THE TECHNICAL RELATIONSHIP OF HUMAN ERRORS TOWARDS THE OPERATION FAILURE OF FERRY SERVICES

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ABSTRACT

Human error is usually triggered by poor design, poor management, violations of use and poor maintenance. The operation failure on ferry services usually happens due to human errors. Human errors have been the major cause in any type of services or work. However, this research focuses on determining the main element of human error that causes failure on ferry services located at Bandar Maharani Terminal Ferry (BMTF) in Muar, Johor, Malaysia. The element of human error covers; *Inadequate Communication, Equipment Failures and Lack of Technical Training*, which should be recognised by the organisation as it helps to reduce or prevent the failure from happening in the maritime industry. 53 respondents among staff at Marine Department and Bandar Maharani Ferry Terminal participated in this research. The pairwise comparison was used for analysis and it shows that inadequate communication was given a score of 45.12, 35.98 for equipment failure and 38.69 for lack of technical training that have contributed to the failure of the ferry operations.

Keywords: Maritime Operation, Human Error, Ferry Services

INTRODUCTION

There are several issues that passengers should be worried while travelling using ferry services. The main issue is on safety during a voyage, which covers on the safety requirement on board, safety equipment, the passenger behaviour and the ability of the crew to control the ferry operations. This research focuses on the main elements of human error that have caused an operation failure of ferry services and emphasis on the effective procedure to prevent the operation failure that resulted from human errors. However, Ferguson & Landsburg (1998), state that there are several human elements that caused the operation failure or accident on board for passenger ships. These elements are inadequate communication, bad decision among top management, lack of skill, and inadequate general technical knowledge. In addition, Rothblum (2006), argues that maritime system as a people system and human error figure have shown that about 75% to 96% of casualties were contributed by human errors. To make sure the safety of ferry or passengers ship is fully safe, the passengers and the crew on board shall comply with the regulation during voyage or before voyage. To maintain the safety level among the crew and passengers require passengers to have sufficient knowledge of the regulations on board. The ferry safety is very important as it involves several issues such as a collision at sea, incomplete equipment, lack of the skills among crew and passenger behaviour. Thus, the ferry or passenger ship is compulsory to adhere to safety regulations and to minimize accidents from happening. The crew is required to fulfil the requirement on safety regulations by Safety on Life At Sea (SOLAS) Convention. The SOLAS International Convention has been made as a guideline while on board. It is also to ensure the passengers and crew are safe from exposure to any accident aboard.

PROBLEM STATEMENT

Poor maintenance and lackadaisical attitude among crew on the engine condition before voyage lead to ferry accidents. Besides that, lack of good management practices in managing the passengers during arrangement and luggage transmission and insufficient space for passenger luggage expose the ferry services to failure too. Human errors are the main factor on the failure to ensure safety on board passenger ships. Those errors include bad communication among crew in giving an instruction to other crew or passengers, poor service maintenance in making sure the equipment is properly installed by the crew before voyage, fire extinguishers do not function during distress and compromising with the safety of passengers and crew. Inadequate basic safety knowledge among crew and passengers also contributes to the human error. The inadequate knowledge among the crew lead to lack of skill in managing the passengers; controlling the ship, lifesaving procedures, and training activities. Operation failures caused by the human errors continuously occurred because of the low awareness level among the crew or passengers. At the same time, the crew also failed to adjust the operation procedures based on the hazardous environmental condition such as current, wind, wave, and other environmental conditions that pose a greater risk for causalities and accidents (Hongzhi & Yang, 2012).

RESEARCH OBJECTIVES

The main objective of this research is to focus on the elements of human error towards failures in ferry operations among passengers and crew at Bandar

Maharani Ferry Terminal, Muar Johor. Thus, the specific research sub objectives are as follows:

i) To determine the main elements of human error `that contribute failure in ferry operations.
ii) To identify an effective procedure to prevent the human error.

SCOPE OF RESEARCH

This research is conducted at Bandar Maharani Ferry Terminal (BMFT), Muar Johor, Malaysia, which is located at the town and nearby Muar River. Government buildings such as; Marine Department, Custom Department, Municipal Department, Immigration Department and Agriculture Department are located adjacent of the terminal. The ferry terminal operates on Tuesday, Thursday and Saturday from 10.00 am to 5.00 pm.

Table 1. Service characteristics of BMFT

Characteristics	Explanation
Punctually	Ferry's customer do not have to wait longer for the trip
Accessibility	Passengers easily can access to the terminal and communicate with terminal staff
Affordability	Passengers can afford to pay the ferry tickets
Security	High security in making sure the passengers are secured and entered legally
Safety	Passengers can reach ferry terminal safely

Table 1 shows the service characteristic of BMFT. The aim of the terminal is to make all passengers confident and satisfied while using the service provided. The service characteristics cover elements of punctuality, accessibility, affordability, security and safety.

