 'to identify the most accident contributed levels of human errors'. In obtaining the relevant information, official maritime accident investigation reports from the UK Marine Accident Investigation Branch (MAIB) are to be studied to identify the root causes of human error and the most accident contributed levels of human error. The document study in this research involved two steps such as: step 1 – data collection and occurrence sequence determination; step 2 – factors identification and classification (Soliwoda, 2014).

Step 1: Data collection and occurrence sequence determination

The first step of the accident report analysis involves collecting accident reports to gather the accident information in determining the causes. 30 accident reports were collected from the MAIB website for the study. The accidents studied in this research were happened in the UK jurisdiction and involving vessels of various flag states and crews of different nationality. After collecting the reports and the related information, a sequence of events and circumstances will be developed. At this stage, all the factors that associated with the incident will be identified.

Step 2: Factors identification and classification

This step involves the classification of the unsafe acts or conditions (causes of accidents) identified in the report

analysis and then classified them into four levels of Human Factor Analysis and Classification System (HFACS) framework. The HFACS framework is explained in Section 3.3.

3.2 Phenomenological

Phenomenology is a qualitative technique that focuses on experiences and events which involves the use of depth description and close analysis of lived experience to understand how meaning is created through embodied perception, rather than to explain or quantify it in any way (Stewart, 1974; Sokolowski, 2000). This technique does not include a hypothesis about the data collected as it is solely concerned with study of the experience from the perspective of the participants. Phenomenology makes use of variety of data collection methods including interviews, reading documents, watching videos and visiting places/events. The main idea of the methodology is to be less structured and more open-ended to encourage respondents to share their experiences. In this study, an interview is implied to gather the information about the safety culture and human error in shipping industry. An interview is a conversation between an interviewer and interviewee where, the purpose is to gather detailed information about a particular issues or topics based on the interviewee's experiences (Flinders, 1997). An interview is the most common method of data collection in qualitative research (Jamshed, 2014). The main aim of the interview is to explore the views, experiences, beliefs or motivations of individuals on specific matters, which in this study it is on safety culture issues. Therefore, interviews are appropriate where detailed insights are required from individual participants. In general, there are three types of research interviews namely: structured, semi-structured and unstructured. In this study, the researcher has adopted one-to-one based semi-structured interview to gather information from shipping company senior managers and seafarers. This is because the semi-structured interview is flexible in how and when the questions are asked and how the interviewee can respond. It also allows more space to the interviewee to understand and answer on their own term compared to structured and unstructured interviews.

Planning of semi-structured interviews

Before conducting a semi-structured interview, it is best to prepare a set of questions that are likely to yield as much information about the topic of interest. It is also important to set good questions for example an open-ended questionnaire that require more than a yes or no answer, neutral and understandable (Gill et al., 2008). The process for conducting a semi-structured interview is: i. survey plan, ii. develop instruments, iii. data collection, iv. analyse data and writing results. These steps are explained in the following paragraphs.

i. **Survey plan**

In a survey, it is important to identify the most suitable respondents or participant that are relevant to the particular study. Therefore, shipping company senior managers and seafarers are the most suitable participants as the study is about the safety culture in shipping sector. The respondents are from various companies and education institute. According to the ethical elements of research (UOS, 2012), it is advisable to not reveal the identities of the respondents or companies/institutions involved in the study.

Then, deciding the sample size is also crucial before conducting the interview. Although large number of sample could provide a broader range of information, data from only a few individuals who have experienced the phenomenon and who can voluntarily provide a detailed information of their experience are suitable to be considered. A typical sample sizes for phenomenological studies range from 5 – 25 respondents (Morse, 1994; Creswell, 1998). In this study, the researcher has abled to get 10 respondents.

ii. Develop instruments

The next step is developing the interview questions and protocol. In this study, the researcher has developed two sets of questionnaires where one is for the shipping company managers (five respondents) and the other is for seafarers (five respondents).

iii. Data Collection

Before conducting the interviews, respondents should be informed about the study details, ethical principles of the interview such as anonymity and confidentiality (Gill et al., 2008). This would assist the respondents of what to expect from the interview and will ease the interview process.

