ANALYSIS ON DETERMINANTS OF INCIDENT INVOLVING MARINE VESSELS IN PENANG ISLAND WATERWAYS

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ABSTRACT

Marine vessel incidents are serious matter that keep increasing worldwide, and this situation can lead to more problems. This study focused on Penang Waterways because it is one of the busiest waterways in Malaysia. This research studied the case pattern of marine vessel incident occurrences. An analysis was conducted through survey/questionnaire method to identify the major factor/determinants of the marine incidents occurrences. Through the collected data of questionnaire, statistical data can be projected to display all the determinants based on rank. The data was analysed through Cronbach's Alpha method and Likert scale in the questionnaire. The data can then be used to raise awareness of the occupational risk of marine industry field. This research will then be serving two purposes, which is first for the purpose of analysing marine vessel incidents while focusing on the factors/determinant and precaution can be made for upcoming voyeur. The second purpose serves as a journal for public to gain information on the occupational risk of the marine field industry.

Keywords: Marine Vessel; Incident; Determinants; Penang Waterways

1 INTRODUCTION

Incident can be categorized as an undesirable event that can lead to actual loss or injury to a person, property, or equipment. Officers and crew shipboard should always be alert of the importance/significance of safety to apply in their daily routine working practices. Although, the fact that this correspond incidents can be prevented or avoided, from time to time, they still occur onboard, incident rate maintained its rate gradually without downfall. Maritime vessel incidents worldwide have shocked the world every now and then. History has proven that list of maritime vessels involved incidents had increased intensively and quite long on list. Casualties involved are also grievously high [1]. The persistence of event occurrence had led changes that reshaped and introduce various safety regulation and protocol to handle the situation by the International Maritime Organization [2]. The research is set at Penang Waterways due to the waterways had always been the main spotlight in all waterways in Malaysia beside the Malacca Waterway with its historic background. Penang Waterways is considered as a pit stop for major import and export passageway, due to this fact various type of vessel tend to sail this waterway and incidents are keen to happen anytime involving these vessels. This research involved multiple agencies of maritime safety such as Malaysia Maritime Enforcement Agency (MMEA), Penang Port (Safety Department) and Marine Department Malaysia (Northern Region). There are several incidents related to marine vessel that occurred at Penang, this research will also help to identify the main cause and internal/external factors that may be involved.

1.1 Malaysia Waterways and Maritime Zone

Malaysia waterways is known for its famous route that shorten the length of travel from past historic event, which the Malacca straits came to be famous for its opening as port [3]. As time pass, Penang has also established as an independent port by Francis Light that increased its capital value for better short port-stop for mercenary [4]. This research was conducted at Penang Waterways for the reason to establish data analyzation of statistic on marine vessel related incident and to identify the major determinants of incidents. The major straits that Malaysia have are Balabac Straits, Straits of Johor, Straits of Malacca, Penang Straits, and Sibutu Passage. In general, Malaysia consists of land and sea area, where land covers about 329,758 km2 that is divided into two regions, Peninsular Malaysia and the state of Sarawak and Sabah, while the territorial waters of Malaysia cover about 150,000 km^2 and Malaysia covers about 4,800 km of coastline. In this research, the researcher only focused on territorial sea, exclusive economy zone and coastal. Malaysia maritime zone consists of Territorial Sea, Exclusive Economic Zone, and Coastal Zone. Each zone has its embedded acts that regulates rules and regulation.

1.2 Marine Vessel Incidents

Marine vessel biggest unwanted situation is to be involved with any incident, whether at sea or not. According to [2], when an incident occurs, it will impact all related authorities, even environment is indirectly affected. Occurrence of this incident had always been a question mark whether internal or external factors mostly to contribute to the incident. The most common factor that was highlighted by the International Maritime Organization (IMO), was human element. Human element has different perspective that might lead to this matter, external element that may have influence in this human element would be environment. Due to the world economy facing downfall, companies are left to recruit low cost and under-qualified worker. This worker that lacks trainings and experience might conduct error in handling machinery and inflict factor that will lead to incident [6]. Human element can also be interpreted into lack of safety awareness in worker's practice. A marine vessel can have the most experience crew in the sea but still face incident, this is possible if safety awareness is not engaged properly or the cost from one in a lifetime mistakes. Human element related factor can be expanded more with influence from internal and external. Marine vessel incident can be classified into various types such as collision, grounding, stranding, fire, and capsizing. Each type of incidents has its own major determinants that lead to occurrence of event.