LITERATURE REVIEW

Definition of Terms

Human Error

Human error is defined simply as a mistake done by human. The human error is a deviation from expected performance by the consequences, which the measurable characteristic of the system at the tolerable limits (Swain and Guttman, 1983). Human error is defined as an action or omission of an immediate cause of the event when a liability arises. It is also as a departure from acceptable or desirable practice on the part of an individual that produces an unacceptable or undesirable results. The errors may range from violations to lack of adequate experience, training and knowledge. These errors are magnified and compounded with times of stress and panic (Catherine et. al., 2006). On the other hand, Rothblum (2012), states that human error is an incorrect decision, an improperly performed action or improper lack of action. However, in most of the marine accidents statistics show that 76% of the accidents are due to human negligence with the starting point of error happened at the bridge of the ship, 17% at engine room, 7% started somewhere else on board of the ship such as the galley due to the fire or explosion. Another study shows that 15% accidents were caused from rating error, 30% from deck officer error, 2% from engine officer error, 8% by pilot error and 7% by shore-based personnel error as stated by Er Z. (2015). Based on STCW Convention, human error is classified into three major categories as addressed through the STCW Code 1995 amendments. The first category is on the operational based human errors, the second category is the management based human error and the third category is the combination of the first and the second category.

Safety

Safety is an important factor in the maritime industry. The safety of the maritime transportation can be defined as a set of measure that are taken to protect a human life, material and non-material assets either directly or indirectly related to the maritime transportation. Safety involves technology, human and the organizational factors. Safety is concerned with the protection of life and property through regulation, management and technology development of all forms of waterborne transportation. International Maritime Organization (IMO) has introduced series of the guidelines for undertaking a full scale evacuation analysis and certification for passenger ship. For international shipping, the safety of ship has been a priority as a result from the sinking of Titanic in 1912 that had developed international concerns on safety at sea. Cartwright and Baird (1999), state that a big attention has been focused on the marine safety of the passenger ships and has made improvement on the safety awareness level among the crews and the passengers. Since a ferry company and the passengers are the main operators and users, which could result in serious injuries to passengers or even their death this matter must be taken seriously by them (Telley et al., 2006; Fabiano et al.,2010). An understanding of stakeholders' on safety concerns provide useful information for ferry operators and administrators to establish criteria in enhancing the ship safety (Vanem and Ellis, 2010).

Failure

Failure is defined as a loss of the key functions and capabilities of the supply chain, or loss of anything that would reduce or remove the ability of the system to perform. The concept of failure is well known and used within safety and reliability application (Rice, 2010). A failure mode in transportation is the inability to move goods and people within the terminal. It is also related with the technical failure of the equipment or machinery on passenger ships. The common sequence of psychological function from the failure is basically on the human behaviour, stimulus, organism and response (Meister, 1990). The failure can be as unpleasant surprises which are unexpected and do not have in the system. The failure has been introduced to the system through the

inherent unreliability of people. The equipment failure means the equipment on board such as fire extinguisher and life-saving equipment do not function well and cause the safety failure on the passenger ships when the engine does not run well during voyage. Fatigue is also one element of failure that can happen on passenger ship. Fatigue is one of the components from working under stress among the crews. This is because the crew has failed to control or manage the stress while handling the task. Failure happens when there is a gap between actual and desired performance. The failure mode can be divided into 3 categories such as; local effect, higher level effect and end effect. For the local effect it is the initial changes in a system condition that occurs if the postulated failure mode occur. The higher level effect is the changes in a condition of the next higher level of equipment or system function caused by the occurrence of the postulated failure mode. End effect is possible when the plan mitigating safeguard for the failure mode has failed. Overcoming failures in the marine system requires a great level of competencies. Hence, a methodological extension to such kind of technical problems should also be considered to find satisfactory solutions for different failure cases as claimed by Celik (2013).

The Main Elements of Human Error

Based from the previous studies, there are several significant types of the human error which cause failure or accident of the passenger ships. It covers inadequate communication, lack of technical knowledge or training, equipment failure and fatigue.

