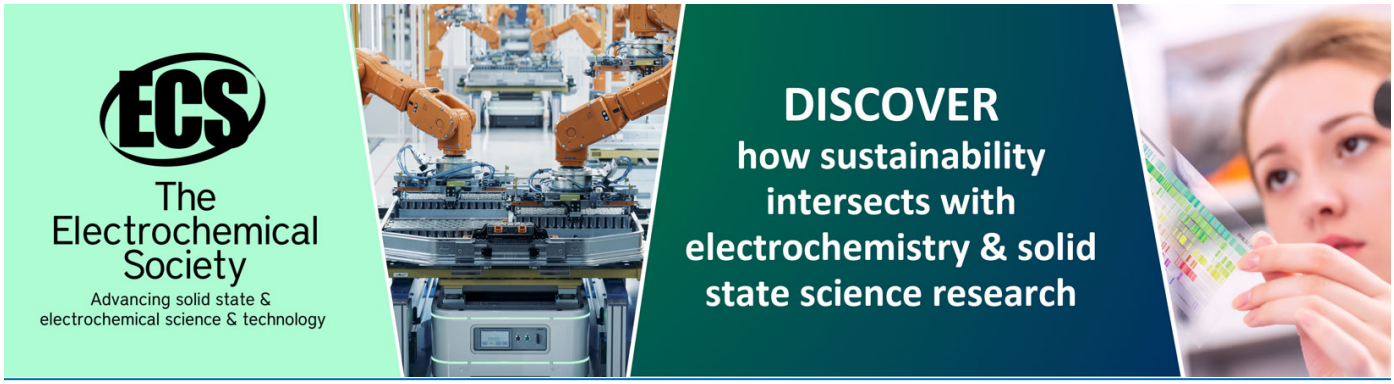
A Study on Preparedness and Response of Oil Spill



A Study on Preparedness and Response of Oil Spill

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Abstract. This study determines the success of an action prepared at an oil terminal in Kemaman, Terengganu. The oil spill is defined as a liquid hydrocarbon release into a marine environment and mostly is caused by human activity which produces water pollution. The oil spill could occur due to the production of crude oil from shipbuilding, drilling rigs and spill from refined petroleum products. The oil spill could affect severe sea ecosystems, fish and rocks, causing environmental damage as well as affected human health and millions of dollars were spent on recovery and consume longer period to recover completely. In addition, the success rate of the oil spill is important which influences by results of the preparation and the response activity. This study analyzes three elements namely assets, human error, and response as the major contribution for the oil spill preparedness towards the oil spill response. 50 respondents from related government agencies such as marine department and environment department and team response members have participated in this research. The results show a strong positive relationship between preparedness and response at 0.857.

Keywords: preparedness, response, oil spill

1. Introduction

Port is important for the country as the main gateway of gigantic import and export activities which directly contribute to the economics of its country as agreed by [1][2]. It is also important and used towards a network of trade gateway and become an important paradigm of globalization as claimed by [3]. According to [4], indicated that the shipping industry is the earliest industry in the world and diversification of exchange of goods depends on international trade. The oil spills could also occur during production while transportation the oil to storage and during oil trading as stated by [5]. However, according to [6], identified that the sea transport has a great risk which affects the condition of the sea and sea life in the event of oil spilled by the shipping activities. The oil spilled is not only caused by ships but could occur during a process of digging oil near the sea, during transferring the oil to refineries or terminal and during oil shipment to storage. Disposal of oil remnants to the sea threatens the marine environment and lead to the destruction of marine habitats, clean water sources and destroy plants on the seabed like plankton as mentioned by [7]. Increased activity in the transportation industry leads to sea contaminated by oil spills created by the terminals as agreed by [8].

1.2 Background of Study

This research discusses the preparedness and response towards the oil spill at one oil terminal located at one oil terminal in Kemaman, Terengganu. This research aims to explain the preparedness activities by the oil terminal and to analyze the response process towards the oil spill according to Standard Operating Procedure (SOPs). This terminal began its operation in 1982 as an onshore support base dedicated solely to service and supplies the offshore petroleum operations. It was specially designed and developed as a comprehensive logistic supply base for Peninsular Malaysia's offshore petroleum exploration and production industries. This terminal is fully supported by a pool of dedicated, well-trained and experienced stevedores to handle a wide range of cargoes and to ensure quick turnaround of the ship. In responding to the oil spilled, the terminal operates using software simulations and mathematical relationships to predict the oil fate and slick trajectory. Based on the simulated prediction allows implementing efficient strategies according to the sensitivity of the shoreline which could affect the capability in handling combating equipment in the oil spill. This research focuses on the oil spill preparedness and response at oil terminal and serves the research objectives in explaining the contingency plan of preparedness and response at the terminal and to analyze the response activities toward the oil spill according to required Standard Operating Procedure (SOPs). From the research in oil spill preparedness and response it could beneficial in providing a discernment on the practices in controlling and preventing of the oil spill provide a positive impact to port management, ship owners and coastal state by listing and emphasizing of the oil spills control practices which could be used in preventing the oil spill and minimize complications by examining the effectiveness of the practices.

