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Analysis of Maritime Induced Factors of Oil Spill Incidents in The Niger Delta Region of Nigeria

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Abstract

In this study, maritime induced factors of oil spill incidences in Niger Delta region of Nigeria were appraised. Quantitative oil spill data were collected from National Oil Spill Detection and Response Agency (NOSDRA), and Nigerian Maritime Administration and Safety Agency (NIMASA) and analysed using Statistical Package for Social Science (SPSS v20.) to carry out a multi linear regression. The result of the analysis showed that oil theft variable has significant impact on total oil spill incidents in the Nigerian coastal waters. While the t-test value on mechanical failure, marine pipeline leakage and shipping activities variables, the null hypotheses was accepted, which by implication suggests that mechanical failure, marine pipeline leakage and shipping activities has no significant impact on the number of spill incident occurrences in the Nigerian coastal waters. The study recommended that oil spill response system should be upgraded by pipeline operators and owners. The creation of regional spill response centres along coastlines will help in managing oil spill problems and the causative factors should be taken care of by Government agency in charge of energy matters.

Keywords: *Oil Spillage, Maritime, induced factors,*

1.0 Introduction

Oil extraction and maritime transportation in the Niger Delta has been going on since the 1950s and Nigeria exports around 15 million tonnes of crude oil day, ranking one of the top 15 exporters in 2009 and oil exports accounts for 95 % of the foreign exchange earnings and 80 % of the budgetary revenues (Olof and Jonas, 2015), Oil pollution is a global issue that has been occurring since the discovery of crude oil, which was part of the industrial revolution. The spillage of oil into the oceans, seas and rivers through human activities is estimated to range between 0.7-1.7 million tons per year (Onyema, Iwuanyanwu, and Emeghara, 2015). Oil spills pose a major threat to the environment of the oil producing areas, which if not effectively checked can lead to the total destruction of ecosystems. The Niger Delta area is among the ten most important wetland and marine ecosystems in the world (Abii, and Nwosu, 2009). The specific objectives will establish the relationship between oil theft (Sabotage) and oil spillage occurrences in the Nigerian coastal waters, ascertain the extent to which Mechanical failures contribute to oil spillage occurrences, determine the impact of marine pipeline on oil spillage occurrences in the Nigerian coastal waters and identify the level to which shipping activities contributed to oil spillage occurrences in the Nigerian coastal waters.

When there is an oil spill on water, spreading immediately takes place. The gaseous and liquid components evaporate. Some get dissolved in water and even oxidize, and yet some undergo bacterial changes and eventually sink to the bottom by gravitational action. The soil is then contaminated with a gross effect upon the terrestrial life. As the evaporation of the volatile lower molecular weight components affect aerial life, so the dissolution of the less volatile components with the resulting emulsified water, affects aquatic life (Akpofure et al, 2000). Once Oil is released on water, the process of spreading takes place immediately, this process stands to be the most significant. Some forces influence the lateral spreading of oil on even calm water. These forces include: (a) Gravitational force which brings about decrease in film thickness and (b) Surface tension and inertial forces.

The force of gravity is found to be proportional to the film thickness, the gradient thickness and the density difference between the oil and water. The surface tension causes co-efficient of spreading which gives the difference between air/oil and oil/water surface tensions. This force that is independent of the film thickness is the dominant process gotten in the final phase of spreading. The inertia of the oil body and the oil/water friction causes retardation on the surface tension. The inertia of a specific oil slick, which is a function of the density and thickness, readily diminishes alongside spreading. Another factor that affects spreading is water temperature (Akpofure et al, 2000). The spreading of an oil slick is one of the most important processes in the early stage of the oil slick transformation, because of the influence of the surface area of the oil slick on weathering processes such as evaporation and dissolution. The balance between gravitational, viscous and surface tension forces determines the spreading of an oil slick.

