An Oil Spill Contribution Factors by Shipping Activities: A Preliminary Case Study at Four Marine Authority Levels in Penang

Ismila Che Ishak[#1], Rahmat Hazim Mohalid[#2],

[#] *Universiti Kuala Lumpur Malaysian Institute Marine Engineering Technology, Jln Pantai Remis, 32200 Lumut, Perak. Malaysia*

[1]ismila@unikl.edu.my

***Abstract*— Shipping event is found as an influential and positive force which donates to huge global trading activities. The sea transportation actions contribute to sea problem, especially on oil spill. There are several factors donating to an oil spill problem at sea. However, this research emphasis on two factors which are on human factors and technical factors. The scope of research focuses at Penang Port and Government related bodies. A semi structured interview was conducted among respondents from law enforcement and government related bodies which comprises of Agency Penguat Kuasaan Marin Malaysia, Environment Department, Penang Port Authorities and Marine Department. Upon approval, only five main respondents were interviewed from 26 total samples and population who are among middle level of management from different related government agencies. The human factor elements caused an oil spill comprises of inadequate knowledge, fatigue, lack of training and misunderstanding throughout ship operation. Meanwhile, the technical factor elements comprise of bad weather at sea, old on board equipment, ship do not enter the dock and system failure. The result shows the oil spill is significantly caused by human factors, especially by the lack of training at 18%, fatigue among crew for 18%, inadequate knowledge among crew at 18%, crew misunderstanding of ship operation at 16%, old equipment at 9%, system failure at 9%, bad weather at 9% and finally only 3% due to ship which do not enter the dock.**

***Keywords*—** *Oil Spill, Shipping Activities*

1. Background Research

Generally almost every year 1 800 million tons of raw petroleum are transported via ocean in the world (Hänninen and Rytkönen, 2004). Marine transport is one of the most secure transport ways and mostly an oil is transported securely to its destination. In any case, there is dependably a danger of a tremendous oil slick. Previously, there have been huge oil tanker accidents conveying about giant volumes of oil slicks that have prompted significant open consideration and to an endeavor to discover approaches to minimize the dangers identified with such occasions. Regularly, substantial oil slick mishaps are connected with the crash, establishing or weight loss of support trustworthiness. A portion of the accidents has brought about vast monetary misfortune and neighborhood harms to the earth. These mischances have an impact on the improvement in the sea models and well-being enactment. Typically corrections of enactment are taken after significant disasters and preventive activities are still phenomenal. This research extents discussion on a special reference to oil spill made by shipping activities especially in Penang Port. The Penang Port is situated along the Malacca Straits and it is more influenced to the oil spill problem since the straits is an international route. Daily, there are various types of vessel use this port. It is assumed the impact of this issue could create a repercussion for the economy of the country. There are several significant factors which leading of this oil spills problem. Thus, this research is conducted to examine contribution factors of this issue, which is from human factor and technical factor. This research focuses on government related bodies such as Marine Department, Agensi Penguat Kuasaan Maritim Malaysia (APMM) and Police Marine.

2. Scope and Location of Research

This research focuses on Penang Port which has shipping activities that could lead higher intention

International Journal of Supply Chain Management
IJSCM, ISSN: 2050-7399 (Online), 2051-3771 (Print)

to occur an oil spill problem at sea. The information is gathered from appropriate government agencies such as the Penang Marine Department, Penang Port Authority, Penang Environment Department and Agensi Penguat Kuasaan Maritim Malaysia (APMM). Penang is recognized as a gateway port for Peninsular Malaysia's in Northern Region. This is a reputable port serving one of the region's busiest trade routes. It is proficient in handling 25 million tons of cargo annually, it adores connecting with to 200 ports worldwide. It serves the Malaysia-Indonesia-Thailand growth triangle and has a thriving manufacturing-based hinterland. Penang Port is a well linked with land and air modes and is manageable to and from all the major economic regions in Peninsular Malaysia.