2. Literature Review

2.1 Definition of Oil Spill

Table 1. Definition of Oil Spill

Authors, years	Descriptions
[9]	Is categorized as a liquid which consists of hydrocarbons.
[10]	Is the significant source of hydrocarbons entering into the receiving aquatic environment.
[11]	Is defined as the removal of hydrocarbons in a marine environment caused by human activity, natural disasters and can cause a lot of effects on the environment and economy.

In general, the oil spill is the release of petroleum liquids into the ocean by ship either intentionally or unintentionally and cause pollution to the earth's ecosystem and usually, the oil spill occurs at sea, but the oil spill also can occur on land. The oil spill not only from ships, but also occur during the process of digging oil near the sea, during oil refineries, during oil shipment to the storage, and also naturally occurring effects of earthquakes on the seabed. The release of toxic substances such as the release of oil into the sea can cause severe damage to crops, fisheries and other seafood sources such as fish, crabs, and other as agreed by [12].

2.2 Oil Spill Preparedness and Response

An effective marine oil spill combat operation relies upon the prompt reaction from the time the oil slick is distinguished. Accident events that involve oil spills would be catastrophic towards the environment depending on how bad is the spills provided the other factors that can affect oil control and prevention operations causing the oil spread even further as mentioned by [13]. The fundamental of the oil spill preparedness and response is looking at the oil spill response itself as a study conducted by [14] found that oil spill response requires a viable reconciliation of the physical and substances properties, transport, and weathering of spilled oil, choice of clean-up strategies, arranging of seaside

security operations, climate and ocean conditions and booking of clean-up offices. Advancement of ideal planning strategies for the oil spills response operations is vital with a specific end goal to adjust the aggregate cost and responsiveness.

2.3 Oil Spill Effects

According to an early study from [15], indicating that many effects contributing from the oil spills as the spills occurred at the point of production and during delivering goods to a destination via the sea transport. Petroleum hydrocarbons such as crude oil released by unintentional into marine areas should lead to marine pollution especially affect the marine life, humans, economic resources of a country and as a major most feared by the community and known as a detrimental effect on the economy especially to fishermen, farms, health, the immediate environment and it's posing a serious threat to economic activities like temporarily shutting down navigation routes and driving away tourists, most serious causes of marine pollution, bring huge economic loss to the society, influences the marine ecological environment and leads to the damages in ecological balance as mutually agreed by [16].

3. Research Methodology

A quantitative survey method is used in this research. A distribution of questionnaires to respondents from the Marine Department, Department of Environment, oil response team members at terminal was conducted and the data was collected and used to gain result for descriptive statistics, frequency, mean, standard deviation, reliability test, multiple correlation analysis, multiple regressions using methods from Statistical Package for the Social Science (SPSS) to fulfill the expected outcome for this research. An individual who is known as an expert exposed and dealing with the response towards the oil spill is identified as a unit of analysis of this research.

3.1 Theoretical Framework

The theoretical framework as a structure that supports a theory of the research is used to determine the relationship of the independent variables such as preparedness of oil spillage for the asset, human resources and team members towards the dependent variable of the oil spill response. The independent variable is a variable that charged in a scientific experiment to study the effect on the dependent variable and has been measured in a scientific experiment as proposed by [17].