Then, the interviews should be conducted in places free from distractions and most importantly at the locations that are most suitable for the respondents. In this study, the researcher has conducted the interview at the respondent's work place and also via telephone as it is easier for them to take part in the interview due to their busy work schedule. To ensure that the interview is productive and interactive, it is important to the interviewer to possess skills and techniques. This would enhance the possibilities of getting comprehensive data during the interview. It is also crucial that the interviewer to present himself as the listener and ask participants/interviewee to give explanations of their experience of that particular issue (Starks and Brown Trinidad, 2007). In this study, the researcher has gained the skills and techniques of doing an interview by understanding all the above criteria, reading, taken short courses on qualitative methodology and discussions with experts in qualitative research field and have implied them during the interview. The interviews take a duration of 1 hour to 1 hour 30 minutes. During the interview, the researcher has taken notes and recorded the whole conversation. The recording of the conversation was useful to have the interview data captured effectively because not all information can be written down during the interview. Considering the ethical requirements and confidentiality of the respondents, all the recorded data has been stored safely at the University of Southampton.

iv. **Analyses data and writing results**

After completing all interview sessions, all the interview data should be well transcribed in order

to analyses the data efficiently. In this study, the researcher has transcribed the recorded audio manually and has taken notes while conducting the interviews. There are few steps in analyzing interview responses as following (Boyce and Neale, 2006):

- Read the responses and identify the patterns or themes among the participants. It is also can be useful to work with specialized software, which makes it easier to group the interview responses. In this study, the research has used NVivo software (refer to Section 3.4) to group the responses.
- Group the responses according to the identified patterns or themes and questions.
- It is important to analyses the responses carefully to identify if there are responses that are opposed to those in only a few words.

3.3 Human Factors Analysis and Classification System (HFACS)

Human Factor Analysis and Classification System (HFACS) framework is adopted to investigate 30 ship accident reports from Marine Accident Investigation Branch (MAIB). All the accident reports were based on accidents that happened in the UK involving merchant vessels. The HFACS framework describes human error at four levels namely: Level - 1 unsafe acts, Level 2 – preconditions for unsafe acts, Level 3 – unsafe supervision and Level 4 – organisational influences. In each levels of HFACS, there are causal categories, which were developed to identify the active and latent failures. The framework for HFACS is illustrated in Fig. 1. and a brief description of the four levels and their sub-categories is elaborated in the following paragraphs.

Level 1 – unsafe acts is divided into two categories namely errors (unintentional mistakes) and violations (non-compliance with rules and regulations). Each category has several sub-categories: errors - decision errors, skill-based errors and perceptual errors; and violations – routine violations and exceptional violations. All the elements of level 1 is summarised in Table 2 (Shappell and Wiegmann, 1997; Diller et al., 2014).

Level 2 of the HFACS describes the preconditions for unsafe acts. This level includes three categories namely: environmental factors, condition of operators and personnel factors. The first category, environmental factors has two sub-categories namely: physical environment and technological environment. The second category, which is the condition of operators, includes three sub-categories namely: adverse mental state, adverse physiological state and physical/mental limitations. Last category, personnel factors, has two sub-categories namely: crew resource management and personal readiness. All the elements of level 2 are summarised in Table 3 (Shappell and Wiegmann, 1997; Diller et al., 2014).

Level 3 of HFACS describes the unsafe supervision, which has four categories: inadequate supervision, planned inappropriate operations, failed to correct problem and supervisory violations. All the elements of level 3 are summarised in Table 4 (Shappell and Wiegmann, 1997; Diller et al., 2014).

Level 4 of HFACS, organisational influences, includes three categories namely: organisational climate, operational process and resource management. All the elements of level 3 is summarised in Table 5 (Shappell and Wiegmann, 1997; Diller et al., 2014).

3.4 NVivo – Qualitative data analysis package

NVivo is a widely used tool by qualitative researchers to evaluate, interpret and explain social phenomena. It is widely used in many fields such as social science, education, healthcare and business (NVivo, 2012). This tool analyses unstructured or semi-structure data like interviews, surveys, field notes, web pages, audio-visual material and journal articles. NVivo allows the users not only store original records in full texts through project documents, but also can help to keep or organise thoughts and ideas through making nodes, setting up documents attributes or nodes attributes, adding memos, building up models, tables or data bites, editing codes and fins links among them or even with background information and literature library. Once an NVivo project is created, the researcher can create, edit, explore or browse the data and nodes. Nodes are created to represent the ideas or categories that have been discovered from the answers (data) given by the interviewee. Coding is considered as the key process of analysis through NVivo (Richards, 2008). In short, nodes were described as the place to store identified ideas or categories, while coding is the way in which to store pointers to the text about those ideas. Coding not only eases a researcher to find quickly all the relevant data to answer the research questions, but also helps to obtain and refine clues from the data. Moreover, memo can be used to keep notes, sets are used to sort and manage the data orderly (Richards, 2008). There are several process in analysing qualitative data using NVivo as shown in Fig. 2. (NVivo, 2012). There are six steps in analysing data in NVivo for example import, explore, code, query, reflect, visualise and memo. Explanation for each of the steps are presented in Table 6 (NVivo, 2012). In this study, the researcher transcribed the notes from interview into 44 detailed NVivo nodes. The aim of transferring the raw data into NVivo is to try to find out; what do the respondents have answered and what are the differences and similarities between the two groups of respondents (seafarers and managers). By answering these questions, the point of view of the respondents on safety culture can be identified. To serve this aim, the data was coded and grouped (themes) until answers can be deprived clearly.