Inadequate communication

Communication is a crucial part of human interaction. It is a self-evident fact that people who are speaking in different languages generally will not converse at all and people who are speaking with own language may misinterpret to spoken messages. People may not focus and divert to do other things in inadequate communication for example playing games while a message is been spread through people. It can also become unrecognisable from the original message after being re-worded or abbreviated by individuals who are passing the message from one to the other people. The reason for these messages becomes distorted is probably due to too many ways of passing ideas from one to another (Winbow, 2002). However, communication is one of the elements of human error that causes the safety failure or accident on passenger ship or ferry. This is because communication is very important while on board. Communication errors resulted from failure to send or receive the information. Every shipmates or crew should have a good communication to communicate with each other. This situation is compulsory to ensure all the information and instruction are received clearly and easy to be followed. Hetherington, Flin & Mearns (2006), state the other area concern for error management is on the communication practices between shipmates, masters and pilots, and ship to ship. A better procedure and training is to be designed to promote for a better communication and coordination on and between ships. In addition, the communication is also related with the communication equipment. Every crew on the ship should have complete knowledge of communication equipment such as radar system, searchlight, broadcasting system, radio and telemetry system in ensuring that the others crew are able to operate or receive the task correctly (Wonham et al, 2013). In addition, inadequate communication between each other also could happen due to the different languages spoken. This is because the crew on the ferry are from several countries and could not understand the other language easily. For example, the crew of the ferry service at BMFT are not only from the local people but also are from other country such as from Indonesia. It shows that not all the Indonesian crew are able to understand English language very well while communicating with other crew or passengers.

Lack of technical knowledge or training.

The lack of technical knowledge or training shows a contribution for 35% of casualties on board. This element requires the crew to increase the knowledge especially while using the proper technology such as a radar (Yadav, 2013). Every crew should have the higher technical knowledge about the facilities on the ferry especially while managing on board. A sufficient technical knowledge or training is not only for the crew but also to the passengers who are using the ferry services should have the knowledge especially on the safety knowledge during voyage. Before the crew proceeds for the voyage, it is the company's responsibility to be in charge on safety management and to make sure the crew had enough training before been given duties on board. When the crew has less training they will not perform well and unable to provide good services to passengers (Arboleda, 2004). A higher knowledge and sufficient practice or training are very important among crew as they have a big responsible to conduct the ferry voyage safely to the destination. The training covers on how to use correctly the life-saving equipment such as a life jacket, how to entertain the seasick passengers, how to control distress situation and how to use the fire extinguishers on board. The lack of training could also occur due to the less of team work spirit among the crew. The training is a situation where the crew is trained by qualified supervisor. The trainer must train their trainees until they become expert and understand their duties and responsibilities and able to perform effectively.

Equipment failure

The second element of the human error that contributes to the safety failure of ferry service is due to equipment failure or poor maintenance. The system reliability will fail when the equipment is not installed properly. The equipment on the passenger ferry includes engine, life-saving equipment, fire extinguishers and life boats. The failure of these equipment mostly is caused by the careless of the crew that do not check properly before voyage and their lack of experience in equipment maintenance. Top management should deliver more knowledge on maintenance to make sure the crew is able to check the equipment on the ferry before voyage. On the other hand, the crew also will fail to follow the given

instruction properly about the maintenance of equipment when they do not give full attention or do not revise the instruction of equipment application properly. This is a simple mistake that the crew always has lackadaisical attitude on the equipment maintenance. An Australian Incident Monitoring Study (2013), indicates from 177 cases, 107 cases or 60% involved an anaesthetic equipment, 42 cases or 24% involved monitors, 17 cases or 10% involved the other theatre equipment and 11 cases or 6% involved gas or electricity supply. The equipment failure is not only caused by the crew's mistakes but the passengers could also be the cause of the equipment failure. This is related especially when the passengers are not able to apply the equipment such as; the passengers fail to use firefighting and life-saving equipment in the ferry correctly especially during an emergency situation. This shows that the passengers also should have the knowledge on how to use the equipment on board the ferry. So, in case of an emergency, passengers will know how to apply the equipment when the crew is not there. The crew must check the equipment maintenance properly to make sure everything is in good condition before voyage.

Fatigue

Sharma Yadav and Dorothy (2013), conclude that the fatigue is a major element in human error. This is based on their study that found 16% errors are from vessel casualties and 33% due to personnel injuries. Fatigue happens when the crew is not in a good health during voyage and there is no necessary medicines and first aid facility on board. Before voyage, the captain on vessel or ferry has to ensure that all the crew are in good health. If the crew is in a poor health condition, the captain should not allow the crew to join the voyage and advise the crew to get medical treatment. Pazara (2008), indicates the crew who does not take a serious attention to good health during voyage contributes to fatigue at sea.

Effectiveness Procedure to Prevent Human Error on Ferry

The effective procedure focuses on the human knowledge, physical and mental capacities in consideration of the flow in their duty from passengers' perspective such as proper maintenance, communication and equipment.