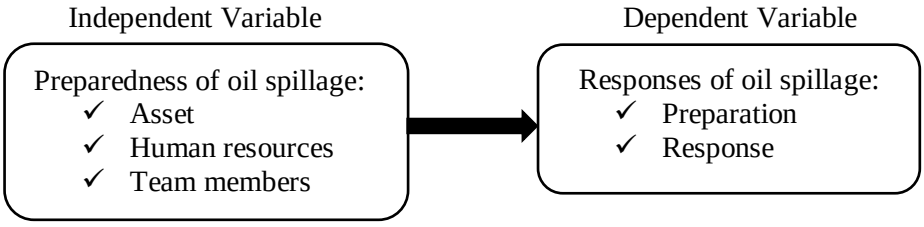

Figure 1. The Theoretical Framework

3.2 Population, Sample and Respondents

The population in this research covers response all team members at the oil terminal, government staff from the Marine of Department and Department of Environment who are involved in the oil spill incidents. Purposive sampling is used in the data collection and involved 41.67% or 50 respondents participated during the questionnaire survey process. The questionnaire was distributed at the different companies which are Oil Terminal Response Team, Lumut Marine Department, Wilayah Tengah Marine Department, and Kemaman Department of Environment. Unfortunately, no respondents from Kemaman Port able to answer the questionnaire because of their company's policy and the research scope is assumed to be private and confidential according to the company. Nevertheless, 10 respondents able to answer the questionnaire successfully from Wilayah Tengah Marine Department,

8 respondents from Kemaman Department of Environment and the balance of 32 respondents were from Lumut Marine Department.(refer Table 2).

Table 2. Population, Sample and Respondents

List of Population	Sample	Respondent
1. Oil Terminal Response Team	20	0
2. Lumut Marine Department	40	32
3. Wilayah Tengah Marine Department	40	10
4. Kemaman Department of Environmnet	20	8
Total	120	50

4. Finding and Discussion

4.1 Respondents Demographic Analysis

Table 3 shows a demographic respondent analysis from 50 respondents who have successfully answered the given questionnaire.

Table 3. Respondents Demographic Analysis

Background Respondent	Descriptions	Frequency	Percent
Gender	**Male**	**39**	**78.0**
	Female	11	22.0
Race	**Malay**	**39**	**78**
	Indian	5	10
	Chinese	6	12
Age	25 years and below	10	20.0
	26-35years	19	38.0
	36-45years	**21**	**42.0**
Education	Ph.D. & Master	21	42.0
	Bachelor & Diploma	**29**	**58.0**
Position	Top Management	9	18.0
	Middle Management	10	20.0
	First Line Management	11	22.0
	Bottom line	**20**	**40.0**
Experience working	Less than 1year	4	8.0
	1-5years	7	14.0
	6-10years	**32**	**64.0**
	More than 10years	7	14.0

Table 3 shows 39 male and 11 female respondents. The difference in gender is due to the nature of the company which is a heavy team response oil spill requires more male manpower. It shows 78% respondents mostly are Malays and dominant in the marine industry sector related to oil preparedness and response. 36-45 years are the majority of the respondent's age with 42% whose play an important role in evaluating the level of competency and maturity in problem-solving related to the oil spill incidents. Bachelor and Diploma have shown the highest result for the education at 58% are because Diploma staff is sufficient to work in the field of maritime operations. 20% of the respondents are from the Bottom Line as the bottom line staff is directly involved in the oil spill incidents. 64% of the respondents with 6-10 years of working experience related to the oil spill.

4.2 Instrument

The instrument of the study is divided into four parts. The first part of the questionnaire is regarding the respondents' background which represents gender, race, marital status, and level of education and working experiences. The second part of the questionnaire covers on company background. The third part inquiries on the measurement of oil spill preparedness of assets, human resources and team members with a Likert scale of 1-5, which indicates: 1- strongly disagree, 2- disagree, 3- neutral, 4- agree and 5- strongly agree. It was developed in 1932 by Rensis Likert as to measure attitudes and the typical Likert scale is a 5- or 7-point ordinal scale used by respondents to rate the degree to which they agree or disagree with a statement as mentioned by [18]. The fourth part of the questionnaires covers on the response of the oil spill of preparation and response by 1-5 Likert scale. To measure the oil spill preparedness, 33 items were included in the questionnaire used to measure the asses, human resources, and team members. The items in the questionnaire were adopted and adapted from several references on the oil spill preparedness and response and some are self-constructed. Therefore, face and content validity were conducted on all the measurements. The scale items were screened by two subject matter experts from the field of maritime management and two practitioners in the maritime management government agencies. The comments and suggestions were considered in improving the questionnaire. A pilot test was conducted among the industrial-experienced staff of the maritime institution and staff of an oil and gas company in Lumut, Perak. Table 4 below shows the Cronbach's coefficient alpha internal consistency reliability and is used to measure the reliability of questionnaires and shows internal consistency reliability as stated by [19][20]. The result shows 0.749 and the reliability coefficient value is closer to 1.0 and the reliability is excellent as the value is between $0.8>\alpha\geq0.7$ the internal consistency is acceptable.