4. RESULTS AND DISCUSSIONS

4.1 HFACS Framework

As previously mentioned, 30 reports from MAIB were used to identify the root causes of shipping accidents that happened in the UK. The breakdown of the analysed accident investigation reports is shown in Table 7. In the 30 accidents, a total of 126 various causal factors have been identified. These factors are grouped by using Human Factor Analysis and Classification System (HFACS)

framework, which were discussed in Section 3.3. Table 8 tabulated those findings of the HFACS classification in a form of levels, sub-categories and frequencies. The four levels and sub-categories were originally from the HFACS framework, while, the frequencies were calculated based on the number of causal factors identified. Overall, the findings show that Level 1 - unsafe acts related human errors were the most frequent accident contributing factors which comprises 38.89% overall. Level 2 – preconditions for unsafe related human errors were 27.78%, followed by Level 3 – unsafe supervision that is 23.81%. Level 4 – organisational influences related human errors were the least contributing factors that comprise of 9.52%.The table reveals that at level 1 - unsafe acts, skill-based errors were associated with the largest percentage (16.67%) of accidents. The most common skill-based errors encountered were lack of sufficient trainings and skills, and poor navigational practices. Among the remaining categories of unsafe acts, accidents associated with decision errors constituted the next highest proportions, which is 11.11%. In other studies, Ziarati and Ziarati (2007) have pointed that decisions errors specifically poor decision-making is one of the most dominate causes of accidents. Research by the International Chamber of Shipping ICS (2013) revealed that for approximately every 330 unsafe acts, 30 are likely to result in minor injury. Of these 30 injuries, one is statistically likely to cause fatality, permanent disability or time lost from work, which indicates the severity of consequences owing to unsafe acts. Accidents associated with Level 2 – preconditions for unsafe acts constituted the next highest contributing factor (27.78%) after unsafe acts. At this level, technological environment such as poor design of the engine room, watch alarm malfunction and inability to use the advanced navigational system are among the most accident contributing factors, which is 7.14%. Adverse mental state (3.97%) and crew resource management (3.97%) have equally contributed towards accidents. According to U.S. Department of Defense (2005), preconditions for unsafe acts such as inattention, distractions and fatigue are among the main factors that led to accidents. In other studies, preconditions for unsafe acts is in the range from 23.4% (Singh, 2014) to 56.4% (Schröder-Hinrichs et al., 2011). These percentages show the importance of identifying precisely the factors associated at this level to determine the appropriate strategies for preventing future accidents.

Level 3 – unsafe supervision was identified as the third most accident-contributing factor (23.81%). At this level, planned inappropriate operations-related errors comprise of 9.52% of the 126 causal factors. Factors such as poor risk assessment practices and inadequate preparation for emergency are among the main accident contributors at this level. In other studies, unsafe supervision is in the range from 3.9% (Baysari et al., 2008) to 29.3% (Singh, 2014) compared to other causal factors. This statement emphasises the importance of giving more attention to the factors at these level to prevent further human error resulting in accidents.

Factors at level 4 – organisational influences were identified as the least contributing factors of accidents, at 9.52%. Lack of proper SMS, inadequate procedures and documentation, and poor ship maintenance were among the main factors that have caused accidents. Various studies have showed organisational influences in the range from 4.3% (Patterson and Shappell, 2010) to 59.4% (Baysari et al., 2008). The findings of this study has been compared with other studies from various fields that have implied HFACS. The findings from the comparison have been summarised in Table 9. This is an evident that human error do exist in most industries and it is a potential threat to safety. In shipping, the most accident contributing factors of human error differs in all the three studies. In the first study, Schröder-Hinrichs (2011) has identified human errors from Level 2 as the most contributing factors of accidents followed by Level 1, Level 4 and Level 3. Contrastingly, Singh (2014) has discovered human errors from Level 3 as the most potential threat to safety followed by Level 1, Level 2 and Level 4. Meanwhile, the current study has contradicts all the studies, however, the risk of the human errors are the same regardless of levels but the identification of the levels would ease the research to find the possible ways to reduce its impact. This can be concluded that external factors such as weather, economy, and natural disasters could also be the reasons that led to difference in results in three different years. Overall, the results of the review showed that, preconditions for unsafe acts represented 32.74% of the total accidents followed by unsafe acts at 31.31%, organisational influences (17.54%) and unsafe supervision (18.41%). This clearly shows that the unsafe acts and preconditions for unsafe acts remain as the most contributing factors of accidents in different areas besides shipping. Therefore, based on the findings, it is clear that there is a causal link between human error and accidents.