Oil spills can occur when there is a problem with an oil well, when a pipeline ruptures or leaks or when there is a transportation accident such as the Exxon Valdez oil spill of 1989. Since conditions are different with each spill, different methods of spill control may be used. Some of the tools used to control oil in a spill include booms, which are floating barriers used to clean oil from the surface of water and to prevent slicks from spreading, skimmers which use pumps or vacuums to remove oil as it floats on water and sorbents which absorb oil when they are placed in a spill area. Sometimes chemicals called dispersants are used to break down oil and move it from the top of the water. Moving the oil in this way keeps it from animals which live at the surface of the water and allows it to eventually be consumed by bacteria. Oil spill control on land is often conducted manually. Scooping, cleansing and scraping of the rocks and sand are performed until the oil has been removed. A variety of approaches to damage control following an oil spill have been tried. In calm seas, if a spill is small, it may be contained by floating barriers and picked up by specially designed "skimmer ships" that can skim up to fifty barrels of oil per hour off the water surface (Carla, 2002). Some spill control products can convert liquid spills to solid waste, making the substance easier to clean up and discard. Others help convert chemical gases to liquid or solid form, to prevent them from escaping or dissipating. Other chemical spill control products work by absorbing the chemicals. Special containers are often used with spill control products to capture and hold the byproducts of a spill absorption or neutralizes Some French workers used ground chalk to absorb and sink oil. Sinking agents like chalk, sand, clay and ash is effective in removing an oil spill from the sea surface, but the oil is no healthier for marine life on the ocean bottom. The British mixed some 2 million gallons of detergent with part of the spill, hoping to break up the spill so that decomposition would work more rapidly. The detergent, in turn, turned out to be toxic to some organisms too (Anderson, 2008). Major oil spills heavily contaminate marine shorelines, causing severe localised ecological damage to the near-shore community. The growth of the country's oil industry, combined with a population explosion and a lack of environmental regulations, led to substantial damage to Nigeria's environment, especially in the Niger Delta region, the center of the country's oil industry. Oil spills pose a major threat to the environment in Nigeria, (Oyem, 2001).

Oil spills in the Niger Delta have been a regular occurrence, and the resultant environmental degradation of the surrounding environment has caused significant tension between the people living in the region and the multinational oil companies operating there. It is only in the past decade that environmental groups, the Nigerian federal government, and the foreign oil companies that extract oil in the Niger Delta have begun to take steps to mitigate the damage. Although the situation is improving with more stringent environmental regulations for the oil industry, marine pollution is still a serious problem. The movement for the survival of Ogoni People (MOSOP) and other Ogoni activists has on several occasions called on the Nigerian Federal Government to regulate the oil exploration, drilling, and processing activities of Shell Oil and other oil companies in the oil producing regions of Nigeria. Oil spills are the uncontrolled discharge of oil or its by-products including chemicals and wastes, into the environment. When an oil spill occurs, the oil being less dense than water floats, the highest most volatile hydrocarbons start to evaporate initially decreasing the volume of spill somewhat but polluting the air. Then a slow decomposition process sets in, due to sunlight and bacterial action. (Magini, 2011). After several months, the mass may be reduced to about 15 percent of the starting quantity, and what are left are mainly thick asphalt lumps. These can persist for many months more. (Carla, 2002).

Tsz Leung Yip, Wayne K.Talley and Di Jin (2011), used regressions and an empirical data set of individual vessel accident pollution incidents investigated by the US Coast Guard from 2001 to 2008. The results indicate that the double hull design on average reduces the size of oil spills by 20% and 62% in tank barge and tanker ship accidents, respectively. Adelana et al (2011), the main sources of oil spill on the Niger Delta are: vandalisation of the oil pipelines by the local inhabitants; ageing of the pipelines; oil blow outs from the flow stations; cleaning of oil tankers on the high sea and disposal of used oil into the drains by the road side mechanics. By far the most serious source of oil spill is through the vandalisation of pipelines either as a result of civil disaffection with the political process or as a criminal activity there result also delves into the evil of oil spillage facing the Nigeria environment. Cheryl McMahon Anderson, Melinda Mayes, and Robert LaBelle (2012), estimated the occurrence rates for offshore oil spills are useful for analyzing potential oil-spill impacts and for oil-spill response contingency planning.