Figure 1: Penang Island (Google Map, 2016)

Figure 2: Penang Port (Google Map, 2016)

3. Literature Review

3.2 Oil spills

An oil slick is the appearance of a fluid petroleum hydrocarbon into the earth, particularly marine regions, because of human movement, and is a type of contamination. The term is normally connected to marine oil slicks, where oil is discharged into the sea or beach front waters, yet spills may likewise occur ashore. Oil slicks force because of influxes of raw petroleum from tankers, seaward stages, penetrating apparatuses, and additionally spills of refined petroleum items, (for example: gas, diesel) and their by-items, heavier fills utilized by huge ships (for example: fortification fuel, or the spill of any sleek decline or waste oil). The oil slick might be transported by an operational and an incidental arrivals of transportation exercises (Vanem, 2009). International Tanker Owners Pollution Federation Limited (ITOPF) has collected information about oil slicks 1974. Most oil slick occurrences have been a repercussion of a mix of various activities and environments. Operational causes are surrogate stacking/releasing, bunkering and different operations. Incidental causes give frequently to ascend to bigger oil slicks. Involuntary causes are delegated crashes, groundings, structure disappointments and flame and blasts. (ITOPF, 2012.) Only 25 % of the oil entering the ocean through transportation is brought about by coincidental oil slicks.

3.2 Factor cause an oil spill

3.2.1 ***Human factor***

It is stated that, 80% of oil slicks and marine accidents have been endorsed to human elements, either singular mistakes or hierarchical disappointments (Hee, 1999, Rothblum, 2006, Hetherington, 2006). As technologies increase, for example: double hull structures can decrease the significance of an oil spill created by groundings or crashes, yet it can't obstruct with the chain of occasions that may bring about the mischance to happen in any case. Then human factors or human mistakes have brought on frequent accidents. For example: Exxon Valdez (1989), accidents were halfway brought about by human error has concentrated on human mistake and marine safety. Some type of human mistake has brought about, at any rate incompletely, around 75–96 % of marine setbacks and 84–88 % of tanker mishaps. Thus, it leads to the oceanic loss rate has remained high Chauvin, (2013). The International Safety Management Code (ISM code) has been built up to diminish the event of human mistakes. Presently, the ISM code has been obligatory over 10 years on safety society in the sea business (Lappalainen, 2008). Gordon (1998), proposed a structure of describing the connections between basic human factors and rapidly clear human errors, as appeared

in Figure 3. Gordon sorts human factor as individual, group, or organization, and takes after the Rasmussen model (Rasumussen, "Recognitions on the Concept of Human Error," 1993 in Gordon, 1998) of ordering human mistakes as aptitudes based, standard based, or information based.

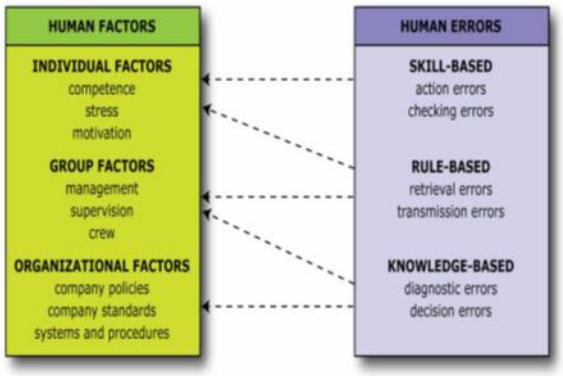

Figure 3: Human factors VS Human errors (Gordon, 1998)

3.2.2 Types of human factor and technical factor

Gordon (1998), proposes three classes of human elements that add to accidents in the seaward oil industry, including tanker operations: organization factors, group factor and also individual human factors. It is found that in spite of the fact that the larger part of prompt causes is rigid from people, the dominant part of contributing, or basic, components can be credited to the hierarchical sett or gathering progression that impacts the person. Correspondingly, once an accident series has started, authoritative impacts may permit the grouping to keep, bringing about a mischance. Thusly, the way of life, motivating forces, working methodology, and methods of associations affect the security of marine framework (Hee, 1999).

3.2.2.1 Organization factor

A few study and case audits have found that organizational factors might be the most basic in considering human factor contributing to an oil spills. At the organization level, different foundations or factors may add to an expansion in occurrences and accidents, including cost-cutting projects and the level of correspondence between work-sites (Gordon, 1998).

3.2.2.2 Group factor

At the group level, the influences over people, the individuals from a vessel group, for example, or between a boss and subordinate, may influence safety. Group factors may cover with organization factors, however, in the marine oil transportation industry, the flow at the group level, for example, groups or duty sections, can be acute to general security (Gordon, 1998). A main significant group factor of tanker processes is the environment that exists on operational units, for example: a vessel team or crew. The sea convention of "iron men on wooden boats" has been referred to as a benefactor to hazard taking conduct. Overconfident or bluster may add to the activities that disregard an organization's expressed security tactic. Weight from the association or organization to meet unrealistic requests for the number and competences of accessible work force may empower variable or hazard taking conduct as team stretch to meet requests for bosses.