4.2 Safety parameters that contribute most towards improved safety culture in the perception of shipping personnel

To examine the conceptual understanding of safety practice in the UK shipping company, the study used interview survey. There were several questions developed related to safety culture, the main threat, human errors, human errors related incidents, safety management system (SMS) and safety training. The questions were crucial to explore safety culture and how the respondent's deal with human error in their companies. Thus, their strategies can be adapted in the industry to improve safety. The researcher has developed thematic areas using Nvivo software that was used to code the responses from all 10 respondents (shipping company managers and seafarers). Based on a thorough study on all their responses, the researcher has group them into six safety practice themes. Therefore, the interpretation of the results in this chapter will be based on the six themes.

4.2.1 Theme 1: Competency Level

All the respondents both shipping company managers and seafarers have an opinion that there are many aspects that affect safety practice in the UK shipping company. As such, competency level is among the aspects that should be improved and given more attention in order to improve current safety practice based on the respondents view. According to a respondent (manager), "competence and professionalism is the main threat to safety in shipping industry". This statement emphasised the importance of competence that would make a person fit to the designated job. In other words, an employee that lacks competence

would be a threat to him/herself and the surrounding. Decision-making mistake due to insufficient training is also closely related to lack of competency level based on the respondents. This factor is merely human error as the employer/employee did not give priority in getting sufficient training to deal with unexpected or emergency situations. The respondents have also claimed that they train their employees on how to implement and comply with safety regulations and emphasised that all the trainings were effective to improve safety practice and to produce competent employees. For examples, the trainings provided in one of the respondents company are safety induction, safety day, platform or ship specific training, video training programme and briefing before joining the ship. Based on the responses, it can be seen that all companies are concern about safety and do provide trainings to their employees and it can be vary from company to company. On the other hand, another respondent (seafarer) has strongly stated that it is important to have competent employees for a ship to run safe. Based on the respondents, human error is a threat to safety practice and it is unpredictable, as there is no standard situation or environment for it to take place but it can happens anywhere and anytime. However, human error can be reduced through training, as it has been the top priorities produce competent employees and to make ship safer.

4.2.2 Theme 2: Health Awareness

Based on the respondent's perception, health awareness is also another important aspect for safety practice in shipping industry. Health is important because it determines the ability of a person to perform or take part in daily routine and it affects a company's productivity. Fatigue is often related to health awareness based on the respondent's perception. Fatigue is one of the main causes of accidents (Oluseye and Ogunseye, 2016). The main causes of fatigue is long shifts that prevent seafarers to perform effectively during watch keeping. One of the respondents (manager) has stated that, "I also do not believe that IMO does enough to address it. There are new guidelines, which have been in development for sometimes, but they are only guidelines they are not regulations and there is unwillingness to recognise their failings of some watch keeping systems (six on six off) for extending periods, which is, comes to work again". The respondents also believe that increased paperwork as required by the regulations as another factor that causes fatigue. This is because the over flowing paperwork consumes most of the seafarer's time and energy that prevents them from performing their main task with full concentration. In addition, wearing good quality of Personal Protective Equipment (PPE) all the time while on duty is important to avoid being injured and it is the responsibility of the company to provide them. For example, one of the respondents (seafarer) shared his experience about a crewmember who has crushed his finger in machinery. Therefore, regular machinery/equipment check, wearing PPE and strict health and safety policy are necessary to avoid casualties that could harm the employees' health.