Table 4. Cronbach's Alpha Value

Cronbach's Alpha	
Cronbach's Alpha	No of Items
.749	33

4.3 Normality Test

A normality test such as Kolmogorov-Smirnov and Shapiro-Wilk test is used to conclude a sample or any group of data matches the standard of the normal distribution as stated by [21]. Kolmogorov-Smirnov test is used to measure the maximum difference between the observed distributed and expected cumulative-normal distribution from the sample mean and standard deviation as mentioned by [22] and as the sample size is 50 or more respondents.

Table 5. Normality Test

Tests of Normality					
Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Statistic	df	Sig.	Statistic	df	Sig.
.268-0.540	50	.000	0.125-.782	50	.000

Table 5 shows the normality test for the Independent Variable (IV) element of preparedness oil spillage approach is highest valued at 0.540 at the statistic and the significant value is 0.000 and is normal as agreed by [23], and is presumed that the data is normal and the statistical value for the element preparedness oil spill is higher than the significant value.

4.4 Correlation Analysis between preparedness and response of oil spill

The correlation analysis is used to obtain the degree and direction and gives an estimated relationship between the two variables as states by [24]. From the range of correlation coefficient (r), the value of

r= 0.857 is considered high and it is acceptable to mention the positive and strong relationship between the variables. This supports by [25][26], shows that the closer the correlation is to 1.0, the stronger the relationship between the two variables. In this case, means that high scores on one are associated with high scores on the other and that low scores on one are associated with low scores on the other. If the higher score on the oil spill preparedness in the marine company will produce a higher rate of response in the oil spill. The Pearson Correlation Coefficient requires both variables to be measured on an interval or ratio scale, and calculations based on actual values.

Table 6. Correlation Between Preparedness And Response Of Oil Spill

Correlations			
		Preparedness of oil spill	The response of the oil spill
Preparedness of oil spill	Pearson Correlation	1	**.857****
	Sig. (2-tailed)		.000
	N	50	50
The response of the oil spill	Pearson Correlation	**.857****	1
	Sig. (2-tailed)	.000	
	N	50	50

**. Correlation is significant at the 0.05 level (2-tailed).

Table 6 shows the Pearson correlation coefficient between preparedness of the oil spill and response of the oil spill is 0.857 which indicates that the value of correlation is positive. The result indicates a strong positive relationship between the oil spill preparedness and response (r=0.857), this result is supported by [27]. The contribution of preparedness and response of the oil spill is vital in the case of oil spillage or oil pollution prevention and control. The result of the correlation analysis has proved that the preparedness of the oil spill and response of the oil spill is influenced by steps and precaution measurements which supported by [24].

Table 7. Correlation of Variables

Model	Collinearity Statistics	
	Tolerance	VIF
Assets	0.417	2.125
Human Resources	0.614	1.63
Team Members	0.394	2.541

Based on the output of Table 7, Coefficient Output – collinearity statistics obtained the Variance Inflation Factor (VIF) value of between 1.63 to 2.541 meaning that the VIF value obtained between 1 to 10. It can be concluded that there are no multicollinearity symptoms. This test is to determine whether there is a similarity between the independent variables in a model. Similarities between the independent variables will result in a very strong correlation. A VIF of greater than 5 is generally considered evidence of multicollinearity.

4.5 Multiple Regression Analysis

Correlation and multiple regression analysis were conducted to examine the relationship between the oil spill preparedness and the oil spill response. The regression coefficients show the number of changes in the dependent variable when independent variables change one-unit independent variables. Table 8 shows a value of 0.850 which indicates a good level of prediction. The coefficient of determination (R Square) states the value of 0.723 or 72.3% explain the variability of the dependent variable on the oil spill response. Thus, can be assumed that the model explains a significant amount of the variance in the oil spill preparedness. Table 9 shows the result of ANOVA whether the overall regression model is a good fit for the data. It shows that the independent variables statistically significantly predict the dependent variables $F(3,56) = 48.752, p < 0.005$.. The regression model is a good

fit for the data. Table 11 shows the result of the regression model that the unstandardized coefficients β indicate how much the dependent variable varies with the independent variables when all other independent variables are held constant. The unstandardized coefficient β for assets, human resources, and team members are 0.283, 0.277 and 0.307 respectively. It indicates that assets, human resources, and team members increase in the rate of the oil spill response at 0.283%, 0.277%, and 0.307%. The result impacts the value of the dependent variable. The multiple regression is analyzed to predict the oil spill preparedness which is caused by an asset, human resources, and team members. These variables statistically significantly predicted the oil spill response $F(3,56) = 48.752, p < 0.005, R^2 = 0.723.$. All three variables added statistically significant to the prediction $p < 0.05$.