3.2.2.3 **Individual human factor**

Although most researchers identify the significance of the organizational safely culture, the part of the individual administrator is basic. The capability, perceptual judgments, anxiety, inspiration, and health dangers, (for example: work over-load) of an individual administrator are basic to the chain of occasions that may bring about an accident or oil slick (Gordon, 1998). Two of the most perceived and examined unusual components as identified with the marine industry are portrayed here: inadequate knowledge and fatigue.

3.2.2.4 Inadequate knowledge

A National Research Council (NRC) studies (1990; cited in Rothblum, 2006), cited inadequate common technical knowledge as the cause of 35% of marine casualties: “Mariners often do not comprehend how the operation works or under what set of operating conditions it was deliberate to work effectively.”. In the same study, 78% of mariners ascribed a lack of understanding of the complete system of the ships while working on as a contributing factor of accidents. Moving among different sizes and types of vessels can cause misperception and conciliation decision-making abilities if mariners are not familiar with the ship-specific systems. At the point when individuals take activities that build the danger of

disappointment, it is regularly in light of the fact that they have experienced a rare occasion that is not a portion of their preparation or general mindfulness, and they are unconscious of how their activities will influence the framework or are ignorant that they are adding to mischance hazard (Pate-Cornell and Murphy, 1996). The mariner is accused of settling on route choices taking into account all accessible information. Too often, it is tended to depend on either a favored bit of gear or our memory. Several casualties result from the failure of counsel accessible information, (for example, that of a radar or a noise sounder). In dissimilar cases, serious information or data might need or wrong, prompting route mistakes (such as, bridge supports frequently are not stamped, or floats might be off-station) (Rothblum, 2006).

3.2.2.5 Fatigue

US Office of Marine Safety, Security and Environmental Protection and the Office of Navigation Safety and Waterway Services found that fatigue was among the top three causes of marine accidents (Gordon, 1998). Rothblum, (2006) cites studies by the Marine Transportation Research Board in 1976 and the NRC in1990 where fatigue was the primary concern of mariners in both cases. In an Australian report that analyzes reporting methodologies and the relationship between sleep, fatigue, and accidents in Incident at Sea Reports, Phillips (2000) found that 86% of the reports analyzed made some reference to sleep, although many of these references described the sleep loss as a way of life on board ship rather than as a direct causal factor. Thirty-nine per cent of the reports considered sleeping or sleepiness as a contributing causal factor. Research has illustrated that there are potentially disastrous outcomes of fatigue in terms of poor health and also diminished performance (Josten, Ng-A-Tham, & Thierry, 2003).

3.2.2.6 Other individual factor

Pate-Cornell and Murphy (1996), oppose that people are basically rational, but their goals and risk attitude may not always match those of the organization, due to policies that may inadvertently encourage adverse behavior. People typically act to obtain awards and avoid negative penalties, but more weight is generally given to potential negative consequences to themselves, such as being trapped and punished, rather than how specific behaviors may contribute to catastrophic accident risks. Production pressures, an organizational factor, may contribute to risk-taking behaviors, because the potential for reward for high production may outweigh the consequences of the worst-case scenario, especially for activities where that risk seems particularly remote. Another component of individual human factors can be attributed to a lack of readiness for crises. Operators may be extremely proficient in routine day-to-day operations; however, because crises occur so rarely and are not always well foreseen, an operator may be poorly prepared to deal with such an event. Finally, people have a tendency to disregard information that is inconsistent with their views until it becomes certain. This has been cited as a cause for impractical optimism in a variety of industries where accident risks are categorized by insecurity. Only when faced with inevitable, catastrophic concerns do people acknowledge the potential for disaster, at which point intervention may not be possible.