4.2.3 Theme 3: Shore Management Support

Shore management support is crucial in improving and maintaining a good standard of safety practice in shipping industry. They play an important role mainly in providing sufficient support to the seafarers in every situation such as ship operations, in educating employees on Safety Management System (SMS), training, health and well-being. As such, one of the respondents (seafarer) has highlighted that his management are aware of their responsibilities in providing sufficient training to all their staffs. For example, they have started to provide video training, PPE, monthly training, regularly ensure all the safety policies are up-to-date, mandatory e-learning courses, tight security check upon arrival and departure, and continuous learning and improvements. The respondents (seafarers) believe continuous support from the management could make a ship safer. They have also stated that, their company is always alert and has a close contact and communication with the staffs on board ship by monitoring and responding to them quickly in all distress situation. They also have provided with sufficient supports, training and safety bulletin to keep their off shore staffs updated with technical and safety related issues. The above explanations illustrate how the seafarers expectation from the shore management to work off shore with full confidence and motivation. It also emphasises the importance of shore management.

4.2.4 Theme 4: Risk Awareness

Risk awareness is an importance aspect of safety practice. Risk or hazards can arise anytime and anywhere, therefore, being aware of the surrounding is essential. "The features that makes it safe are we have risk based approaches and everything risk assessed. There are no features that makes it unsafe." The above statement was from a respondent (manager). The respondent has stated that when he was asked what features that makes the company safe/sustain safety culture. Based on the response, regular risk assessment on everything that being carried out in a company or on a ship is vital in order to prevent casualties. The respondents have also shared their experience regarding risk awareness. As such, their crew members do get injured or slipped on-board as a result of no aware of their surroundings before carrying out their work. However, another respondent (seafarer) has mentioned that commercial pressures resulting in short cuts have been taken rather than taking time to work how to eliminate or reduce risk. They have also highlighted that, in most incidents, the employees often poses risk tolerance, lack of situational awareness or overlook risk. For example, they often use the statement, "it would not happen to me, why bother?" This should be treated a serious threat to safety practice as this attitude will not only harm the person but also could affect people around that person. Above explanations have strengthen the importance of risk awareness where, everyone should aware of the risk in order to work safely. Therefore, one should always learn and share especially from past incident documents as it is one of the best ways to mitigate the risk based on the respondent's perception.

4.2.5 Theme 5: Working Environment Satisfaction

Working environment satisfaction has been identified as one of the theme that closely related to safety practice. Studies shows that working environment satisfaction is achieved when the work place is safe, supportive and understanding, and hence, enables personnel to perform

effectively (Oswald, 2012). In the interview, the respondents (managers and seafarers) have claimed that the culture and the work environment of their companies are very good. This is because their companies practice safety effectively by adapting great focus on life saving rules and goal zero accident. Other respondents (seafarers) have mentioned that their companies has good features such as proper operation procedures, behavioural based safety, learning and continuous improvement and sustainable, which, creates a safe environment to work with satisfaction. "Forced culture is an unsafe feature because over emphasis will cause a bit of 'kick back' or demotivation. Forcing someone to follow the rules, I do not count it as culture. You should get people's heart rather than the procedure." However, one respondent (manager) stated that he can feel a forced culture at work, which, he believes discourages most people at work to follow rules. In addition to that, peer pressure and commercial pressure often seen as a factor that decreases working environment satisfaction. With many distractions at work or poor working environment will be a threat to safety. This is because one can only perform safely and focused if the surroundings are favourable, and hence achieve satisfaction to perform better.

4.2.6 Theme 6: Importance of Maritime Regulations

Safety regulation and its implementation influences industrial performances of hazardous activities from health, safety and environmental considerations. In shipping industry, safety regulations can decrease the frequency of accidents and also motivate maritime organisations to take safety precautions more seriously (Størkersen, 2015). These statements strongly portrait that regulations are an important factor for better safety practice.

"Good and effective management of SMS will give positive impact to safety performance."

"Following safety management system and routine training will make a ship safer."

"Our company has strict health and safety policy, which, we all religiously follow it."

Based on the above statements, the respondents (managers and seafarers) believe that regulations such as ISM Code and SMS are effective in enhancing safety. Making regulations for example SMS less prescriptive, could enhance its effectiveness. This emphasises that SMS can over prescriptive sometime, which can become a burden that could create hesitation to comply with it among the employees.

"There is so much regulation that trying to comply with all of the time is difficult to ship staff."

However, based on the respondent's perception, the attitude of disobeying the rules can be seen among the crews, which, often led to casualties. This is because they are not fully aware of the consequences of not complying. Hence, they practice taking short cuts while doing their task, which expose them to high risk of casualties. Several respondents (managers and seafarers) have an opinion that too many regulations could increase the workload and this should be seen as a threat to safety. This is because increased workload besides their main task can lead to fatigue and poor work performance. Generally, presence and utilisation of regulations should prevent or reduce accidents; however, accidents are still occurring. The reason is maritime regulations are not being complied properly, hence, the increase of accidents. Based on the respondent's opinion, they believe, educating the crewmembers whom disobeying the rules is a best way compared to penalising them. In addition, regulations can only be utilised through effective training and inspections to obtain the possible outcome besides improving the standards of the requirement for the trainings and equipment.