1. Methodology

This research is purely a trend analysis study, secondary source data were obtained majorly from National Oil Spill Response agency (NOSDRA) spill data website, Nigerian Ports Authority annual bulletin and Nigerian Maritime Administration and Safety Agency (NIMASA). All data on oil spill from 2009 to 2018 were collected and subjected to analysis, verification and classification based on the causation factor of oil spill as indicated on the objective of the study.

The analytical methods employed in this study were both inferential and descriptive and are derived from the analysis of oil pollution and spill forecasts relative to the causative factors. The analysis was based on the concepts of the input- output model, which serves as theoretical base.

Statistical Package for Social Sciences (SPSS v.20) was employed in the analysis of the multi regression model, which explains the mathematical relationship between the dependent and the explanatory variables. The quantitative technique used was the multiple regression analysis. It defined the relationship between quantity of oil spill, sabotage, equipment failure, ship/operational discharges and pipeline rupture, and was used to obtain the coefficients associated with oil pollution in the Niger Delta region. The regression line which defined this relationship is expressed as:

$Y = \beta + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \mu$ --------------- Equation 1

Where:

Y = Total number of oil spill incidences

β = Constant

Y = Independent Variables

X_1 = Oil theft

X_2 - Mechanical failure

X_3 = Marine pipeline leakage

X_4 = Shipping activities

μ = Error term (which accounts for factors that affect quantity of oil spilt not reflected in the model). β is the baseline while $\beta 1$, β_2, β_3 and β_4 are coefficients of the regression parameters estimated. The values of the coefficients were obtained using the ordinary least square method. The values were gotten from the output of SPSS. The sign and value of the estimators indicated the proportionate direction and magnitude of effect each independent variable (input) had on the dependent variable (output). For instance, a positive sign will indicate a direct proportionate effect.

2.0. Results and discussions

TABLE .1: A **table showing, Total Number of spillages and the causation**

Factors of oil spill incidence.

YEAR	TOTAL NO OF SPILL INCIDENCE	OIL THEFT	MECHANICAL FAILURE	MARINE PIPELINE LEAKAGE	SHIPPING ACTIVITIES
2009	80	60	6	9	12
2010	125	100	4	12	20
2011	98	80	2	5	16
2012	110	94	9	13	14
2013	626	295	12	45	39
2014	546	307	18	55	25
2015	652	463	23	64	14
2016	785	578	14	53	26
2017	936	740	39	74	20
2018	1048	1060	81	99	20

Source; National Oil Spill and Response Agency (NOSDRA)

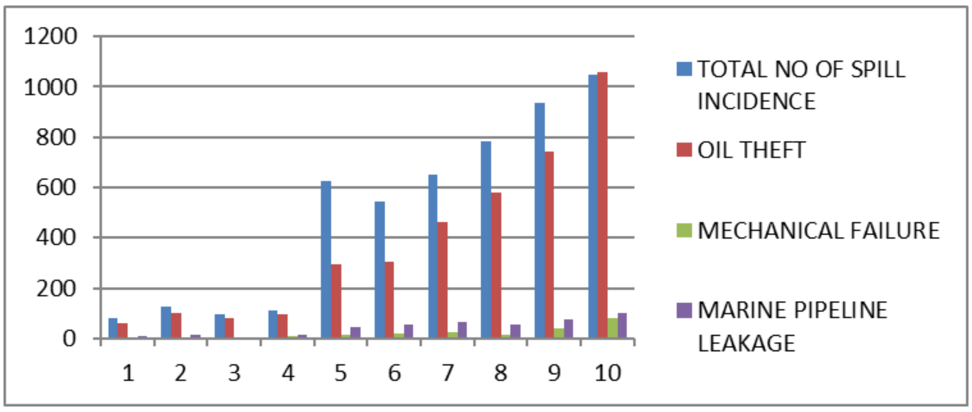
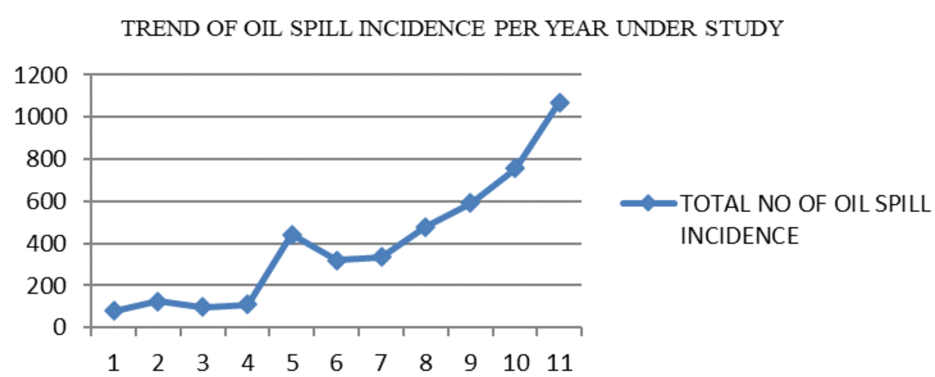