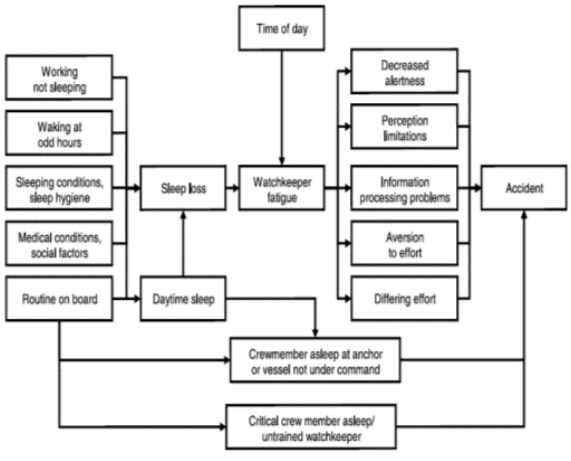

Figure 4: Relationship between sleep loss, fatigue, and accidents (Phillips, 2000)

4. Methodology

4.1 The semis structured interview

An interview is a conversation with two or more person between an interviewers and respondents. The interview is commonly to acquire information about someone and produce inclusive, flexible data with questions asked. The interview meeting is a subjective exploration method which normally covers directing concentrated individual meetings with respondents. It is also used to investigate

points of view on a specific thought, project, or circumstance. The semi-organized interview is a subjective interview that is characterized by a pre-set question direct. It aims to provide in-depth results from informal deliberation with members (Collis and Hussey, 2013). This interview strategy was picked over unstructured or organized meetings, since this review expects to answer the exploration inquiries by asking particular inquiries, however less (unstructured) that it creates wasted information, and not all that less (organized) so as not to pass up a major prospect of any unexpected data. The semi-organized meeting guide to give unique procedure of guidelines on questioners and provides dependable, alike subjective information. The semi-organized meetings are used in this research since it is frequently ended before by perception, unexpected and unstructured talking keeping in mind the end goal to permit the specialists to build up a sharp comprehension of the theme of interest vital for creating relevant and important semi-organized inquiries (Cohen, 2006). The interview session was conducted among law enforcement and government associated bodies in Penang water on oil spill experiences. The respondent bodies are from:

i) Penang Environment Department
ii) Penang Port Authorities
iii) Agensi Penguatkuasaan Maritim (APMM)
iv) Penang Marine Department

Table 1: Semi structured interview

Strategy	**Aim**	**Sample**	**Type of questions**	**Method of analysis**
Qualitative semi-structured interviews	To ascertain the contribution factors toward an oil spill which is from human and technical factors	Department of the law enforcement in Penang area	Structured questions and Open questions	Content analysis

4.2 Population, sample and respondents

Umar (2016), state that the validity of data onto respondents in qualitative method should be 30% and above for sample. Each respondent signifies sample and the population of the research. The unit analysis of this research involves an individual among Top Management and Middle Management who has sufficient knowledge on oil spill and, is representing the different four marine government organizations. The actual population of this research is 37 staff and, the targeted sample is among 26 samples covers among Middle Management which upon discussion have agreed to participated in responding to the research questions. However, due to time constraint and other full agenda during the interview session only five or 19.23% authorized respondents who have contributed in this research which comprises among middle level of management in various associated marine law enforcement in Penang. The qualitative analysis is based from the five respondents respectively.

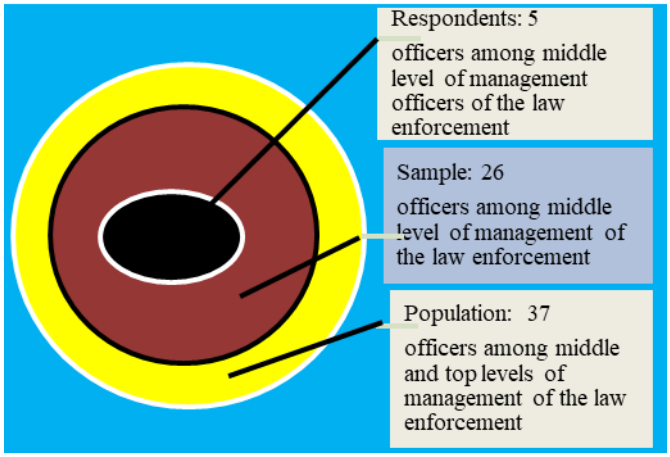

Figure 5: Population, sample, respondent.