5. CONCLUSION

This paper analysed 30 shipping accident reports and a new dataset developed from semi-structured interviews on the safety practices in shipping industry. HFACS framework has been implied to identify the most accident contributed levels of human error. The HFACS has enabled the researcher to identify 126 causal factors (root causes) of human error and identified human error from Level 1-unsafe act and Level 2-preconditions for unsafe act as the most accident contributing factors. NVivo was used to analyse the data from the interviews to explore the insights of safety practices from the perception of shipping personnel. This analysis has identified six themes of safety practices that believed to contribute the most towards an improved on-board safety culture. In a broad sense, this research enables the following contributions towards shipping safety. The contributions are (1) it has identified 126 causal factors from 30 ship accidents, (2) it has identified the most accident contributed levels of human error based on HFACS framework and (3) six themes of safety practice the believed to contribute the most towards an improved on-board safety culture on shipping personnel's perception. Identifying causal factors of human error from previous accidents can provide the management of shipping companies and stakeholders to measure and view the problems and threats in the industry to improve the safety culture. This can create an awareness among the shipping personnel and can prevent the occurrence of similar errors. The perception of the well-experienced shipping personnel through the interviews is useful as reviewing the people from the industry itself can rectify many issues that common people would not be able to find a solution. This suggests that document analysis and interviews among the shipping personnel can be used to identify existing problems and the measures to improve safety. This effort could motivate the seafarers in continuous process of improving safety as their point of view is treated importantly in the process.

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***Table 1**. Definition of human error*

Year	Author	Definition
2004	Lutzhoft	Anything human.
2004	Royal Institution of Naval Architects (RINA)	Aspects of human capabilities/ unacceptable performance.
2001	Koester	An act that cause large amount of casualties in the maritime domain.
1999	Health and Safety Executive (HSE)	Factors such as environment, organisation & job and characteristics of human and individual that effect behaviour at work which might affect health and safety.
1998	Hollnagel	Evaluation of human behaviour against performance standard.
1997	Reason	Human and organisational error taxonomy.
1991	Senders & Moray	Result of psychological processes on different levels.
1990	Reason	Slips, lapses, mistakes and violations.
1982&1983	Swain, Swain & Guttman	Errors of omission, errors of commission, extraneous acts.
1981	Rasmussen	Skill, rule and knowledge based behaviour.

***Table 2**. Features of Level 1 – Unsafe Acts*

Categories	Explanations
Error	
Decision errors	• Decision error occurs when the personnel lack in knowledge, information or experience.
Skill-based errors	• Skill-based errors occur when the personnel make a mistake in a task that is familiar to them. • These errors take place due to poor attention and memory, and unstandardized procedures and techniques.
Perceptual errors	• These errors arise when sensory input is degraded. • For example, the personnel may misjudge the distance or location in poor weather or restricted visibility environment.
Violations	
Routine violations	• Related to behaviours such as breaking the rule or procedures that has become a normal way of working within the work group, in which, often overlooked or tolerated by management. • Personnel often involved in routine violations due factors such as: to save time and energy; lack of enforcement of the rule; perception that rules are too restrictive; and creates perception among new workers where routine violations are the norm and not realising that this is not the proper way of working.
Exceptional violations	• This type of violations take place when a new problem arises and the personnel willing to disobey the rule even though aware that they are taking a risk. • These violations represents a behaviour that is outside the norms and regulations that are not tolerated by management.

***Table 3**. Features of Level 2 – Preconditions for Unsafe Acts*

Categories	Explanations
Environmental factors	
Physical environment	• This refers to factors that include weather, lighting, noise, excessive clutter and room layout.
Technological environment	• This factor focuses on a variety of issues related to the design of equipment and controls, display and interface characteristics, checklist layouts and automation.
Condition of operators	
Adverse mental state	• It refers to factors that have arises due to mental conditions that negatively affect performance, such as fatigue, stress or distraction.
Adverse physiological state	• It refers to acute physiological conditions that affects safe operation, such as illness or physical fatigue.
Physical/mental limitations	• This factor refers to the circumstances such as permanent physical or mental disabilities that may adversely affect performance. • For examples: poor vision, lack of physical strength or chronic mental illnesses.
Personnel factors	
Crew resource management	• It refers to a variety of communication, coordination, planning and teamwork issues that impact performance.
Personal readiness	• It refers behaviours, which are not adhering to regulations related to crew rest requirement, alcohol consumption or medication.