Information display

Human actions need to be performed correctly such as detecting the information, understanding the information given, selecting an action accordingly and implementing an action. The crew and passengers should be aware on every information given either at the ferry or from the terminal. This is because the actual causes of safety failure or accident are contributed by the human behaviour who are unaware on the existence of hazard, harm, and the information given. The display information is very important and must be easy to understand and clear to passengers. Firstly, Cooper (2012), says the information display to prevent harm should not only display the word caution in terms of material and equipment but it should also display the harms. The information display should include a clear information such as; technique to avoid hazard. Secondly, the information display is not necessarily in writing but it also can be in a different colour with surrounding or different size or shape. The information should display at a strategic place or corner to ensure the crew and passengers notice the information. Lastly, the information about safety should display as a guide or caution to passengers and crew before voyage. The information display about the maintenance of equipment should be included in order to increase knowledge while performing the maintenance activities before voyage. This good information could be a quick reference to new crew and passengers about the maintenance procedures.

Prevention of incorrect operation

Celik (2013), mentions the effectiveness procedure can be made to prevent the human error occurs continuously on ferry. Preventing of incorrect operation on equipment needs attentiveness to avoid failure of perception, memory error and wrong selection. The improvement in training and a good labour condition play a main role in enhancing improvement related to hardware. Celik (2013) Celik & Cebi (2009) and Soner et al. (2015) suggest the following procedures which were adopted from several studies to be kept in mind in preventing incorrect operation from happening:

i. To provide an interlocking mechanism to ensure safety of operation.
ii. To make sure the adequate resistance to controller operation to prevent any operation due to unintended movement.
iii. To ensure the controller should install at the proper location and directions to reduce risks of unintended contact.
iv. To provide attentive responds by light, sound in the operation.
v. To involve a proper controller in the delicate operations such a half-press should be avoided.
vi. To install head-to-head controller at the appropriate distance to avoid any unplanned pressing of button.

Improvement in operability and working environment

The operability ability to keep equipment, system or a whole industrial installation in a safe condition and dependable functioning condition is the operational requirements. According to Rice (2013), operability is important to maintain the safety level or to prevent the accident in ferry. The poor operability makes the operator use an awkward posture when operating due to the operator not able to use the low level of operability to control the equipment or system in a ferry. It is very important to pay attention on the arrangement of equipment so that there is space left for the movement of the crew and passengers. It is important to make sure there is no problem which can interfere with the operation. At the space that the crew members are likely to reside for a long period, the care action should be taken to control the

temperature, vibration, noise and humidity. This may help the crew to overcome fatigue. The design and the installation of the equipment should be considered and the operation can be performed without adopting awkward postures. To control the weight of heavy object that is handled manually needs consideration based on the physical strength of the normal crew and hoisting equipment to be installed to handle heavy objects in the ferry. The determination of the maximum operating force is essential for the operation based on the passengers and crews physical strength. Each ferry or ship should have stairs and step ladders in the fore and aft direction of ferry or ship which makes the crew or passengers movement easier. The step height of the stairs should be constant throughout the ship. The crew is also encouraged to help each other as a team. This can reduce or prevent the human error or mistake among the crew from happening. A working environment should be peaceful and supporting each other. If all crew gives a full cooperation, the passengers feel confident and comfortable while using the service.

Improvement in communication

Communication is very important in our daily life. A good communication is an ability to speak well with other people such as when communicating with passengers or a captain. If poor communication exists, it may lead to a misunderstanding and mistake. The duty crew on board should have a good verbal communication while communicating with ferry operator or ship master and make sure the information is clearly received. The crew needs to master English language to make the process on board smoothly (Winbow, 2002). The ferry service involves tourists and local people. Therefore, simple English language is necessary to make people understand and easy to communicate with each other. In a safety situation, good communication is very important because smooth voyage must involve good communication between crew and captain.

METHODOLOGY

This research applied survey method to collect relevant data from respondents. To complete this research, hypothesis and testing the association between the research constructs were used in line with the objective of the research. This research established and verified hypothesis relationship between human errors and operation failure of ferry services at BMFT.

Population, Sample and Respondents

Population of 55 reflects the number for the overall employees at BMFT, an organization mainly responsible for the operation and service of the ferry. Gay and Airasian (2003), suggest that sample should be between 10%-20% of total population. Taylor (2016), suggests the arrangement of sample is drawn from population. Therefore, 55 questionnaires were sent. 53 questionnaires were returned and usable. The overall response rate was 96.36%. In order to ensure the effective distribution and collection of the questionnaire, the Human Resources department was involved and questionnaires were distributed through face to face session. Table 2 shows the list of the total respondents and Table 3 shows the profile of the respondents.

