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COMPREHENSIVE ANALYSIS OF THE FACTORS THAT AFFECTING THE EFFICIENCY OF THE MANAGEMENT OF VESSELS USING LRM, RSM AND SEM

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ABSTRACT

There are several factors affecting the safety in maritime industry especially in shipping organization or sailing vessels. These factors have arisen due to lack of proper management system in shipping organization or onboard vessels particularly on smaller. In conjunction with this, ISM Code was introduced to enhance the maritime safety but it is not applicable for vessels <500 GRT. Hence, this has lead the smaller vessels to exposed to safety related problems and dangers. Thus, the accident rate has increasing. Therefore, the purpose of this study is to find out the factors contributing towards inefficient management as a result of lack of proper management system. A sample consists of 324 respondents from varies field in shipping industry was collected using questionnaire forms as an instrument and analyzed using Logistics Regression Modeling (LRM), Response Surface Methodology (RSM) and Structural Equation Modeling (SEM) methods. As a whole, the findings indicate that the grand mean values of entire of the sections of the questionnaire are above 3.00 which prove that the hypothesis is accepted. Moreover, the result shows that inefficient management has gained the highest grand mean values of 4.11 followed by external factor which is 4.05 meaning these two factors has contributed the most to maritime accidents in the absence of proper management system. Whereas, based on the SEM technique, it was proven that human error($\beta = 0.49$, $p = 0.050$) and stability factor($\beta = 0.49$, $p = 0.002$) are contributing directly to inefficient management while, the demography of the respondents ($\beta = 0.18$, $p = 0.103$) and external factor ($\beta = 0.65$, $p = 0.000$) are contributing indirectly to inefficient management. From the results of logistic regression modeling, there are two significant factors that has cause the developing of inefficient management. The factors are human error (CI: 3.232-23.354, p-value = 0.000) and external factor (CI: 3.006-21.715, p-value = 0.000). Besides, the p-value obtained is ($p = 0.682$) which were greater than 0.05 (p-value > 0.05) indicates that the produced final logistic regression model is a very appropriate model. Also, in testing the effectiveness of this final model is found that the percentage of the area under the curve is 83.6% and the overall percentage of the model is 93.5%.In RSM, the counter and surface plots indicate that the highest value or impact of efficiency on management is obtained when the count of human error and external factor to be the contributing factor is agreed the most by respondent while stability factors does not affect the efficiency. Consequently, the study shows that human error, stability factor and external factor are affecting the efficiency of the management. This has occurred because most of the shipping companies are failed to implement an effective and skillful management system as this will lead to human error, stability factor, and will worsen the external factors, as an effective management system can provide a clear exposure to the staff and crews of a shipping company to manage the ship or company effectively, safely and systematically.

Keywords: ship management, safety management structure, maritime accidents,

1. INTRODUCTION

In recent times, shipping industry or seafaring occupations is not considered unsafe. However, initially, the shipping industry was connected with risks and problems due to lack of proper regulations, policies, proper safety guidelines and many other important criteria for a ship. The absence of improper guideline has led towards ineffective and less safe navigation (Gobi *et al.*, 2014). Thus, serious marine accident which happens from time to time has increased vigorously. Due to this, the seafaring occupation has become one of the most dangerous jobs (Tarelko, 2012; Kobylinski, 2007). Therefore, ISM Code is being the most appropriate regulation code that contributes in abundance to prevent and reduce the number of accidents. Many studies and research shows that there is more positive outcome of the ISM Code in term of Greek Shipping (Bhattacharya, 2012). Thus, positive impacts were proven especially in the tanker and roll-on-roll-off passenger sectors which dropped drastically from 85% to 55% (Bhattacharya, 2012). However, according to the SOLAS Chapter IX, ISM Code is only applicable for conventional vessels while the non-conventional vessel which is under 500 GRT is exempted from this ISM Code. Thus, the accident rates among non-conventional vessels particularly the fishing vessels have continuously rise. In accordance with this, many other factors have risen and thus have led to inefficient management. Therefore, the purpose of this study is to develop model of factors that affects the efficiency of management in smaller vessels. The diagram below clearly shows that the absence of a proper management system is being the main root of occurrence of maritime accidents. When the shipping company or ship does not have a management system, it will led to human errors, stability problems and will worsen the external factors as well and thus, all this three factors will led to an inefficient management. Thus, it will end up with maritime casualties as the result of inefficient management of the vessel.