Table 2: Breakdown of population, sample and respondent

Population 37	*Top Management:11* APMM (2) Environment Department (2) Penang Port Authorities (4) Marine Department (3) *Middle Management: 26* APMM (5) Environment Department (6) Penang Port Authorities (10) Marine Department (5)
Sample 26	*Middle Management: 26* APMM (5) Environment Department (6) Penang Port Authorities (10) Marine Department (5)
Respondent 5	*Middle Management:* APMM : 1 Environment Department : 2 Penang Port Authorities : 1 Marine Department : 1

Table 3: Respondents background

Respondent	Role	Number of Respondent	Year in the field	Feedback
R1	Middle Management of APMM	2	18	Support that human factor give main reason towards an oil spill problem at sea and do not deny there also some technical factor
R2 and R3	Middle Management of Environment Department	2	10	Agree that an oil spill problem at sea came from human factor
R4	Middle Management of Penang Port Authorities	1	14	States that the human factor is always happened toward an oil spill problem made by shipping activities at sea
R5	Middle Management of Penang Marine Department	1	9	Mostly, an oil spill problem at sea happened because of the human itself

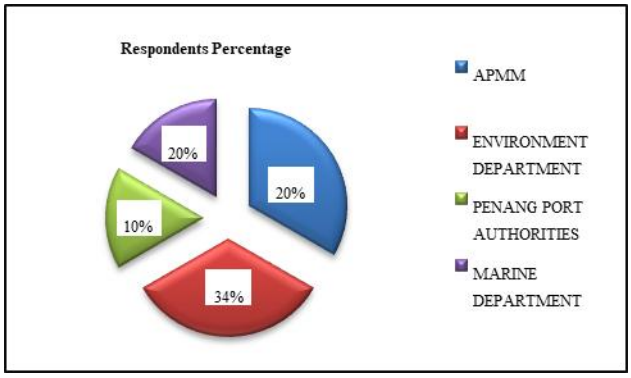

Figure 6: Percentages respondent from each department

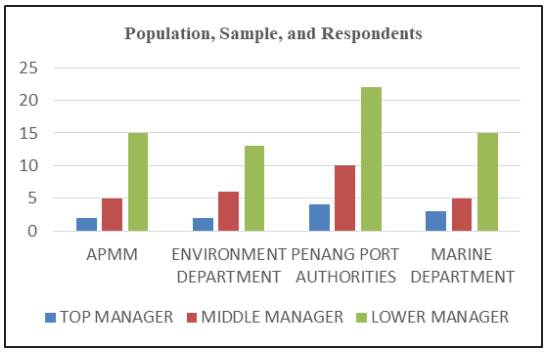

Figure 7: Graph of population, sample, respondent, from each department.

5. Data Analysis

5.1 Human and technical factors results

It shows the breakdown elements caused by human factors which contribute to spill are by lack of training for 18%, fatigue among crew at 18%, inadequate knowledge among crew at 18%, crew misunderstanding of ship operation at 16%. Meanwhile the results caused by technical factors of oil spill are by old equipment at 9%, system failure at 9%, bad weather at 9% and finally only 3% due to ship which do not enter the dock. The respondents are from related law agencies, bodies who have working experiences ranging from 9 to 18 years. All of the respondents have agreed the oil spill is caused mostly by human factor rather than technical factors.

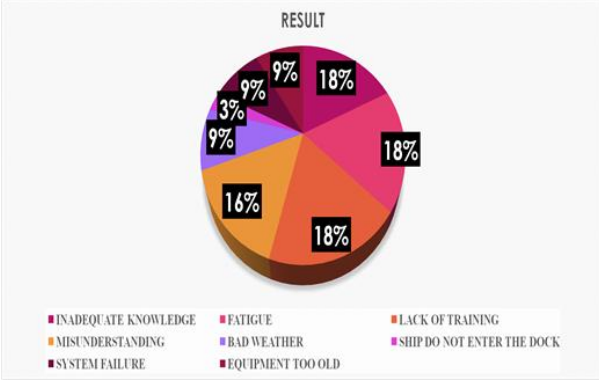

Figure 8: Result for human and technical factors that caused an oil spill

5. Conclusion

It is concluded that, based from the different respondents from the four different government authorities at Middle Management Level which stated that the human factors caused significantly compared to technical factors towards an oil spill by shipping activities in Penang Port water area. The human factors caused a higher percentage of oil spill, especially by lack of training, fatigue, crew misunderstanding during ship operation at sea and inadequate knowledge. Meanwhile, the technical factors also contributed to an oil spill problem, but in a small percentage. However, this oil spill issues to keep on permanently arising, but it can be reduced. (Rothblum, 2006), shows 78% of mariners eligible a lack of understanding of the complete system of the ships while working as the causal factor to spill. Hee (1999), stated 80% of oil spills and marine accidents have been recognized due to human factors, individual errors and organization factors.