***Table 4.** Features of Level 3 – Unsafe Supervision*

Categories	Explanations
Inadequate supervision	• This factor arises when the management of personnel and resources provides inadequate trainings, guidance and operational leadership.
Planned inappropriate operations	• This factor includes all aspects of inappropriate crew scheduling and operational planning such as crew pairing, crew rest and managing the risk associated in a particular task.
Failed to correct problem	• It refers to problems among personnel, equipment, training or anything related to safety are known to the supervisor but overlooked.
Supervisory violations	• This includes the behaviour of managers in which, disobey rules, regulations, instructions or standard operating procedures.

***Table 5**. Features of Level 4 – Organisational Influences*

Categories	Explanations
Organisational climate	• It refers to several factors that influence personnel performance, for examples policies, command structure or culture.
Operational process	• It refers to organisational decisions and rules which affect the personnel such as time pressures, schedule or performance standard.
Resource management	• This factor refers to the allocation and maintenance of organisational resources such as human resources, monetary/budget resources or equipment/facility resources.

***Table 6**. Data processing in NVivo*

Steps	Process
Import	Bring in interview documents.
Explore	Open and explore the interview documents.
Code	Make a node for interested keywords or information.
Query	Run a search query to find out if there is any respondents used similar keywords or information.
Reflect	Gather the query results of the interested node and review all the material in one place.
Visualise	Display a word tree to view how the respondents talk about the interested keywords or information.
Memo	Record the insights and imply the information on the memo when write up the report or the findings.

***Table 7**. Breakdown of accident investigation reports analysed*

Accident categories	Number of reports analysed
Fire & Explosion	4
Grounding	13
Collision	7
Capsize & Sinking	2
Contact	3
Gas Leakage	1
Total	30

***Table 8**. Four levels of Human Errors*

Levels	Sub-categories		Frequencies
Level 1 - Unsafe Acts	Errors	Decision errors	14 (11.11%)
		Skill-based errors	21 (16.67%)
		Perceptual errors	6 (4.76%)
	Violations	Routine	6 (4.76%)
		Exceptional	2 (1.59%)
		Total	49 (38.89%)
Level 2 – Preconditions for Unsafe Acts	Environmental factors	Physical environment	4 (3.17%)
		Technological environment	9 (7.14%)
	Condition of operators	Adverse mental state	5 (3.97%)
		Adverse physiological state	2 (1.59%)
		Physical/mental limitations	2 (1.59%)
	Personnel factors	Crew resource management	5 (3.97%)
		Personal readiness	8 (6.35%)
		Total	35 (27.78%)
Level 3 – Unsafe Supervision	Inadequate supervision		5 (3.97%)
	Planned inappropriate operations		12 (9.52%)
	Failed correct problem		5 (3.97%)
	Supervisory violations		8 (6.35%)
		Total	30 (23.81%)
Level 4 – Organisational Influences	Resource management		1 (0.79%)
	Organisational climate		5 (3.97%)
	Organisational process		6 (4.76%)
		Total	12 (9.52%)

***Table 9**. Percentage of HFACS causal factors identified in different accident investigation report analysis.*

HFACS application	Area	Number of accident reports	Unsafe acts		Preconditions for unsafe acts		Unsafe supervision		Organisational influences	
			No.	%	No.	%	No.	%	No.	%
Current study	Shipping	30	49	38.89	35	27.78	30	23.81	12	9.52
Singh (2014)	Shipping	15	156	24	152	23.4	190	29.3	151	23.3
Schröder-Hinrichs et al. (2011)	Shipping	41	75	20	208	56.5	21	5.7	51	13.9
Patterson and Shappell (2010)	Mining	508	481	42	416	36.8	186	16.4	49	4.3
Li et al. (2008)	Civil aviation	41	107	32	84	25.5	82	24.8	57	17.3
Baysari et al. (2008)	Railway	40	49	13	83	23.1	14	3.9	214	59.4
Reinach and Viale (2006)	Railway	6	12	33	9	25.0	6	16.7	9	25.0
Gaur (2005)	Civil aviation	48	37	38	23	23.7	12	12.4	25	25.8
Total			966	31.31	1010	32.74	541	17.54	568	18.41