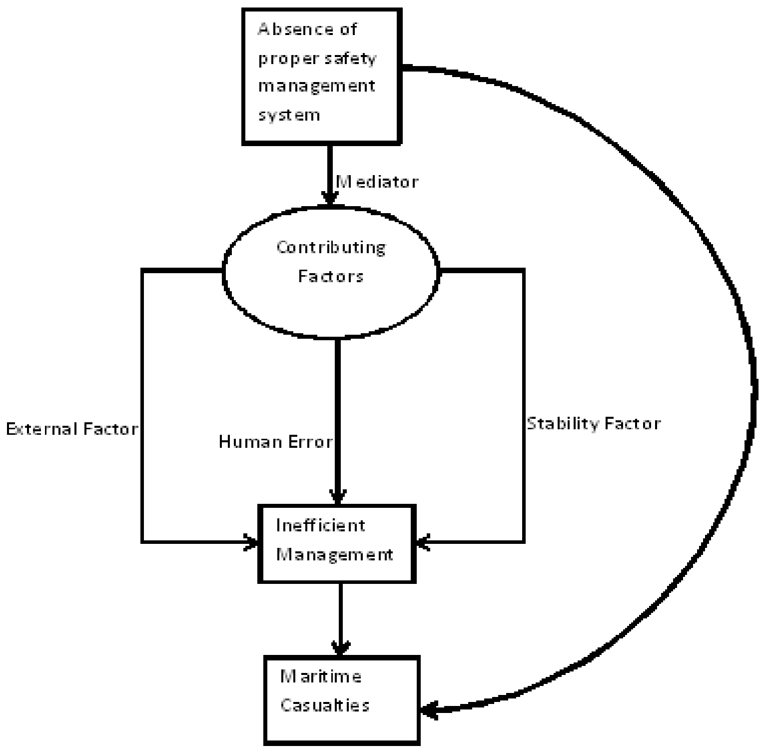

Figure 1: Consequences in the Absence of Safety Management Structure
(Source: Gobi et al., 2014)

2. LITERATURE REVIEW

A Safety Management System (SMS), is always refers to organizations having a systematic approach in managing safety which includes organizations structures, accountabilities, policies and procedures. Moreover, SMS helps to create and develop a safety culture especially in the shipping industry. Generally, when comes to marine casualties, human error are frequently linked as the main contributing factors. It is commonly accepted that maritime accidents which are due to human error is in the range of 75% - 96% (de la Camp, 2005 and Rothblum, 2002). In relevant to this, studies have shown that human errors have contributes to various types of accidents in the range of 84% - 88% of tanker accidents, 79% of towing vessels groundings, 89% - 96% of collisions and 75% of fires and explosions (Rothblum, 2002). On this side, an inappropriate or unstructured and

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incomprehensive operational procedure aboard ship is always leaded to trouble during distressed circumstances (NTSB, 1981). Moreover, the main problem solvent for human errors will be through safety management (Thematic Network for Safety Assessment of Waterborne Transport, 2003). Correspondingly, stability matter, on the other hand, is another prime factor that leads to maritime accidents and casualties. A successful voyage is always depends on the good conditions of the particular ship where stability matters plays a crucial role. Therefore, as mentioned by Kobylinski, (2008), stability criteria are considered as a factor contributing to loss of ship stability accidents (LOSA). Climate change and weather conditions can be considered as a global problem (Mark, and Piet, 2009) and equally has impacts on the maritime industry. Fundamentally, shipping industry is a risky industry and specifically ships are always exposed to various external factors or conditions such as bad weather, low visibility, currents and many more which will lead to maritime casualties such as collisions, stranding or groundings (Akten., 2006). Statistics showed that, 74% of maritime accident which are happened due to fast current, heavy traffic and bad weather conditions, usually frequent on the month of April and May, as the bad weather falls on this two months respectively (Le Blanc, and Rucks, 1996). Thus, in the case of natural or external factors, a proper management or further actions should be taken in order to manage similar bad weather conditions in future.

The management of a vessel is potential to cause problems and stress to the seafarers in managing the vessel (Xhelilaj and Lapa., 2010) and therefore a good management system is very important as it plays a crucial role in the industry. Correspondingly, in order to have a good management system, a good safety management system must exist. In fact, ISM Code has required all the shipping companies to develop and implement an effective safety management system (SMS) in order to have a safe operation at sea (ISM, 1998), and SMS do protect and prevent accidents from arising (Watcher, and Yorio, 2013). Safety management system (SMS) should be well documented and must be kept in every ship (Wu and Jeng, 2012). This is because the SMS would be very helpful during emergencies and any doubts regarding ship operation and management can be cleared by referring to the SMS. As described by Gordon et al (2007), if an organization practices safety culture but without a SMS, then the organization is considered as it is on a risky path and obviously, SMS can be improved by identifying human factors and analyzing human interactions (Einarsson, and Brynjarsson, 2008). Therefore, to improve safety in shipping industry, management measures must be revised and assessed and come out with a good management system.

3. METHODOLOGY

A sample consists of 324 respondents from varies field in shipping industry was collected using questionnaire forms as an instrument and analyzed using Logistic Regression Modeling, Response Surface Methodology and Structural Equation Modeling techniques.

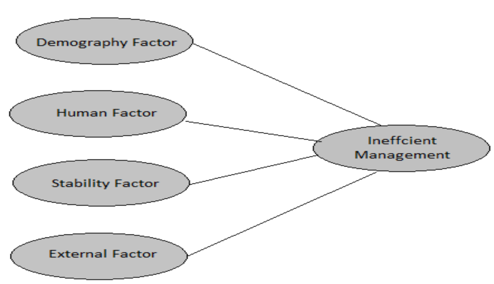

Figure 2: Conceptual Framework of Factors Affecting Inefficient Management of Vessels

3.1 Questionnaires

The questionnaire consists of five main sections. **Section A** comprises of the demography items such as sex, age, race, status, and education background of the respondents. **Section B** comprises of the 6 items for human error factor. They are (Gobi *et al*., 2014):

i. Human error is the main factor for maritime accidents.
ii. Crew should hire according to their competency level and qualification.
iii. Advanced technologies onboard cannot overcome human errors.
iv. Effective SMS can reduce human errors.
v. Human errors happen due to low qualifications of crews.
vi. Communication problem is the main factor of human error.