Fig1: Number of spillages and the causation Factors of oil spill incidence.

Table 1 shows the incidents of Oil Spill and Marine Pollution in Bonny Pilotage District within the period 2009 to 2019, from the above data, the sum total incidence from the sources is 4409. The total spillage within the period from marine pipeline leakage is 44, total spillage within the period from oil and gas pipeline blow out is 14 and the total leakage from oil theft or sabotage is 4189 while the total incidence from shipping activities is 162. From the data above, it is obvious that sabotage or oil spill incident from theft has the highest number.



Source:NOSDRA, 2019

FIGURE 2: Graph showing the trend of oil spill per year under study using the data in table 1

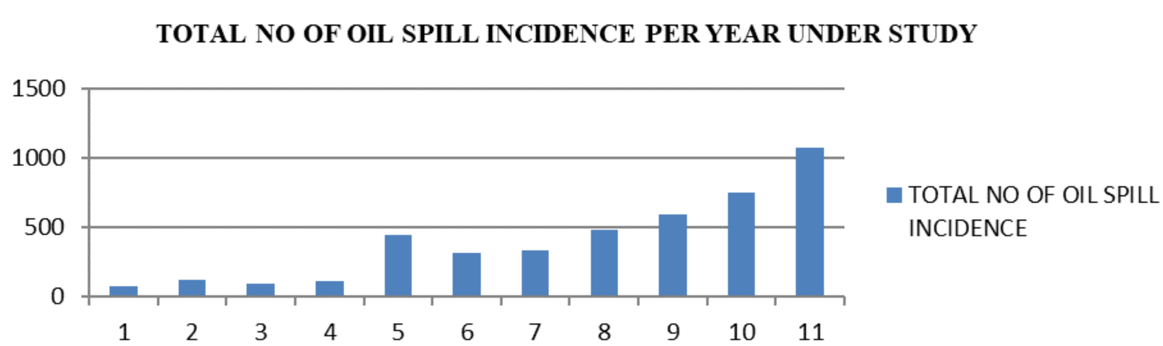


FIGURE 3: A bar showing total no of spill per year using table 1 (NOSDRA, 2019)

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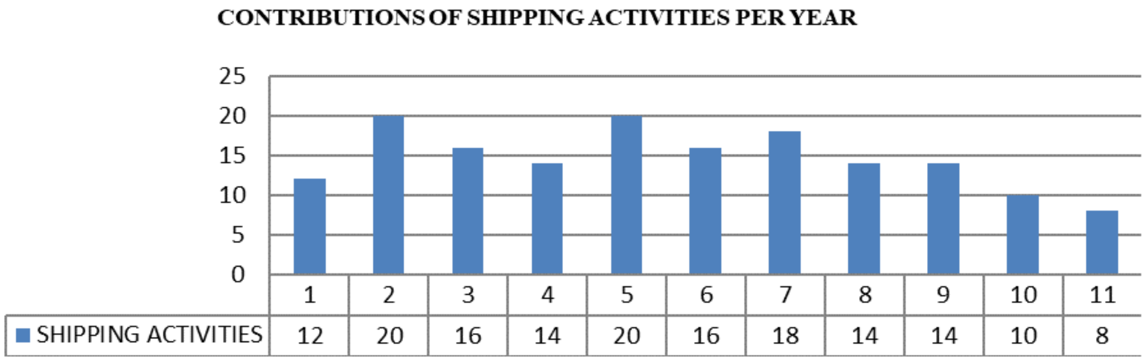