1.3 Marine Safety

Maritime safety includes area of safety of navigation, seafarers, and oil spill response and vessel traffic system. There is a law enforced by worldwide organization which is the International Maritime Organization (IMO). This law exists to ensure every marine vessel (Malaysian vessel included) safety is well assured, this also helps to ensure, waterways are safe, secure and at the same time preserve the environment from pollution of maritime industry may surge. To fortify the law, required by the IMO, there are also supported by conventions which is the International Convention on Safety of Life at Sea (SOLAS), Standard for Training and Watch Keeping (STCW), and International Convention for the Prevention of Pollution from Ship (MARPOL). To elaborate more, this convention helps to maintain the harmony of the sea, to prevent any unwanted event and propose idea on how to solve any current issue faced by the maritime industry.

The International Convention for the Safety of Life at Sea (SOLAS) sets the minimum safety standard for every maritime industry either in construction, equipment handling and operation of merchant vessels. SOLAS enforces that every marine vessel to be highly authorized signatory flag states to make sure every vessel is bound and adhere to their minimum safety regulation in equipment handling, construction and operation. Standard for Training and Watch Keeping (STCW) functions as a guidance for

seafarers, which set the minimum requirement of training for worker to apply any designated job scope. This ensures that every vacancy is filled in with the most qualified worker and not underqualified.

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the convention that focused on the prevention of pollution from maritime industry towards the environment. This ensure the longevity and perseverance of the nature from human element. MARPOL prevent pollution from operational from marine industry or incident occurrence. It was adopted at the International Maritime Organization (IMO) in 1973. In a nutshell, MARPOL functions to protect the marine life from danger and any incidental occurrence of pollution.

1.4 Major Determinants of Marine Vessel Incidents

Marine incidents are divided into multiple factors and determinants that may cause this occurrence. This section will explain more on article related to each possible determinant and how this determinant affects the outcome of the incident. In maritime industry, the most common risk and danger faced by workers are incident related. Incidents can happen unexpectedly and result in injuries on worst casualty. There are several determinants that may lead to maritime incidents, some are common than others. Marine vessel incidents factors can be categorized into two types which are human element error and machinery/structural fault and error, and weather condition. Human element error consists of language barrier, miscommunication, and lack decision making skill. While machinery and structural faulty consists of structural faulty itself and maintenance factor. Weather conditions rely on the statement which depends on the weather condition while on voyage.

1.5 General Statistics of Vessel Incidents in Malaysia Waterways

This statistical data analysis of vessel incidents is acquired from the Marine Department of Malaysia from the year 2008 to 2017. During this period, there were 774 incidents involving various vessel types in Malaysia water. Figure 2 shows the highest number of incidents is 113 which occurred in 2009, while the least amount of incident is 43 which happened in the year 2014. According to Marine Department of Malaysia record, the most common incident type is collision, grounding, and foundering. While other type of less common incident type is fire, missing person, flood, and capsize. The figure below shows the type of incidents incurred by various types of vessel in Malaysia waters.

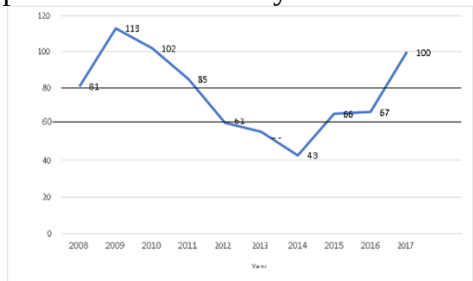

Figure 2: Number of incidents in Malaysia Waterways

1.5 Analysis on Type of Incidents in Malaysia

As stated by the Marine Department of Malaysia, the major types of incident involving marine vessel on Malaysia waters are collision, foundering, and grounding. From the record, a total of 774 cases reported involving marine vessel incidents from the year 2008 to 2017. Figure 3 shows that 38% from the 774 case is due to collision, while 24% from foundering and 11% from grounding.