Section C consists of 6 items of stability factor which has occurred in the absence of proper safety management system. They are (Gobi *et al.*, 2014):

i. Old vessels are difficult to be handle/operate.
ii. Old vessels are less safe.
iii. Improper ship designs can cause accidents.
iv. Lack of attention on stability matters can cause accidents.
v. Vessels should be built complying to rules and regulations to avoid stability problems.
vi. Vessels built using aluminium can get structural damage even in medium size waves.

Section D consists of 7 items of inefficient management and they are as follow (Gobi *et al.*, 2014):

i. Good SMS practices can lower the accident rates.
ii. Clear safety management training for crews can prevent accidents.
iii. Management system which stressed on safe working procedures and wearing protective clothing can maintain save environment.
iv. Inappropriate ship management system can cause accidents.
v. Standard rules and operation procedures is an important factor to increase the safety of a ship.
vi. If there is a SMS but not in used, then the system will not be effective.
vii. Inefficient management system can cause human errors.

The last section of the questionnaire is the **section E** which comprises of 5 items of external factor. They are (Gobi *et al.*, 2014):

i. Heavy rain, fog and strong wind are hazardous towards navigation.
ii. Natural factor is an important factor in causing maritime accidents.
iii. Most of the accidents occurred during months of bad weather.
iv. Small vessels frequently involved in accidents than large vessels during bad weather.
v. All captains should get the weather forecast before starting a voyage.

4.0 FINDINGS AND DISCUSSION

4.1 Sample Size Calculation

The calculation was solved by using a single proportion formula with anticipated population proportion, (p) = 0.838, level of significance = 5% and absolute precision (Δ) = 5% (Dupont and Plummer, 1997, Mugusi et al., 2009, Naing, 2003).

$$n = \left(\frac{1.96}{0.05}\right)^2 p(1-p)$$

Based on the formula given above, p is expected proportion of individuals in the sample with the characteristic of interest at the 100(1-α) % confidence interval.

Table 1: Sample Size Calculation

Previous research	Anticipated population proportion, *p*	Absolute precision (Δ)	Level of significance	Sample size
Safety culture aboard fishing vessels (Jon Ivor Havold, 2010)	0.838	5%	5%	209 respondents
Calculation	$n = \left(\frac{1.96}{0.05}\right)^2 0.838(1-0.838) = 208.6 \approx 209$ respondents			

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From the Table1 above we can see that the sample size needed is 209(Jon, 2010). Therefore, after adding 25% more data, the minimum sample needed to be collected is 209 + (209 x 0.25) = 261 respondents.

4.2 Demographics Profiles

The finding shows that 88 percent are males and 12 percent are female. Based on randomly chosen respondents, it was found that 42 percent of the respondents were more than 30 years old. With regard to race, most of the respondents were Malay as the percentage is 82.1 percent or 266 respondents followed by Chinese and Indian, 11.1 percent and 6.2 percent respectively. In addition, the findings also shows that 83.0 percent of respondents were from shipping organization and second highest were ferry operators which obtained 37 percent of the total respondents. Concerning education background, 32.4 percent had completed their higher education at university level and the highest level of education was certificate level which was 33.3 percent.

Table 2: Demographic Profile

Demographic Profile	Category	Frequency	Percentage
Gender	Male	285	88.0
	Female	39	12.0
Age	18 years and below	2	6.0
	19 to 25 years	75	23.1
	26 to 30 years	111	34.3
	Above 30 years	136	42.0
Race	Malay	266	82.1
	Chinese	36	11.1
	Indian	20	6.2
	Others	2	0.6
Status	Ship Management Unit (UPK)	23	7.1
	Fishermen	20	6.2
	Ferry Operator	12	3.7
	Shipping Organization	269	83.0
Education Background	Primary School	9	2.8
	Secondary School	102	31.5
	Certificate	108	33.3
	University	105	32.4

(Source: Gobi et al., 2014)

4.3 Reliability Test

The cronbach's alpha values for the factors in the study are as in the Table3. The alpha value for human error and stability factors are a pretty well level of reliability which are 0.634 and 0.690 respectively. Whereas, the alpha value of external factor is 0.724. The alpha value for dependent variable that is the inefficient management is 0.767. The alpha value as an overall for the whole questionnaire was 0.837. In short, the Cronbach Alpha test shows a decent reliability level and all the alpha values are higher than 0.6 meaning that the factors used in the study is suitable and can be accepted as a measurement (Sekaran, 2003).

Table 3: The Alpha Cronbach's Values *(Source: Gobi et al., 2014)*

Dimensions	No. of Items	Alpha
Human Error	6	0.634
Stability Factor	6	0.690
Inefficient Management	7	0.724
External Factor	5	0.767

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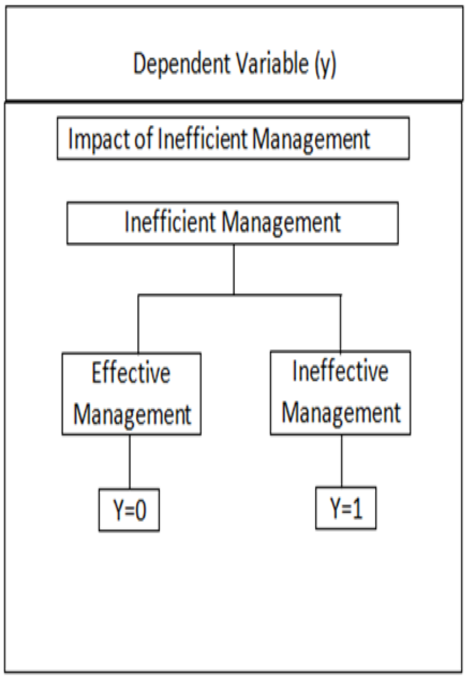
4.4 An Approach of Logistic Regression Modeling (LRM) to Dataset.