FIGURE 4: A column graph showing the contributions of shipping activities to spill incidences per year under study (**NOSDRA, 2019)**

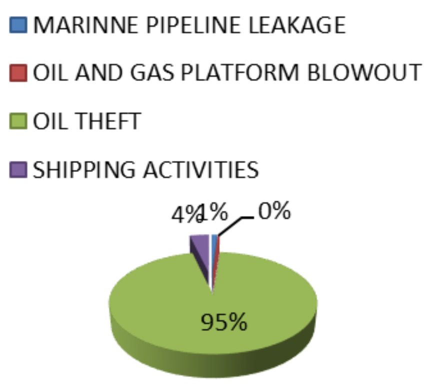

FIGURE 5:A pie chart showing the percentage contributions of the spill causation factors to spill incidences.

NOSDRA, 2019

TABLE 2: **Total number of spillages and the causation factors of oil spill incidence.**

YEAR	TOTAL NO OF SPILL INCIDENCE	OIL THEFT	%	MECHANICAL FAILURE	%	MARINE PIPELINE LEAKAGE	%	SHIPPING ACTIVITIES	%
2013	626	295	47.1	91	14.5	201	32.1	39	6.3
2014	546	307	56.2	63	11.5	151	27.7	25	4.6
2015	652	463	71.0	61	9.4	114	17.5	14	2.1
2016	785	578	73.6	65	8.3	116	14.8	26	3.3
2017	936	740	79.0	68	7.3	108	11.5	20	2.1
2018	1248	1060	84.9	73	5.8	95	7.6	20	1.6
TOTAL	4793	3443	71.8	421	8.8	785	16.4	144	3.0

Source; National Oil Spill and Response Agency (NOSDRA)

The above table shows the number of spillage and causative factors of oil spill incidence in the Niger Delta. In 2013, the total number of incidents was 626. Oil theft incidents was 295, mechanical failure 91, marine pipeline leakage was 201 while shipping activities took only 39. In 2014, the total number of incidents was 546. Oil theft incidents was 307, mechanical failure 63, marine pipeline leakage was 151 while shipping activities took only 25. In 2015, the total number of incidents was 652. Oil theft incidents was 463, mechanical failure 61, marine pipeline leakage was 114 while shipping activities took only 14. In 2016, the total number of incidents was 785. Oil theft incidents was 578, mechanical failure 65, marine pipeline leakage was 116 while shipping activities took only 26. In 2017, the total number of incidents was 036. Oil theft incidents was 740, mechanical failure 68, marine pipeline leakage was 108 while shipping activities took only 20. In 2018, the total number of incidents was 1248. Oil theft incidents was 1060, mechanical failure 73, marine pipeline leakage was 95 while shipping activities took only 20

REGRESSION OUTPUT FOR TABLE 2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.998[a]	0.995	0.991	34.364

a. Predictors: (Constant), Mechanical failure, Shipping activities, Pipeline leakage, Oil theft

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1237542.126	4	309385.531	262.001	0.000[a]
	Residual	5904.274	5	1180.855		
	Total	1243446.400	9			

a. Predictors: (Constant), Mechanical failure, Shipping activities, Pipeline leakage, Oil theft

b. Dependent Variable: Number of spill Incidences

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-84.348	33.098		-2.548	0.051
	Oil theft	0.833	0.139	0.749	6.005	0.002
	Shipping activities	5.636	1.696	0.121	3.324	0.021
	Pipeline leakage	6.584	1.227	0.568	5.367	0.003
	Mechanical failure	-6.174	1.335	-0.395	-4.623	0.006