Table 8: Correlation Result

Model	R	R square	Adjusted R square	Std. The error of the Estimation
1	.850	.723	.708	.18369

Predictors: (constant), lack of knowledge, communication, fatigue

Table 9. ANOVA Test

Model	Sum of squares	df	Mean square	F	Sig.
Regression	4.935	3	1.645	48.752	.000[b]
Residual	1.890	56			
Total	6.824	59			

a. Dependent Variable: Oil Spill Response
b. Predictors: (Constant), Assest, Human Resources, Team Members

Table 10. Dependent variable preparedness of oil spill

Model		Standardized Coefficients B	Beta	t (value)	Sig.
Adjusted R Square				.739	
F		70.244		8.984	.000
Constant		1.012			
1	Asset	.262	.397	2.997	.004
2	Human Resources	.713	.814	10.532	.000
3	Team Members	.086	.131	1.692	.097

Table 11. Regression Coefficients Model

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	.653	.305		2.142	.037	.042	1.264
Assets	.283	.101	.288	2.809	.007	.081	.485
Human Resources	.277	.080	.313	3.489	.001	.118	.437
Team Members	.307	.090	.381	3.399	.001	.126	.487

a. Dependent Variable: Preparedness b. Response

The result indicates that 72.30% of the total variation in the dependent variable "preparedness of oil spill" is explained by the independent variable. The model is statistically significant as the F value is significant at $p<0.05$ and has a value of 8.984. When preparedness of the oil spill has analyzed the results indicates that all is positive significantly related to the response of the oil spill. Whereas for preparedness of oil spill out of five variable and all are significantly ($p<0.05$) related response of oil spill, in which is an asset and human resources is 0.004 are positively related because of the significantly $p<0.05$.

5. Discussion, Conclusion, and Recommendation

5.1 Discussion

Asset readiness is essential for controlling oil spills occurs at sea. But with $p>0.05$ is a positive relationship for significantly to control oil spill spread to other areas. Asset are a key ingredient is quite important in the response of the oil spill, the readiness of maintaining more sophisticated assets in the regulation of marine pollution. **Human resources** were found to have a positive and significant relationship with the response of the oil spill. One case must be handled if one person gives a higher commitment to ensure the ocean clean for the oil spill or oil pollution. Human resource is one committee to ensure a very planning or another under we must be smoothly run. **Team members** show negative significant because the relationship with the response oil spill is $p<0.05$. Refers to the committee based on the numbers of a person in the group to the response oil spill in the ocean. The person associated with standby 24 hours and 7 days without leaving the organization (due to the higher responsibility to group members). Potential antecedents of the response of oil spill in team members must include age, weight, high, body mass index (BMI) stable, no injury, no criminal record, career satisfaction.

5.2 Conclusion

The outcomes are reviewed based on the objectives of the research which has been successfully achieved in this research. The outcomes were based on 50 purposive respondents from the maritime industry. The two research objectives have positively achieved for the preparedness of oil spill and response of the oil spill. The preparedness of the oil spill is very important in the oil spill contingency plan. In addition, a crucial decision making helps to determine the response rate of oil spill control and prevention. The t-test method is used in order to distinguish the highest mean to determine the preparedness of the oil spill. Prompt reaction time and enough resources during decision making lead to increases and has a higher rate of response. In addition, the second objective which is to investigate the preparedness and response oil spill in minimizing the oil spill have been analyzed and discussed using correction strength. It shows that most variables have a strong relationship between independent variables and dependent variables of the preparedness and response of the oil spill control and prevention.

5.3 Future Recommendation

Recommendation of this research facility for another sector that wants to explore new simulation or programming system to read the rate of oil drops on the surface of the water through changes in winds, waves, and current movement. Each Standard Operation Procedures (SOP) must be published by the Department of Environment (DOE). Mostly every oil spill case must be reported to the Department of Environment (DOE) in managing the oil spill issues and prepare for the immediate action requirements. A systematic oil spill training schedule is needed for three times per year to create awareness, alert and almost ready among the oil spill response team members. Malaysia has not suffered a massive oil spill that could be devastating to the environment, the oil spill is a very serious issue in the maritime industry. Firstly, prevention is always better than cure because, in the context of oil spillage, the excess oil is persistent and can stay pollution the environment for other several years if untreated well. This research has shown that the management approach will contribute to the success rate of oil spill prevention and control. Secondly, the preparedness and response are the key

elements to curb future accidental in the marine environment which could trigger more pollution and the recommended measurements for the worst of the oil spill scenario.

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