Logistic Regression analysis was carried to identify the relationship between dependent and independent variables. Based on the Figure 3, the dependent variable will be inefficient management of the vessel. Due to the nature of the binary logistic regression analysis, the dependent variables are divided into two, namely 0 and 1. As for "inefficient management will not lead to ineffective management" was set as 0, while for "inefficient management will lead to ineffective management" was set as 1. Henceforward, the dependent variables were tested with every independent variable such as age, sex, race, status, education background, human error, stability factor and external factor.



Independent Variable (x)

Variables	Explanation	
Sex	1 = Male	2 = Female
Age	1 = <18 years	2 = 19-25 years
	3 = 26-30 years	4 = >30 years
Race	1 = Malay	2 = Chinese
	3 = Indian	4 = Others
Status	1 = UPK Staff	2 = Fishermen
	3 = Ferry Operator	4 = Shipping Organization
Education Background	1 = Primary School	2 = Secondary school
	3 = Certificate	4 = University
Human Error	0 = Disagree	1 = Agree
Stability Factor	0 = Disagree	1 = Agree
Inefficient Management	0 = Disagree	1 = Agree
External Factor	0 = Disagree	1 = Agree

Figure 3. Classification of Dependent Variable and List of Independent Variable of the Study

In logistic regression model, a criterion was set for identifying significant independence variables. The significant independent variable were identified based on a fixed criteria, where the relevant independent variable have to achieve the significant values of not greater than $\alpha = 0.05$ ($p < 0.05$). Multiple logistic regression analysis performed to examine the correlation between the independent variables which are significant to the model. The logistic regression analysis was performed on the eight independent variables (age, sex, race, status, education background, human error, stability factor and external factor) simultaneously with the dependent variables (inefficient management). All of these factors were analyzed using SPSS 18.0 and statistical Analysis Software, SAS. In the use of the software, manual technique was used to simplify the calculation of the data analysis by logistic regression. This method was used in the determination of the model.

4.4.1 Preliminary Model with Significant and Non-significant Variables (Factors)

The preliminary results obtained from the manual technique are as follows:

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Table 4. Multiple Logistic Regressions Using Method of Enter

Factors	β	*p*-Value	Exp(β)
Age	-0.192	0.578	0.825
Sex	-0.473	0.551	0.623
Race	0.247	0.583	1.280
Status	0.231	0.353	1.260
Educationbackgrounds	-.0332	0.290	0.717
Human error	1.984	0.001	7.275*
Stability factor	0.428	0.480	1.535
External factor	1.975	0.000	7.210*
Constant	0.644	0.752	1.904
*Significant level p<0.05**			

Based on the Table 4, there are two significant factors towards formation of the model namely human error (*p*-value = 0.001) and external factor (*p*-value = 0.000). We also can see clearly that others variables do not have a significant impact to inefficient management.

4.4.2 Testing Goodness of Fit of Model

On the other hand, testing Goodness of fit model (Goodness-of-Fit) was carried out to determine whether the model is good or otherwise. There were three tests were carried out to test the effectiveness of the model. The tests which were conducted are Hosmer-Lemeshow Test, the Classification Table and the Area under the ROC Curve.

4.4.3 Hosmer-Lemeshow Testing

Table 5.Hosmer-Lemeshow Test

Chi-square	Degree of Freedom	*p*-Value
6.313	8	0.612

Table 5 shows the results of the Hosmer-Lemeshow test by using SPSS 18.0. Based on the table, the p-value obtained (p = 0.612) which were greater than 0.05 (*p*-value > 0.05) indicates that the produced logistic regression model is very good (David Hosmer & Stanley Lemeshow, 2000).

4.4.4 Classification Table Results

Furthermore, the testing of the effectiveness of the model can also be referred to the classification table which is obtained through the analysis using SPSS. The obtained classification table is as follows:

Table 6. Classification of the Impact of Inefficient Management

Review		The Expected Status of the Impact of Inefficient Management		Percentage of Valid
		Ineffective Management No	Ineffective Management Yes	
Status of the impact of Inefficient Management	Ineffective Management No	7	15	31.8
	Ineffective Management Yes	6	296	98.0
Overall Percentage				93.5

The effectiveness of an analysis is considered good of the total percentage of the model exceeds 80%. Based on the multiple logistic regression analysis, the overall percentage of the study was 93.5%, which greater than 80%, indicating the effectiveness of the model obtained is very good.