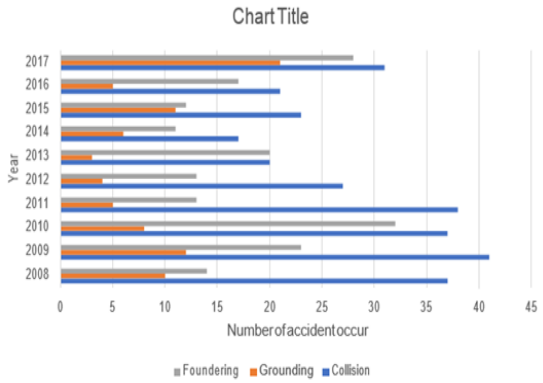

Figure 3: Shows the number of incidents regards to the type of incident

In general, there are tons of marine incidents cases that had occurred, this incident indirectly had affected the marine environment. This research study focused on finding, identifying, and analyzing factors contribute toward the incidents' severity and occurrence. In 2019, marks the 107 years anniversary of the Titanic incident that had left a huge impact that literally cause the International Maritime Organization to take serious and strict law and regulation regarding to safety [8]. Type of incidents also vary into four types, collision, grounding, stranding, fire, and capsize. No denying that incidents that happen are bound to factor whether internal or external. The rate of incident in the marine industry had significantly increase year by year, this is alarming to the marine industry. As incidents rate increases, The International Convention community had also reacted by introducing new regulation related to solve the issue and perhaps in distant future issues . But incident kept happening with significant different factor arose with differ challenges, that requires more calibration with regulation. Lack of encouragements toward safety engagement in marine industry are major factors that contributed to past incidents that occurred. Even at Malaysia, Feb 9th 2019, two vessel collided at Johor Bahru, involving a Malaysian vessel Polaris and Greek-registered bulk carrier Piraeus Port According to thestar.com.my (Marine Dept: Vessel Collided in Malaysian Waters), Marine Department will investigate and observe every case file involving marine vessel, and the most common result are bound with worker lack of safety awareness and engagement. The most common and general factors that leads to marine vessel incidents is human error, collision, foundering, capsize off, grounding and the fire/explosion onboard ship. Human error, grounding, collision, and shipboard fire has been classified as major dominants factors of marine vessel incidents worldwide [8].

Shipping/marine vessel incidents are unexpected event that can lead to profit loss financially and properties. Fatality or serious injury can also occur toward human onboard [7]. Marine vessel incident also affects the marine environment through oil spillage that threatens the life of thousand marine species, also human will be affected through loss of resources. Marine vessel incidents undeniably cause a ripple effect that affects various sector in the world. The effects of marine vessel incidents affect human safety, structural of surrounding, environmental, reputation and economical. Each has their own risk level in percentage of effectiveness toward their resources of the world.

This research is to help identify the major determinants of marine vessel incidents occurrence, and display statistic data of the incidents rate at Penang Waterways. This research helps to propose every aspect of marine incident determinant. This research aims to help Marine Department (Northern region) to focus determinants of marine incidents occurrence at Penang waters, aid to fabricate idea on solution for the occurrence by focusing on major determinants.This research also has significance safety prospect of awareness of marine vessel that can benefit the government, society and the company

2. RESEARCH METHODOLOGY

To accomplish the objectives set for this research, the main purpose is to analyse the statistics of marine vessel incidents and identify the major determinants of the incident's occurrence at Penang Waterways. Data for research were obtained through the related agencies authority of Marine Department, and Malaysia Marine Enforcement Agency (MMEA). Data collected from the stated agencies had helped to further strengthened the research. There were two types of data sources utilized for this research, which were primary data and secondary data. Primary data is collected through method of interviews and questionnaire. Secondary data is collected through data collection from previous research and data analysis from the targeted respondent statistic data.

3. RESULTS AND DISCUSSION

3.1 Analysis Statistic of Marine Incidents in Penang Waterways

The statistical data analysis of vessel incidents was based on Marine Department Malaysia record from the year 2008-2018. There were 802 incidents ranging from various types of vessels and type of incidents in Malaysia waterways. Figure 5 below shows the statistic for number of marine vessel incidents occurrence for each year, and based on that graph, the highest number of incidents is 113 which occurred in 2009. While the least number of incidents occurred in year 2018. There was also a statistical data analysis of marine vessel incidents based on the Marine Department Malaysia in Penang waterway, Pulau Pinang from year 2013 until 2018. There were 20 marine incidents. Figure 6 below shows the number of marine vessel incidents for each year. The highest number of incidents in Penang Waterway was 10 which occurred in the year 2018. The lowest number of incidents per year was in the year 2013 and 2016 which was 2.