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	Pipeline leakage	6.584	1.227	0.568	5.367	0.003
	Mechanical failure	-6.174	1.335	-0.395	-4.623	0.006

a. Dependent Variable: Number of spill Incidences

$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + u$ Where:

Y = Total number of Oil Spillages

X_l= Oil theft

X_2 = Shipping activities

X_3 = Marine pipeline leakage

X_4 = Mechanical failure

u = Error term

The parameters B_0, B_1, B_2, B_3, and B_4 are coefficients of regression parameters of the equation and are obtained by making use of the values of table 1 to run regression analysis on SPSS, chosen for its simplicity and accuracy.

Test for Goodness of Fit

The relationship parameters are: coefficient of correlation (R) = 99.8%, coefficient of determination (R^2) = 99.5%, and adjusted coefficient of determination (99.1%). The above imply that 99.5% of the variation in the number of spillages per year can be explained by the variation in the independent variables (oil theft, mechanical failure, marine pipeline leakages, and shipping activities).

This implies that there is a high goodness of fit between the dependent and independent variables. It further indicates that 99.5% of spill incidents/ pollution generated in the Niger Delta are explained by oil theft, mechanical failure, marine pipeline leakages, and shipping activities, 0.5% could be explained by parameters not included in the model.

The adjusted R-square of 99.5% means that the model has accounted for 99.5% of the variance in the independent variable. The remaining 0.05% of the variation is explained by stochastic factors.

The regression model, $Y = \beta + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \mu$

This from our result will be;

$Y = -84.3 + 0.83X_1 + 5.64X_2 + 6.58X_3 - 6.17X_4$ ---------------Equation .1

The significance of the above model is tested by way of the F-test and the student t- test. The interpretation of the regression line is that, there is a direct proportionate effect on the independent variable such that the value of number of oil spillages generated within the Niger Delta environment will increase by; 0.83 barrels for every act of oil theft, -6.17 barrels for every mechanical failure of oil equipment, 6.58 barrels for every marine pipeline leakage, and 5.64 barrels for every 1 unit increase in shipping activities. The regression intercept has a negative value which shows an indirect proportionate effect on the dependent variable.

Test for Significance of Regression Model - ANOVA Method

We test for the specification status of the model through the analysis of variance. Therefore, we refer to Table 1 by comparing the calculated F - ratio with the F -ratio tabulated. The F statistics can be calculated using the ratio of mean square regression (MS regression) to the mean square regression (MS residual). To test the Null hypothesis, if the calculated F exceeds the tabular F distribution at 0.05 (95%) confidence level of significance, or if the sig-value is less than 0.05 or the value 1-sig is greater than 95% confidence level, then the Null hypothesis is rejected, otherwise it is accepted.

Hypotheses

H_0 = sig = 0 which says that none of the independent variable are significantly related to oil spillage incidents variation.

HI = sig ^ 0 which says that at least one of the independent variables is significantly related to oil spillage incident variations

The calculated F is approximately 262.0 which correspond with the F statistics of the output. Since the significant value (0.217) is greater than 0.05 and the calculated F-value exceeds the tabular F-value of (5.19) at (4,5) degrees of freedom then the null hypothesis is rejected, that is, not all of the regression parameters are equal to zero. This implies that the R^2 model is significant and the model can be used to explain oil spill incidents in the Nigerian coastal waters.