Table 2. Population, sample, respondent

No	Scope	Population	Sample	Respondent
1	Staff at Marine Department and Bandar Maharani Ferry Terminal	55	55	53
	Total	55	55	53

Table 3. Respondents demography

Gender	**Frequency**	**Percent**
Male	30	56.6
Female	23	43.4
Age	**Frequency**	**Percent**
20 to 35	12	22.6
36 to 50	20	37.7
50 and above	21	39.6
Race	**Frequency**	**Percent**
Malay	31	58.5
Chinese	20	37.7
Indian	2	3.8
Position	**Frequency**	**Percent**
Supervisor	17	32.1
Ordinary staff	27	50.9
Ship crews	8	15.1
Others	1	1.9
Education	**Frequency**	**Percent**
SPM	11	20.8
Diploma	28	52.8
Degree	14	26.4
Experience	**Frequency**	**Percent**
1 to 5	12	22.6
6 to 10	28	52.8
11 and above	13	24.5

Instrument

Table 4. Elements in the questionnaires

Section	**Element of questions**
A	Background of respondent
B	Company information
C	Element of human errors
D	Effective procedures
E	Suggestion and recommendations

Table 4 shows the example of element of question in the questionnaires by section. Section A; consists of the respondent background such as the gender of respondent, the age, the status and others. Section B; consists information about the company background that serves

ferry services on punctuality of ferry arrival, time taken for a journey, the ticket price, condition of ferry, services of ferry (one way or two-way), number of limited passengers, the time ferry services in one day and others. Section C; contains about three main elements of the human errors on ferry towards safety failure operation on inadequate communication, equipment failure and lack of technical training. Section D deals with the effective procedures applied to prevent human errors for the ferry service and safety operation on board on information display, prevention of incorrect operation and improvement in communication. Section E; covers the suggestion or recommendation by the respondent towards the operation failure on ferry services. The responses were measured on a Likert scale between 1 – 5, where 1 represents Strongly disagree, 2 represents Disagree, 3 represents Neutral, 4 represents Agree and 5 represents Strongly agree.

Theoretical Framework

The theoretical framework is the structure that supports a theory of the research and determine the relationship between independent variables and dependent variable. The independent variables are the variables that cover on inadequate communication, equipment failure and lack of technical training that change in scientific experiment to study on the effect on the dependent variable, which is the operation failure of ferry services.

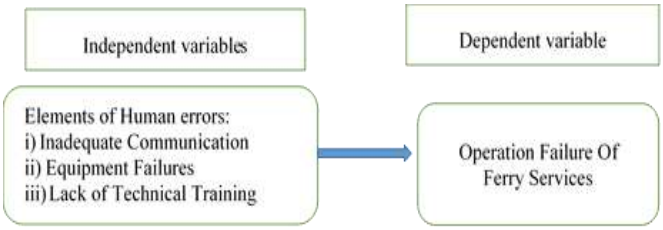

Figure 1. Theoretical framework

Hypothesis

The hypothesis statement is developed among the three group that had been recoded to be analysed by using the Kruskal-Wallis test. The development of hypothesis required that the null hypothesis. Null hypothesis is the data which is normally distributed, while alternative hypothesis is the data that is not normally distributed.

*H*0 = Null hypothesis
Assume that there is no significant different among selected group.

*H*1 = Hypothesis alternative
Assume that there is significant different among selected group.

The equations for hypothesis are as follows:
*H*0= μ1= μ2=μ3
Assume no significant different between the three groups.

*H*1= μ1 ≠μ2 ≠μ3
Assume significant different between the three groups.

Where:
***H*0** = Null hypothesis
***H*1** = Hypothesis alternative
μ**1** = Mean for group disagree
μ**2** = Mean for group natural
μ**3** = Mean for group agree

DATA ANALYSIS AND RESULTS

Data analysis is the next step after data collection. Usually, researchers used Statistical Package Social Science to analyse the data based on the response received from respondents. Allen (2005), argues that Cronbach alpha is performed to analyse the reliability and validity of the data and to measure the internal consistency of the instrument. Gliem & Gliem (2003), argue that it become stress because the item in the scale of internal consistency would be higher if the result from this option coefficient is closer to 1.0. The strong reliability and validity of the data should be 0.5 and above. Mean analysis was performed to analyse the highest and the lowest mean for each question. Normality test was performed to differentiate the characteristics of the normal distribution that focuses on skewness and kurtosis values of the distribution function and liner relationship existing between the distribution of the variable and the standard normal variable. Kruskal wallis and Pairwise comparison was performed to analyse abnormal data by using non-parametric test and to determine the high score based on group recoded scale.