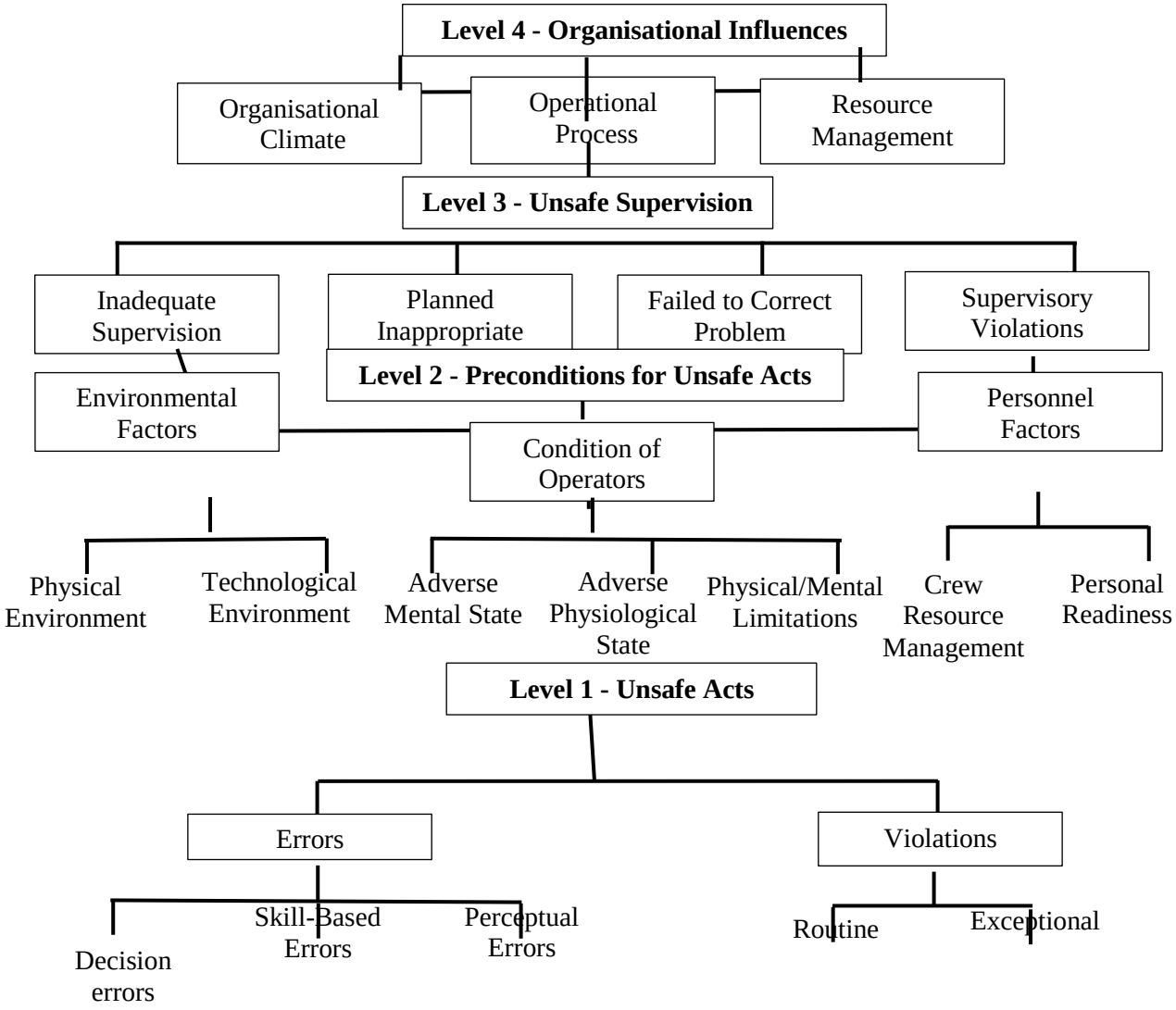

***Fig. 1**. HFACS Framework (Shappell and Wiegmann, 1997; Diller et al., 2014)*

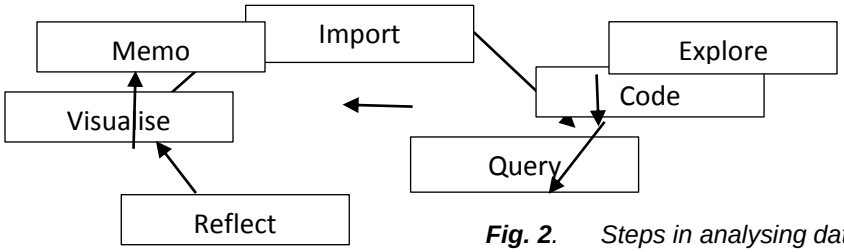

***Fig. 2**. Steps in analysing data in NVivo*