Test for the Hypotheses

This test is the test for the null hypotheses. The test was carried out to assess the significant relationship between number of spill incidences and the slope parameters with n-k+1 degrees of freedom and 0.05 or 95% confidence level, where 'n' is the number of observations and 'k' is the number of parameters considered in the study. Testing the regression coefficients not only gave some insights into the fit of the regression model, but also helped in evaluating how worthwhile individual independent variables are predicting Y and the impact Y will have on each of the slope parameters. The t value is calculated as the ratio of coefficient, B_0 to standard error, $S_e i$, and compared to a table of critical value that measured the level of significance or confidence to reject the Null hypothesis. If the calculated 't' value exceeds the critical tabular 't' value at 0.05 significance level and n-k+1 degrees of freedom, then the Null hypothesis is rejected, slope parameters are significantly related to number of oil spill incidences variations, otherwise it is not rejected.

Test for Hypothesis One

H_{O1}: Oil theft does not contribute significantly to oil pollution in the Nigerian coastal waters.

From the regression output, the coefficient of Oil theft (X_1) was 0.83 and the standard error, 0.139, therefore; t, = 6.005. This value corresponds to the oil theft t-stat value of the regression output; the significant value of oil theft is 0.002. Since the sig- value is less than 0.05 and the calculated t -value (6.005) is higher than that of the tabulated (2.02) at (5) degrees of freedom and 95% confidence level, then we reject the null hypotheses and conclude that Oil theft does not contribute significantly to oil pollution in the Nigerian coastal waters and accepts that it does significantly. This supports the work of Adelana et al (2011), that the main sources of oil spill on the Niger Delta are include vandalisation of the oil pipelines by the local inhabitants, mechanical failure, oil theft and many other factors.

Decision Rule: we concluded that there was a near equal contribution by variable X,(oil theft) on the dependent variable. Therefore, X had a significant relationship on oil spill incidents per year under study in the Niger Delta region.

Test for Hypotheses 2

H_{O2}: Mechanical failures do not contribute significantly to oil pollution incidences in the Nigerian coastal waters.

From the regression output, the coefficient of Mechanical failure (X_4) is (-6.174) and the standard error is 1.335, therefore; t= -4.623. This value corresponds with the Mechanical failure (X_4) t-stat value of regression output, and the sig-value is 0.006, since this sig-value is less than 0.05 and the calculated t value (-4.623) is less than the tabulated t value (2.02) at (5) degrees of freedom and 95% confidence level, then the null hypothesis is not rejected, i.e., Mechanical failure do contribute significantly to oil pollution incidences in the Nigerian coastal waters.

Decision Rule: We therefore conclude that there is an inverse contribution by (X_4) to the dependent variable. Therefore from the above t test, the calculated t is lesser than the tabulated t. This implies that we reject Mechanical failure do not contribute significantly to oil pollution incidences in the Nigerian coastal waters. This supports the work of Adelana et al (2011), that the main sources of oil spill on the Niger Delta are include vandalisation of the oil pipelines by the local inhabitants, mechanical failure, oil theft and many other factors.

Test for Hypotheses 3

H_{o3}: Carriage of oil by marine pipelines does not contribute significantly to oil spillage in Nigerian coastal waters

From the regression output, the coefficient of Marine pipeline leakage (X_3) is (6.58) and the standard error is (1.227), therefore; t= 0.568. This value corresponds with the ship operational discharges (X_3) t-stat value of regression output, and the sig-value is 0.003, since this sig-value is less than 0.05 and the calculated t value (5.367) is higher than the tabulated t value (2.02) at (5) degrees of freedom; then the null hypothesis is not rejected, i.e., Carriage of oil by marine pipelines does contribute significantly to oil spillage in Nigerian coastal waters.

Decision Rule: We therefore conclude that there is less contribution by (X_3) to the dependent variable. Therefore, from the above t test, the calculated t is lesser than the tabulated t. This implies that Carriage of oil by marine pipelines does not contribute significantly to oil spillage in Nigerian coastal waters. This coincided with the work of Adelana et al (2011), that the main sources of oil spill on the Niger Delta are: vandalisation of the oil pipelines by the local inhabitants; ageing of the pipelines; oil blow outs from the flow stations; cleaning of oil tankers on the high sea and disposal of used oil into the drains by the road side mechanics.

Test for Hypothesis 4

H_{o4}: Shipping activities do not contribute significantly to oil pollution incidents in the Nigerian coastal waters.