Acknowledgement

First of all, thanks and grateful to Allah S.W.T. The Most Gracious, The Most Merciful and The Most Mighty and, also to Muhammad the Prophet of Allah Peace be Upon Him that blessed us the chance and strength created and completed this research. I would like to prompt my special thankfulness to my team member named Rahmat Hazim Mohalid who has given the support in completing this research paper. I would like to express my sincere thank you to everyone that has helped in completing this research paper. A genuine thank you to Universiti Kuala Lumpur MIMET who provided the budget allocation form Final Year project to run this research paper. Last but not least, an extension appreciation for all the respondents at Penang Port respectively who had given cooperation during the questionnaires surveys session. Thank you very much.

References

[1] Cohen, D, & Crabtree, B, "Qualitative research guidelines project", 2006.

[2] Chauvin, C, Lardjane, S, Morel, G, Clostermann, J.P, & Langard, B, "Human and organisational factors in maritime accidents: Analysis of collisions at sea using the HFACS. Accident Analysis & Prevention", No. 59, pp.26-37, 2013.

[3] Collis, J, & Hussey, R. "Business Research: A practical guide for undergraduate and postgraduate students", Palgrave Macmillan, 2013.

[4] Exxon Valdez, 1989, Peterson, C.H, Rice, S.D, Short, J.W, Esler, D, Bodkin, J. L, Ballachey, B. E., & Irons, D. B, "Long-term ecosystem response to the Exxon Valdez oil spill", Science, Vol. 302, No. 5653, pp. 2082-2086, 2003.

[5] Josten, Ng-A-Tham, &Thierry, Hetherington, C, Flin, R, & Mearns, K, "Safety in shipping: The human element", Journal of safety research, Vol. 37(4), pp.401-411, 2006.

[6] Gordon, R. P, "The contribution of human factors to accidents in the offshore oil industry", Journal Reliability Engineering & System Safety, Vol. 61(1-2), pp.95-108, 1998.

[7] Hänninen and Rytkönen, Kujala, P, Hänninen, M, Arola, T, & Ylitalo, J, 2009, "Analysis of the marine traffic safety in the Gulf of Finland", Journal Reliability Engineering & System Safety", No. 94(8), pp.1349-1357, 2009.

[8] Hee, D. D., Pickrell, B. D., Bea, R. G., Roberts, K. H., & Williamson, R. B, "Safety Management Assessment System (SMAS): a process for identifying and evaluating human and organization factors in marine system operations with field test results". Journal Reliability Engineering & System Safety, Vol. 65(2), pp.125-140, 1999.

[9] ITOPF. "Use of skimmers in oil pollution response. Technical Information Paper, (5), Lond, 2012, Retrieved from http://www.itopf.com/fileadmin/data/Documents/TIPS TAPS/TIP5UseofSkimmersinOilPollutionResponse.pdf.

[10] Lappalainen, J, "Transforming Maritime Safety Culture. Evaluation of the impacts of the ISM Code on maritime safety culture in Finland", 2008.

[11] Pate-Cornell, M. E, & Murphy, D. M, "Human and management factors in probabilistic risk analysis: the SAM approach and observations from recent applications". Journal Reliability Engineering & System Safety, Vol. 53(2), pp. 115-126, 1996.

[12] Phillips, R, "Sleep, watchkeeping and accidents: a content analysis of incident at sea reports", Transportation research part F: Journal Traffic Psychology and Behaviour, Vol. 3(4), pp.229-240, 2000.

[13] Rothblum, A. M, "Human Error and Marine Safety. U.S. Coast Guard Research & Development Center, pp.1–9, 2006. Retrieved from https://www.google.co.za/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#.

[14] Hetherington, C, Flin, R, & Mearns, K, "Safety in shipping: The human element. Journal of Safety Research, Vol. 37(4), pp. 401-411, 2006.

[15] Sekaran, U., & Bougie, R. J, "Research methods for business: A skill building approach". John Wiley & Sons, 2016.

[16] Vanem, E, Puisa, R, & Skjong, R, "Standardized risk models for formal safety assessment of maritime transportation". ASME 2009 28th International Conference on Ocean, Offshore and Arctic Engineering, Journal American Society of Mechanical Engineers, pp. 51-61, 2009.