Kruskal Wallis Test and Pairwise

Kruskal Wallis is one of the methods for analysing the data, which is not normal and provide an assumption that the dependent variable is not normally distributed. The Likert scale is being used and the data was analysed using the five scales. However, by using the Kruskal Wallis the test are dynamic to analyse the scales from 1 until 3. The result whether there is significant statistical difference among the group of scales will be identified as the result of the analysis.

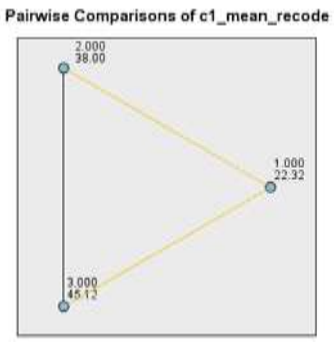

Figure 2. Kruskal wallis Test and pairwise

Objective 1: The Main element of Human Error

This part analysed three main elements of human error that cause operation failure on ferry services.

Element of Inadequate Communication

The first element is inadequate communication that causes operation failure on ferry services.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Inadequate_communications is the same across categories of c1_mean_recode.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 3. Kruskal wallis element of inadequate communication

Figure 3 shows the result of the output from the test analysis that portrays that there is a significant difference between group 1, 2 and 3 from the Likert Scales recorded. It shows that there is a difference value of distribution from the answer of agree, natural and disagree answer.

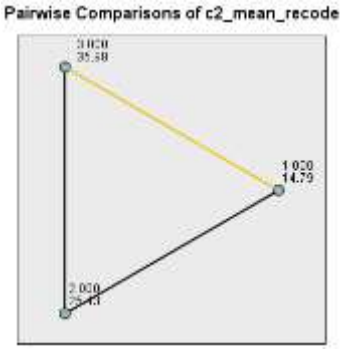

Figure 4. Pairwise comparison element of inadequate communication

Figure 4 demonstrates the pairwise comparison of inadequate communication. It indicates the highest score among 3 groups of Likert scale. It shows three groups have been addressed by the respondents. However, the researcher needs to gain the most dominant answer for this element. After making the pairwise comparison, it shows that group 3 is the answer for this analysis with the total of the respondent answer is 45.12. This means that the element of inadequate communication has been agreed by the respondents.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Equipment_failures is the same across categories of c2_mean_recode.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 5. Kruskal wallis element of equipment failure

Element Equipment Failure

The second element analysed in Kruskal Wallis test human error is on equipment failure. Figure 6 shows that there is a significant difference between the group 1, 2 and 3 on the Likert Scale recorded. That means there is a difference in the total distribution of answers that consists of agree, natural and disagree. The result shows that null hypothesis is rejected because the significant is below 0.05. The confident level for significant different is normally under 95 percent.

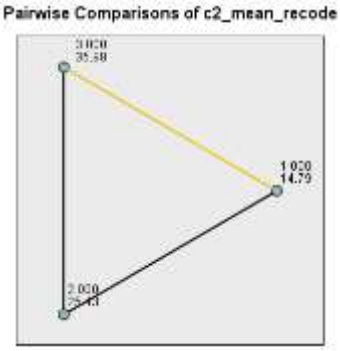

Figure 6. Pairwise comparison element of equipment failure

When using the pairwise comparison, the result will appear with the score among the group that had been recorded. For this element, the highest answer is group 3 with 35.98 score meaning the element of equipment failures has been selected by the respondents.

Lack of Technical Training

The third element analyse in Kruskal Wallis test for the human error element is on lack of technical training.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Lack_of_technical_trainings is the same across categories of c3_mean_recode.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 7. Kruskal wallis element of lack of technical training

Figure 7 shows that there is a significant difference between group 1, 2 and 3 of the Likert Scale. That means there is a difference in total distribution of the answers based on agree, natural and disagree. The decision shows that null hypothesis is rejected because the significant is below 0.05.

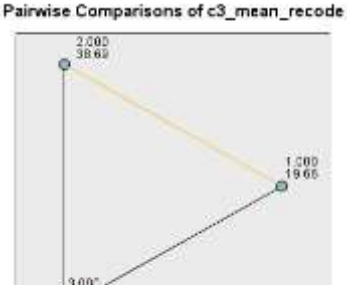

Figure 8. Pairwise comparison element lack of technical training

Figure 8 shows the highest answer is group 2 with the score 38.69 meaning the element of lack of technical training is agreed by the respondents.

The main element of Human Error that cause operation failures

This research analysed the human errors that cause operation failure on ferry services based on the pairwise comparison result.