4.4.5 Area under ROC Curve for Preliminary Model

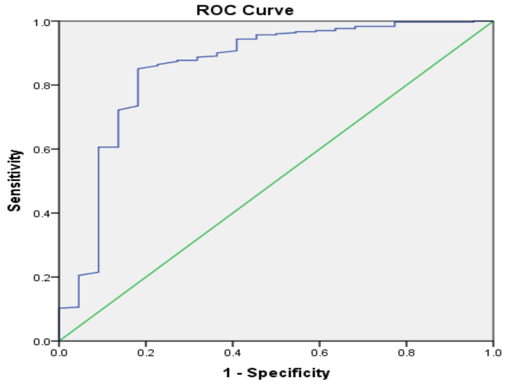

Figure 4. Area under ROC Curve for Preliminary Model

Table 7: Area under ROC Curve

		Asymptotic 95% Confidence Interval	
Area	Asymptotic Significance (p-Value)	Lower Bound	Upper Bound
0.853	0.000	0.752	0.955

Theoretically, the percentage of the area under the ROC curve is considered good if the percentage obtained is above 70%. In testing the effectiveness of this model is found that the percentage of the area under the curve is 85.3% which is more that 70% (85.3% > 70%) (Hosmer & Lemeshow, 2000). This indicates that the model obtained is good. Among the three tests to determine the effectiveness of the model (Goodness-of-Fit) is found that Hosmer-Lemeshow Test is the most appropriate and suitable test. Therefore, this logistic regression model is good because the Hosmer-Lemeshow Test meet the *p*-value = 0.612 which is higher than 0.05. In addition, the area under ROC curve test also shows that the model as overall is good enough.

4.4.6 Establishing Final Model with Significant Variables

Table 8. Table of 95% Confidence Interval

Factor	β	*p*-Value	Exp(β)	95% Confidence Interval for EXP (β)	
				Lower	Upper
Human Error	2.162	0.000	8.687	3.232	23.354
External Factor	2.089	0.000	8.080	3.006	21.715
*Significant level p < 0.05**					

Interpretation of the final data is the analysis of the resulting model. The effectiveness of the model can be determined by referring to the confidence interval which specifies the risk obtained. Based on Table 8., we can make a statement on the occurrence of risk factors associated with inefficient management with respect to the risk value. The odds of developing inefficient management among respondents which

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agrees to the human factor (CI: 3.232-23.354, *p*-value = 0.000) is $8.687 \approx 9$ times of those respondents which is not agree. The results also shows that external factor also contributing a significant results towards inefficient management. We can see clearly that the odds of developing inefficient management among respondents which agrees to the external factor (CI: 3.006-21.715, *p*-value = 0.000) is $8.080 \approx 8$ times of those respondents which is not agree. We can conclude that, from the results, human error factor has the highest score compared to the external factor.

4.4.7 Hosmer-Lemeshow Testing

Table 9. Hosmer-Lemeshow Test

Chi-square	Degree of Freedom	*p*-Value
0.168	1	0.682

Table 9 shows the results of the Hosmer-Lemeshow test for the final model, by using SPSS 18.0. Based on the table, the p-value obtained (p = 0.682) which were greater than 0.05 (p-value > 0.05) indicates that the produced final logistic regression model is a very good model (David Hosmer& Stanley Lemeshow, 2000).

4.4.8 Classification Table Results

Furthermore, the testing of the effectiveness of the final model can also be referred to the classification table which is obtained through the analysis using SPSS. The obtained classification table is as follows:

Table 10. Classification of the Impact of Inefficient Management

Review		The Expected Status of the Impact of Inefficient Management		Percentage of Valid
		Ineffective Management No	Ineffective Management Yes	
Status of the impact of Inefficient Management	Ineffective Management No	8	14	36.4
	Ineffective Management Yes	7	295	97.7
Overall Percentage				93.5

The effectiveness of an analysis is considered good of the total percentage of the final model exceeds 80%. Based on the multiple logistic regression analysis, the overall percentage of the study was 93.5%, which greater than 80%, indicating the effectiveness of the final model obtained is very good.

4.4.9 Area under ROC Curve for Final Model

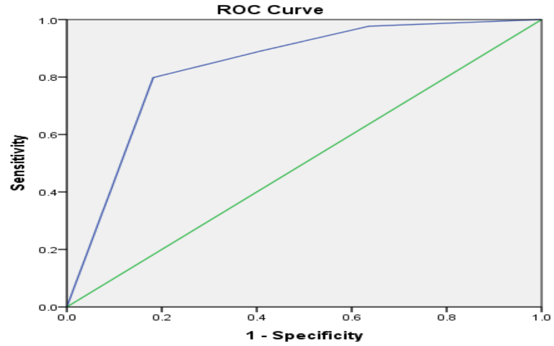

Figure 5. Area under ROC Curve for Final Model

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Table 11. Area under ROC Curve

Area	Asymptotic Significance (*p*-Value)	Asymptotic 95% Confidence Interval	
		Lower Bound	Upper Bound
0.836	0.000	0.736	0.936

Theoretically, the percentage of the area under the ROC curve is considered good if the percentage obtained is above 70%. In testing the effectiveness of this final model is found that the percentage of the area under the curve is 83.6% which is more that 70% (83.6% > 70%) (Hosmer&Lemeshow, 2000). This indicates that the obtained final model is good. Among the three tests to determine the effectiveness of the model (Goodness-of-Fit) is found that Hosmer-Lemeshow Test is the most appropriate and suitable test. Therefore, this logistic regression final model is good because the Hosmer-Lemeshow Test meet the suitable *p*-value=0.682 which is higher than 0.05. In addition, the area under ROC curve test also shows that the final model as overall is good enough.