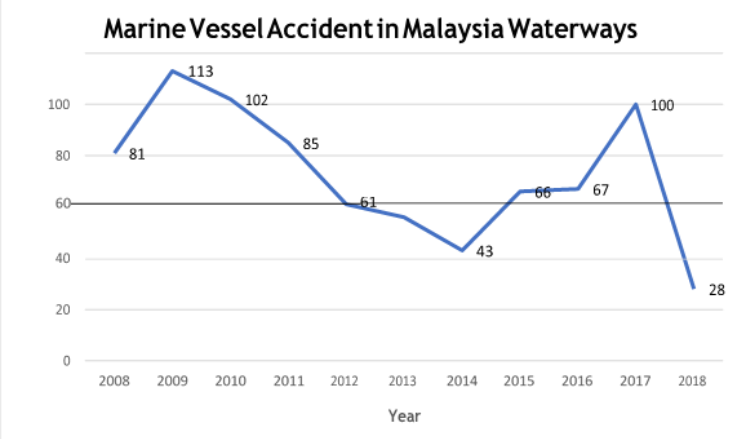

Figure 5: Number of vessel incidents in the year 2008 to 2018 in Malaysia Waterways

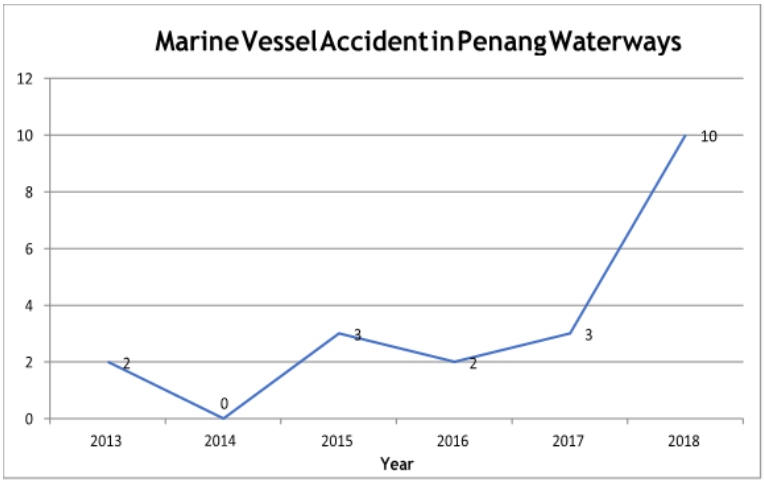

Figure 6: Number of vessel incidents in the year 2013 until 2018 in Penang Waterways

3.2 Questionnaire (Section A)

Section A of the questionnaire is designed to obtain general information of the respondents which consist of gender, age, years of working experience, highest education level, workplace incident experience, and knowledge on marine vessel incident. Below are the tables which display the findings on the respondent's demographic data in table form:

Table 1: Gender

Gender	**No. of Respondents**	**Percentage (%)**
Male	43	72
Female	17	28
Total	60	100

Table 2: Years of Experience

Experience	**No. of Respondents**	**Percentage (%)**
Less or equal 5 years	17	28
6-10 years	19	32
11- 15 years	10	16
More than 15 years	14	24
Total	60	100

Table 4: Highest Education Level

Highest Education	**No. of Respondents**	**Percentage (%)**
SPM	10	16
Certificate	12	20
Diploma	7	12
Degree	24	40
Master	2	4
Others	5	8
Total	**60**	**100**

Table 5: Respondents' Experienced Incidents

Respondents Experienced Incidents	**No. of Respondents**	**Percentage (%)**
Have experienced	12	20
Have not experienced	48	80
Total	**60**	**100**

3.3 Questionnaire (Section B)

In section B, respondents are required to rate the agreement of the main determinants of marine vessel incidents. In this section, the data was analysed using Reliability Test. Table 6 below shows the Cronbach's Alpha value in section B. Cronbach's Alpha measures the consistency and accuracy of item. The Cronbach's Alpha value illustrated the item listed for data analysis are acceptable for usage. The table above shows that section B is reliable and useable. Relative Importance Index (RII) method was used to measure each of the indicator and ranked the data acquired from section B. The result of the rank in section B will use Likert Scale for agreement (1 was considered as strongly disagree, 2 as disagree, 3 as moderately agree, 4 as agree and 5 was considered as strongly agree) is shown in the table 7.

Table 6: Value of Cronbach's Alpha in Section B

Major Occupational of Incidents	**Cronbach's alpha (α)**	**No of Items**
Human Factors	0.876	4
Environment Condition		
Technical Failure		
Route Condition (Traffic)		

Table 7: RII Value for Major Determinants of Incidents

	Item	RII Value	Rank
Major Determinant Incidents	**Human Factor**	0.752	2
	Environment condition	0.744	3
	Technical Failure	0.776	1
	Route condition	0.728	4

3.4 Questionnaire (Section C)

This test was conducted in section C, descriptive analysis was used to illustrate the percentage and the frequency of the data acquired. Data obtained were analysed using Reliability Test. Cronbach's Alpha was also used to measure the consistency and accuracy of the answer from the question in the questionnaire form. Table 8 below shows the Cronbach's Alpha value in section C.