Table 5. The pairwise comparison score

Element	Score
Inadequate communication	**45.12**
Equipment failures	35.98
Lack of technical training	38.69

Table 5 shows that the highest score for main element of human errors that cause operation failures on ferry service on the element of Inadequate Communication with 45.12 score. Respondents mostly agreed that this element is the major cause of human error on ferry services.

Objective 2: The Effective Procedure to prevent the human errors

This part analysed the effective procedure to prevent human error on ferry services.

Information Display

The first element for effective procedure to prevent human error on ferry services is on the information display.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Information_displays is the same across categories of c4_mean_recode.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 9. Kruskal wallis element of information display

Figure 9 shows there is a significant difference between the group 1, 2 and 3 of the Likert Scale meaning there is a difference in total distribution of answers based on agree, natural and disagree. The result shows that null hypothesis is rejected because the significant below 0.05 which is equal to 0.00.

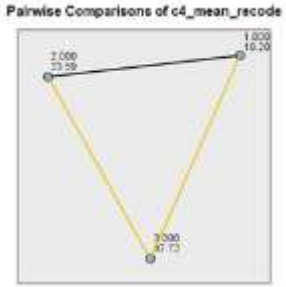

Figure 10.Pairwise comparison element of information display

Figure 10 shows the highest answer is group 3 with the score 37.72. This means the element of information display procedure can be the effective procedure to prevent the human error on ferry services.

Prevention of Incorrect Operations

The second element of effective procedure is on the prevention of incorrect operation on ferry services.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of prevention_of_incorrect_operation is the same across categories of c5_mean_recode.	Independent-Samples Kruskal-Wallis Test	.015	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 11. Kruskal wallis element of prevention in incorrect operation

Figure 11 shows there is a significant difference between group 1, 2 and 3 of the Likert Scale meaning there is a difference in total distribution of answers based on agree, natural and disagree answer. The decision shows that null hypothesis is rejected because the significant below 0.05 which is equal to 0.015.

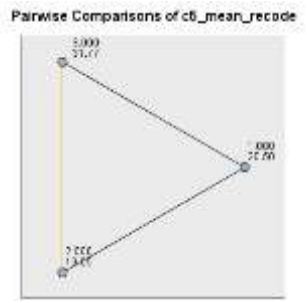

Figure 12. Pairwise comparison element of prevention in incorrect operation

Figure 12 shows that 3 groups have been selected to answer the questions on these elements. From this figure, it can be concluded that the highest score for these elements is group 3 with 31.77, which means the highest score among the 3 groups and the respondents assume that this element also can be the effective procedure to prevent human error on ferry services.

Improvement in Communication

The third element of effective procedure to prevent human error on ferry services is improvement in communication.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Improvement_of_communications the same across categories of c6_mean_recode.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 13. Kruskal wallis element of improvement of communication

Figure 13 shows there is a significant difference between group 1, 2 and 3 of the Likert Scale. That means there is a difference in total distribution of answers based on agree, natural and disagree answer. The result shows that null hypothesis rejected because the significant below 0.05 which is equal to 0.000.

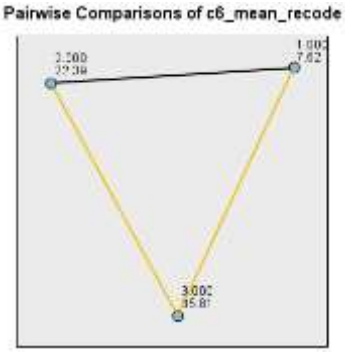

Figure 14. Pairwise comparison element of improvement of communication

Figure 14 shows the pairwise comparison among three groups of Likert scale recorded. For this element the highest score represents group 3 with 35.81 score. It means that the procedure can be either one of effective procedures to prevent human error on ferry services and this situation has been agreed by the respondents.

The Effective Procedures to prevent Human Errors on Ferry Services

In this section, the researchers analysed the most effective procedures to prevent human errors on ferry services. Based on pairwise comparisons for each element, the researchers will determine which of the element can be the effective procedure to prevent human errors on ferry services.

Table 6. Pairwise comparison score

Element	Score
Information Display	**37.72**
Prevention in Incorrect Operation	31.77
Improvement in Communication	35.81

Table 6 shows the highest score for the effective procedure to prevent human error on ferry services is the element of the information display with a score of 37.72. Respondents agreed that the element can be the effective procedure to prevent human errors on ferry services and can be practice at the ferry terminal.