4.5 An Approach of Response surface Method for Inefficient Management Using Binary Data

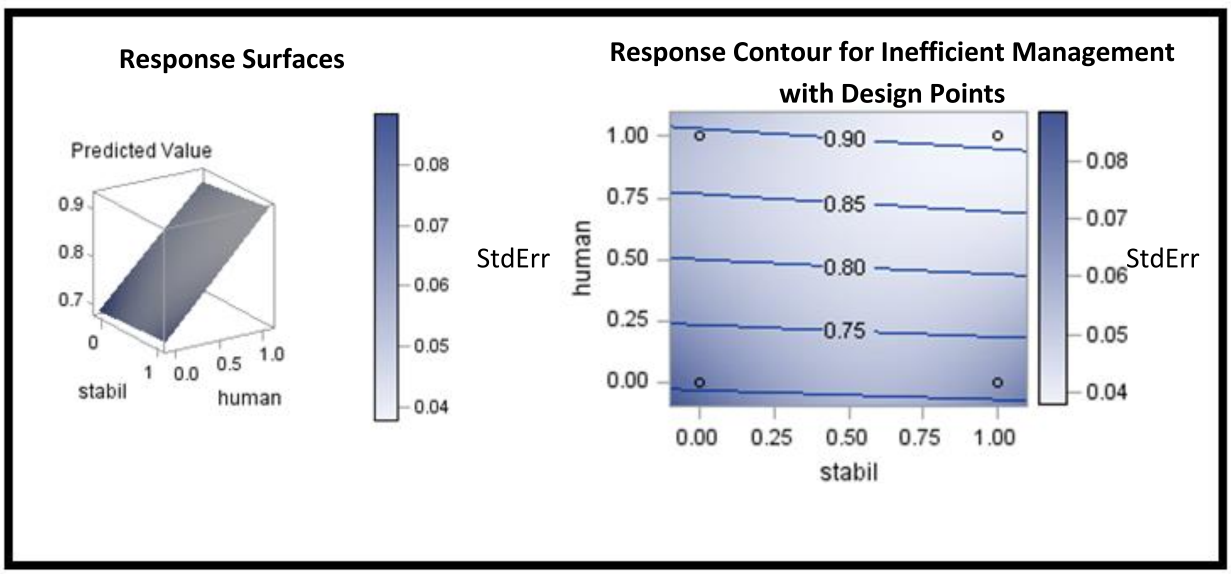

Figure 6: Response Surfaces and Response Contour for Inefficient Management vs Human Error, Stability Factor

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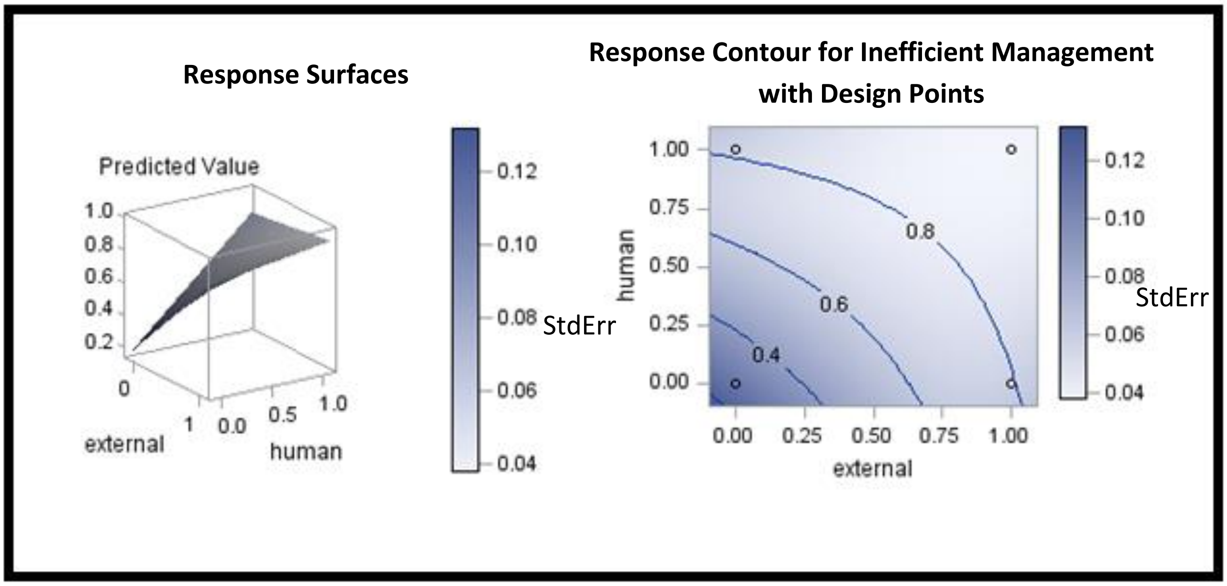

Figure 7. Response Surfaces and Response Contour for Inefficient Management vsHuman Error, External Factor