Table 8: Value of Cronbach's Alpha for Each Factor in Section C of Questionnaire

Factors of Accident	Cronbach's alpha (α)
HUMAN FACTOR	
Lack of knowledge and experience in making decision	0.788
Carelessness in commanding a ship	
Misinterpretation of radar information	
Not paying proper attention to procedure and rules	
Improper/bad look-out	
Insufficient rest period	
Improper level of watch keeping duties	
TECHNICAL FAILURE	
Engine stop working	0.828
Failure of steering gear	
Hull failure arising	
Corrosion on the machinery	
Failure of navigation tools	
Fault in the propulsion system	
Failure to monitor ship system in order to search potential problem	
Lack of necessary equipment and protective part	
Breakdown in operating procedure	
Breakdown in communication procedure	
Environment Condition	
Severe Wind	0.777
Heavy rain reduced visibility	
Darkness environment	
Abandoned wrecks on navigational channel	
Fog make hard to see well enough to properly navigate the ship	
Route Condition	
Navigational error	0.707
Inaccurate nautical chart	
Narrow channels with abrupt and angular wind	
Dense marine traffic	

The questionnaire is then analysed by using Descriptive Analysis method. This test measures the percentage and frequency of the data acquired from section C for each factor.

Table 9: Descriptive Analysis on Human Factor

Human Factor Items	Strongly Disagree N (%)	Disagree N (%)	Moderate N (%)	Agree N (%)	Strongly Agree N (%)	Mean
	1	2	3	4	5	
Lack of knowledge and	0 (0)	0 (0)	12 (20)	48 (80)	0 (0)	3.72

experience in making decision						
Carelessness in commanding a ship	0 (0)	0 (0)	22 (36)	38 (64)	0 (0)	3.6
Misinterpretation of radar information	0 (0)	0 (0)	22 (36)	38 (64)	0 (0)	3.6
Not paying proper attention to procedure and rules	0 (0)	0 (0)	19 (32)	41 (68)	0 (0)	3.64
Improper/bad look-out	0 (0)	0 (0)	14 (24)	46 (76)	0 (0)	3.72
Insufficient rest period	0 (0)	0 (0)	24 (40)	36 (60)	0 (0)	3.52
Improper level of watch keeping duties	0 (0)	0 (0)	29 (48)	31 (52)	0 (0)	3.48
TOTAL AVERAGE MEAN					(Medium)	3.61

Table 10: Descriptive Analysis on Technical Failure

Technical Failure Items	Strongly Disagree N (%)	Disagree N (%)	Moderate N (%)	Agree N (%)	Strongly Agree N (%
	1	2	3	4	5
Engine stop working	0 (0)	0 (0)	22 (36)	38 (64)	0 (0)
Failure of steering gear	0 (0)	0 (0)	7 (12)	53 (88)	0 (0)
Hull failure arising	0 (0	0 (0)	26 (44)	34 (56)	0 (0)
Corrosion on the machinery	0 (0)	0 (0)	26 (44)	34 (56)	0 (0)
Failure of navigation tools	0 (0)	0 (0)	22 (36)	38 (64)	0 (0)
Fault in the propulsion system	0 (0)	0 (0)	14 (24)	46 (76)	0 (0)
Failure to monitor ship system to search potential problem	0 (0)	0 (0)	17 (28)	43 (72)	0 (0)
Lack of necessary equipment and protective part	0 (0)	0 (0)	2 (4)	58 (96)	0 (0)
Breakdown in operating procedure	0 (0)	0 (0)	7 (12)	53 (88)	0 (0)
Breakdown in communication procedure	0 (0)	0 (0)	7 (12)	53 (88)	0 (0)
TOTAL AVERAGE MEAN					(High

Table 11: Descriptive Analysis: Environment Condition

Environment Condition Items	Strongly-Disagree N (%)	Disagree N (%)	Moderate N (%)	Agree N (%)	Strongly Agree N (%)	Mean
	1	2	3	4	5	
Severe Wind	0 (0)	0 (0)	38 (64)	22 (36)	0 (0)	3.36
Heavy rain reduced visibility	0 (0)	0 (0)	43 (72)	17 (28)	0 (0)	3.28
Darkness environment	0 (0)	0 (0)	41 (68)	19 (32)	0 (0)	3.32
Abandoned wrecks on navigational channel	0 (0)	0 (0)	43 (72)	17 (28)	0 (0)	3.32
Fog make hard to see well enough to properly navigate the ship	0 (0)	0 (0)	36 (60)	24 (40)	0 (0)	3.40
TOTAL AVERAGE MEAN					(Medium)	3.34