CONCLUSION

As a conclusion, the main element of human error that causes operation failure on ferry services is inadequate communication since communication is very important to deliver information to other people. The communication must be clear and understood by other people. However, for the effective procedure to prevent the main element of human error on ferry services is on the information display. This is because, nowadays most people are not interested to read on given information but the people are more interested if the information shows are in visual display. Most of the respondents have agreed that visual information display is an effective procedure to prevent the main element of human error on the failure of the ferry services. This is proven by 96% of the respondents that have agreed with this element. The awareness of the staff at the ferry terminal and Marine Department must be progressively improved to ensure the implementation of this procedure is successful and in making sure that the ferry services are operated smoothly. Overall, the research objectives of this study have been achieved.

REFERENCES

[1] Arboleda, C. A., & Abraham, D. M. (2004). Fatalities in trenching operations analysis using models of accident causation. Journal of Construction Engineering and Management, 130(2), 273-280.

[2] Cartwright and Baird, (1999). Formal safety assessment of cruise ship.

[3] Casparian, M., Rego, R., Azor, F., Estrada, D., Berry, A., Cooper, B., & Gonzalez, G. (2012). *U.S. Patent No. 8,259,080*. Washington, DC: U.S. Patent and Trademark Office.

[4] Celik, Metin. (2013). Safety science: application of failure modes and effect analysis to main engine crankcase explosion failure on board ship.

[5] Celik, M., & Cebi, S. (2009). Analytical HFACS for investigating human errors in ship ping accidents. *Accident Analysis & Prevention*, *41*(1), 66-75.

[6] Er, Z. (2005, October). Definitions of human factor analysis for the maritime safety management process. In *International Association of Maritime Universities (IAMU) 6th Annual General Assembly and Conference World Maritime University*.

[7] Ferguson, S. J., & Landsburg, (1998). A. C. BIMCO/USCG partner for safety: all aboard for NMSIRS. *BIMCO Bulletin*, *93*(6), 42-48.

[8] Gay, L and Airasian P. (2003). Educational research: Competencies for analysis and applications'. *Recherche*, *67*, 02.

[9] Gliem, J. A., & Gliem, R. R. Calculating, Interpreting, and Reporting Cronbach's Alpha ReliabilityCoefficientforLikert-TypeScales,82–882003. Retrieved Oct 2017 from https://doi.org/10.1109/Proc.1975.9792.

[10] Hanzu Pazara. (2008). Human Error and oil pollution from tanker. Journal Volume 2 No 4 – December 2008.

[11] Hetherington, Catherine; Rhona Flin; Kathryn Mearns; (2006). Safety in shipping: the human element.

[12] Kluger, M. T., Tham, E. J., Coleman, N. A., Runciman, W. B., & Bullock, M. F. M. (2000). Inadequate preoperative evaluation and preparation: a review of 197 reports from the Australian Incident Monitoring Study. *Anaesthesia*, *55*(12), 1173-1178.

[13] Meister,D. Human error, (1990). Cambridge: Cambridge University Press, p.9.

[14] Rice Jr, James B. (2010). Failure modes in the maritime transportation system: a functional approach to throughput vulnerability.

[15] Rothblum, A. M. (2006). Human error and marine safety. US Coast Guard.

[16] Sharma, S. B., Yadav, R., & Dorothy, B. C. (2013). A study on human errors and classification of commonly prevalent errors in shipping operational practices.

[17] Shi-xian, Yang, (2012). Climatic Conditions and Countermeasure Research of Garlic Growing in Yiyang County [J]. *Modern Agricultural Science and Technology*, *12*, 147.

[18] Soner, O., Asan, U., & Celik, M. (2015). Use of HFACS–FCM in fire prevention
modelling on board ships. *Safety Science*, *77*, 25-41.

[19] Storch, E. A., Murphy, T. K., Geffken, G. R., Sajid, M., Allen, P., Roberti, J. W., & Goodman, W. K. (2005). Reliability and validity of the Yale Global Tic Severity Scale. *Psychological assessment*, *17*(4), 486.

[20] Swain,A.D. and Guttman, (1983). Handbook of human reliability analysis with reference to nuclear power plant application, Washington.

[21] Taylor, C. (2016). What Is a Population in Statistics? Retrieved November 2017 from http://statistics.about.com/od/Glossary/a/What-Is-A-Statistical-Population.

[22] Telley et al.,(2006). Fabiano et al.(2010). Crucial safety assessment criteria for passenger ferry services.

[23] Vanem and Ellis, 92010). Crucial safety assessment criteria for passenger ferry services.

[24] Wonham, M. J., Byers, J. E., Grosholz, E. D., & Leung, B. (2013). Modelling the relationship between Propagule pressure and invasion risk to inform policy and management. *Ecological Applications*, *23*(7), 1691-1706.

[25] Winbow, A. (2002). The importance of effective communication, International Seminar on Maritime English.