From the regression output, the coefficient of shipping activities (X_2) is (5.636) and the standard error is (1.696), therefore; t= 5.367. This value corresponds with the equipment failure (X_2) t-stat value of regression output, and the sig-value is (0.021), since this sig-value is less than 0.05 and the calculated t- value (3.324) is higher than the tabulated t -value (2.02) at (5) degrees of freedom, then we reject the null hypotheses, i.e., Shipping activities do contribute significantly to oil pollution incidents in the Nigerian coastal waters.

Decision Rule: We therefore conclude that there is a contribution by variable X_2 (shipping activities) on the dependent variable. From the t - test conducted above, the t calculated is higher than t tabulated. Therefore X_2has a significant relationship on oil spill incidents per year under study in the Nigerian coastal waters. This is in line with the assertion of Tsz Leung Yip, Wayne K.Talley and Di Jin (2011), that that shipping activities influences oil spill and that double hull design on average reduces the size of oil spills by 20% and 62% in tank barge and tanker ship accidents, respectively.

Adequacy of the Model

Checking for the adequacy of the model will approve or disapprove the results obtained, so as to confirm the reliability and accuracy of the regression results obtained. The model is adjudged to be adequate by examining the value of the coefficient determination R^2 (or adjusted R square). The closer it is to 1 the better the model.

The significance of R^2 adjusted from the output of regression analysis is basically the same as that of R^2 (the closer to 1 the better). Strictly speaking, adjusted R^2 is used as an indicator of adequacy of the model since it takes into accounts not only deviations but also numbers of degrees of freedom.

The adjusted R^2 value from the regression output which is (99.5%), is fairly close to 100%, suggesting that the overall model is adequate to fit the variables, consequently, the results earlier obtained concerning the t-values can be accepted as being adequate and reliable.

3.0 Conclusion/ Recommendations

The positive sign of oil theft, marine pipeline leakage and shipping activities variables indicates a direct proportionate mathematical relationship with the total number of oil spill incidences, suggesting that an increase in any of these input variables will reasonably increase the number of spill incidences while the negative sign of mechanical failure variable indicate an inverse proportionate mathematical relationship with the total number of spill incidences, showing that mechanical failure is not significant as an oil spill causation factor

- The causative factors should be taken care of by Government agency in charge of energy matters.

- Sabotage and oil theft can be stopped through proper engagement and empowerment of the youth and women groups and also through proper and adequate monitoring of pipelines and oil installations/facilities.
- Corrosion can be prevented by periodic coating of pipelines and application of modern anti corrosion inhibitors.
- Oil spill response system should be upgraded by pipeline operators and owners.
- Major flow stations should be stocked with first-line response materials (such as booms, absorbents and tanks) that enable field operators to respond promptly and effectively to spills
- The creation of regional spill response centers along coastlines will help in managing oil spill problems.

4.0 References

Akpofure E.A., Efore M.I., and Ayawei P. (2000). Oil Spillage in Niger Delta. Integrated Grassroots Post Impact Assessment Of Acute Damaging Effects Of Continuous Oil Spills In The Niger Delta. Urhobo Historical Society (Oil Spillage in Niger Delta).

Anderson, I. (2005). Niger River basin: A Vision for Sustainable Development. Pp. 1-131. The World Bank: Washington D.C.

Carla W. M., (2002). Environmental Geology. page308. Fifth Edition. McGraw Hill Higher Education, USA.

Cunnigham W.P. and Cunnigham, M.A., (2002). Principles of Environmental Science. Pp. 241- 242.

McGraw Hill Higher Education, U.S.A. Magini Endurance, J. (2011). Effects Of Oil Spillage On Water Quality /Management In Emadaja, Udu LGA, Delta State, Nigeria, M.Sc. Thesis Submitted to Nnamdi Azikiwe University Awka, Postgraduate School.

Oyem P, (2001). Ballast Water Treatment System Selection. K.O. M. Tech Technology Review MICA (P) 039/02/2001.