Table 12: Descriptive Analysis on Route Condition

Route Condition Items	Strongly Disagree N (%)	Disagree N (%)	Moderate N (%)	Agree N (%)	Strongly Agree N (%)
	1	2	3	4	5
Navigational error	0 (0)	0 (0)	14 (24)	46 (76)	0 (0)
Inaccurate nautical chart	0 (0)	0 (0)	53 (88)	7 (12)	0 (0)
Narrow channels with abrupt and angular wind	0 (0)	0 (0)	14 (24)	46 (76)	0 (0)
Dense marine traffic	0 (0)	0 (0)	46 (76)	14 (24)	0 (0)
TOTAL AVERAGE MEAN					(Medium)

4 CONCLUSION AND RECOMMENDATION

An analysis of marine vessel determinants is important to all marine sector to prevent any unwanted event and to maintain shipping company's good reputation. This study was conducted at Penang Waterways, Pulau Pinang. It produces all the data analysis and all the data can be classified as acceptable and reliable. Based on the findings, it can be concluded that the determinants that resulted in Penang Waterways marine vessel incidents are caused by technical failure. So, all ship crew must be aware in any excessive noise from the onboard ship's machinery to prevent this event from occurring. Next, periodic maintenance and checks for the smooth functioning of the ship's steering gear should not be missed. In addition, ship crew also must be aware of the necessary equipment, protective part, and spare part of the machinery during some problem in any machinery.

The study indicates that the determinants which lead to Penang Waterways marine vessel incidents are caused by technical failure. To reduce these errors, standardized procedures involving testing, repairing and maintenance of equipment to ensure that the machinery operation works well and at maximum efficiency is performed. Maintenance can be performed in several ways, including planned maintenance,

corrective maintenance. Planned maintenance, among others, gives a lot of benefit. The planned maintenance schedule is the necessary work schedule indicating action to prevent breakdown or failure and the planned maintenance includes revision of the machinery, inspection of the machinery and change of heavy lubrication equipment oil. Next, the ship crew must ensure that the vessel is fully equipped with the necessary safety equipment to handle emergencies and give all on board the best chance of survival. The shipping company plays a vital role in this operation, as this is designed to ensure the level of safety of the crew when sailing at sea. When tackling the problem that occurs at inappropriate time, safety equipment is required. In addition, the crew of the ship must also ensure some spare part on board the ship because this is to ensure that the ship can be maneuverer for a certain period of time until it reaches nearby port for inspection and repair of the necessary machinery.

Other than that, to prevent this mistake from happening, sailors should be specific about how sleep loss affects their performance and should not accept a watch while in a state of fatigue which makes them unfit for duty. This is essential because to ensure that a ship is adequately, efficiently and efficiently manned to ensure the safety and security of the ship, safe navigation and maritime operations, safe operations in port areas, prevention of human injury or loss of life, the most important thing is also to prevent damage to the marine environment and property. To get reliable data and acceptance, some additional work and procedure need to be implemented from the research. This also helps the researcher get strong data to prove relevant area scope. Some of the procedure that can be done is to interview the different department of Malaysia Marine. So, regarding this procedure, the researcher may get a lot of information from the opinion of the interviewee toward this project's goal. Their opinion is a vital component for strengthening the data gained from the question of surveys. The researcher can also get opportunities to compare the data given to multiple interviewees and draw the conclusion from their opinion and their experience. Next, quantity of survey question also plays an important role in gaining more data and making the research valid for future research. So, if the number of respondents can be added up to 100, the data may be more accurate, and the panel and the supervisor may accept it. Another question can also be added in the section questionnaire form which determined the factor that led to the incident of marine vessels because the researcher obtained more data that can be analysed in Microsoft Excel and the Statistical Package for Social Science (SPSS).

Finally, as we know, there are huge waterways in Malaysia consisting of several straits in Malaysia, namely the Balabac Strait, the Johor Strait, the Malacca Strait, the Penang Strait, and the Sibutu Passage. So, the researcher can also apply this case study from other waterways in Malaysia to enhance more data. Through this, we can get different data from different waterways in Malaysia, especially factor data that causes incidents in the marine vessels.

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