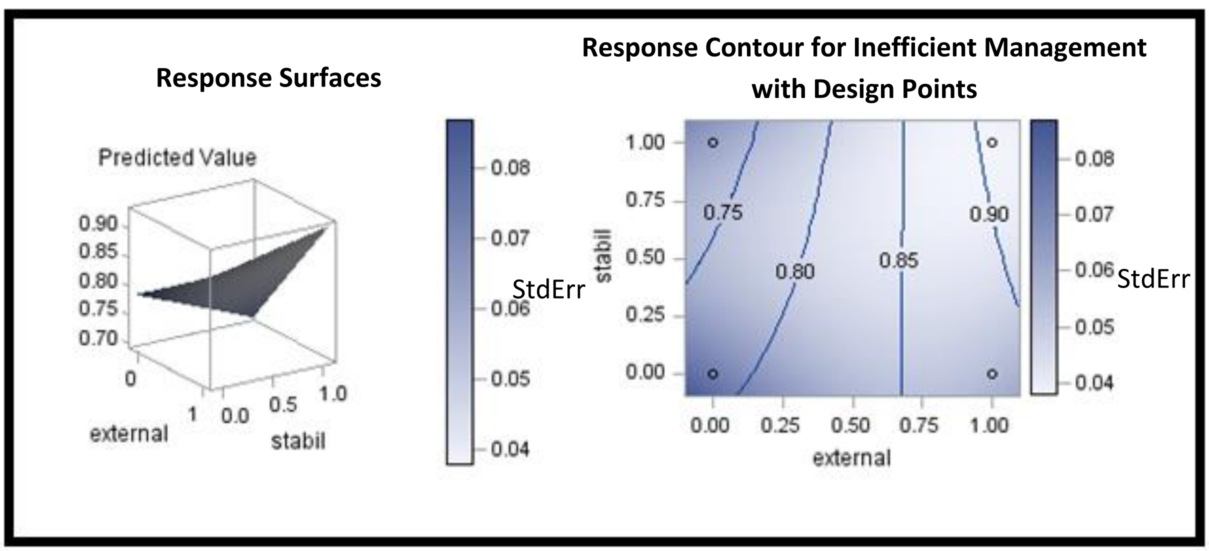

Figure 8. Response Surfaces and Response Contour for Inefficient Management vsStability Factor, External Factor

Response surface method is used to examine in detail to show the factors that contribute towards inefficient management. Additionally, the response surface can be pictured graphically through contour plot and it will be very helpful to see the shape of a response surface. Based on the Figure 6 above, the counter and surface plots indicate that the highest value or impact of efficiency on management is obtained when the count of human error to be the contributing factor is agreed the most by respondent while stability factors does not affect the efficiency.

Whereas, in Figure 7, the counter and surface plots indicates that the highest value or impact of efficiency on management is obtained when the both human error and external factor has been agreed the most. Thus, both human error and external factor has

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been the contributing factors towards inefficient management. Finally, in Figure 8, the counter and surface plots indicates that the highest value or impact of efficiency on management is obtained when the external factors has been agreed the most to be the contributing factors, however the stability factor does not give any contributions towards inefficient management. Therefore, based on the results obtained in the response surface method for inefficient management, there are two significant factors found namely human error and external factor. This two factors are contributed more towards inefficient management compared to other factors.

4.2.5 Structural Equation Modeling : The Assessment of Fitness for the Model

Structural equation modeling technique was used to estimate multiple and interrelated dependence relationships and used to represent the unobserved concept in these relationships and account for the measurement error in the estimation process (Hair, 1998). In this study the unobserved exogenous variables are demography, human error, stability factor, and external factor, and unobserved endogenous variable is inefficient management. Amos version 18 was used to measure the model fit.

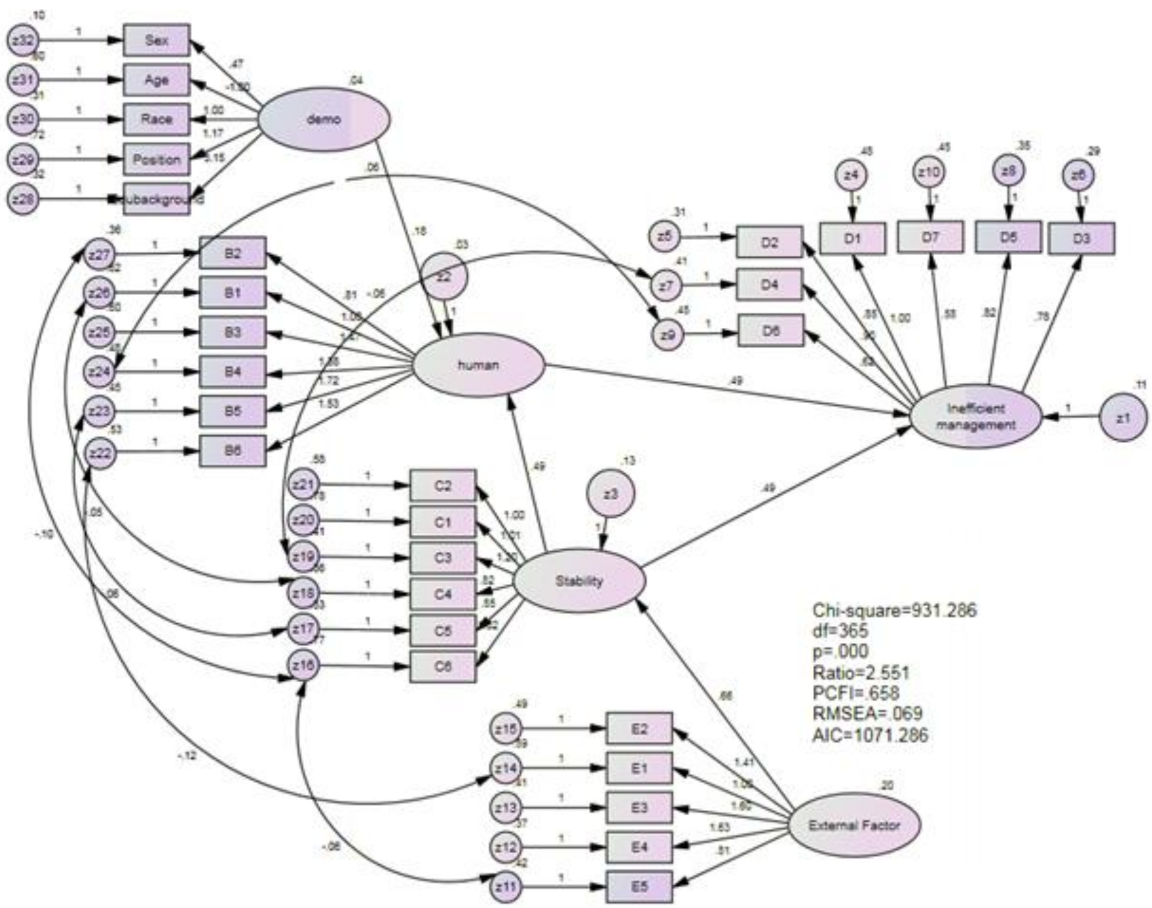

Figure 9: Modeling of Factors Affecting Inefficient Management of Vessels in Malaysia
(Source: Gobi et al., 2014)

5. Discussions of the Modeling of Factors Affecting Inefficient Management of Vessels in Malaysia.

According to Gobi et al.,(2014) the model was constructed based on the recommendations proposed by Amos 18.0 to ensure that this model fits the data. The section of demography showed three items in term of standardized regression weights that contribute to these dimensions is race (β = 1.00, p <0.05), position (β = 1.17, p <0.05), and education background (β = 3.15, p <0.05). Race is refers to the race of respondents which consists of Malay, Chinese, Indian and others. While position or status is refers to the job background of the respondents that comprises of staff of ship management unit (UPK), fishermen, ferry operator and shipping organization personnel. The next section indicates the education background of the respondents such as from primary, secondary, certificate level and university or higher level. Fundamentally, based on the model, it seems clear that the section of demography has an impact on human error. This means the occurrence of human errors has a high connectivity with the respondent's education background.

All the indicators in human error have contributed towards human error. The B3 which is the advanced technologies onboard cannot overcome human error, has the standardized regression weights of (β = 1.47, p <0.05). B4 which is the effective SMS can reduce human errors, is (β = 1.38, p <0.05) and B5 which is the human errors happens due to low qualifications of crews, has contributed more (β = 1.72, p <0.05). The findings also indicated that the indicator B4 (effective SMS can reduce human errors) has a connection with D6 (If there is a SMS but not in used, then the system will not be effective) of inefficient management. On the other hand, the human factor has shown the overall effect of β = 0.49 on the inefficient management. Likewise, there are also a strong relation between B1 (Human error is the main factor for maritime accidents) of human error and C4 (Lack of attention on stability matters can cause accidents) of stability factor. It is likely that, human error has always leaded to stability problems and this can be overcome by an effective management system. Therefore, based on this result, it is clear that an effective management system is required in order to overcome issues related to human errors by providing applicable management, work modules or trainings to the crews besides hiring the crews based on the job requirement and qualifications as well. The role of stability factor has been shown the overall effect of β = 0.49 to the human error and inefficient management respectively. All the sections in stability factor are at significant level and among the most contributed sections are C6 (Vessels built using aluminium can get structural damage even in medium size waves) with β = 1.22 and p <0.05, C3 (Improper ship designs can cause accidents) with β = 1.20 and p <0.05, and C1 (Old vessels are difficult to be handle/operate) with β = 1.01 and p <0.05. Whereas, C3 (Improper ship designs can cause accidents) and D4 (Inappropriate ship management system can cause accidents) has a relation where a proper management system guideline has to be introduced so that a better and sTabled vessels can be built in order to reduce the accident rate.

Similarly, the external factor has an overall effect of β = 0.65 on the stability factor. Whereas, in external factor all the items, has shown a significant contribution and for example E2 (Natural factor is an important factor in causing maritime accidents) shows the significance of (β = 1.41, p <0.05), E3 (Most of the accidents occurred during months of bad weather) is (β = 1.60, p <0.05) and E4 (Small vessels frequently involved in accidents than large vessels during bad weather) has the most significant contribution (β = 1.63, p <0.05) towards the external factor. In short, lack of proper management skills has led to difficulties in handling vessels during bad weather especially for the small vessel where the number of accidents involving small vessels are always very high. There a systematic management system can overcome all the consequences.
Therefore, the study proves that human error, stability factor and external factor are contributing towards inefficient management. This has occurred because most of the shipping companies are failed to implement an effective and skillful management system. This is because an effective management system can provide a clear exposure to the staff and crews of a shipping company to manage the ship or company more effectively, safely and systematically.

6. CONCLUSION

This study verifies that all the hypothesis of the study has been accepted as based on the results obtained. The hypotheses of the study are 'H_{1-} Inefficient management system will lead to human error', 'H_2-Inefficient management system may cause stability/unseaworthiness problems''H_3-Inefficient management system will lead to ineffective management' and 'H_4-Inefficient management system will worsen the external conditions' (Gobi *et al.*, 2014). In addition, based on all three analysis namely LRM, RSM and SEM that has been carried out, it is shown that human error, external factor and stability factors has a big contribution towards the efficiency of the management of the vessels.
Therefore, it is very transparent that, the nonexistence of a proper safety management structure can lead to human error, stability problem, and worsen an

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external condition. Hence, this will affect the management efficiency of an organization or vessel and therefore further maritime accidents are more likely to happen.

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