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Maritime Piracy: 'A Disruptive Implication for Global Oil Transportation Security'

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Abstract— *Global transportation of crude oil links both upstream and downstream activities, and plays an important role in global oil industry supply chain management. It is increasingly evident that crude oil tankers plying unpoliced waters around the globe have become a favorite target for piracy and terrorist attacks. Terrorist attacks, though not so often, can cause damages and disruption along the crude oil supply network. Indeed, the petroleum industry has been a target for terrorism. Large quantities of crude oil freight are transported around the globe, and selection of transport mode and route as well as general security management are not necessarily at the optimum level. Findings suggest that, enhanced vigilance, watch keeping and other protective measures have drastically increase the chances of thwarting terrorist attacks and pirate at sea. Indeed the result from this study strongly supports the fact that, adopting some of the ship protection measures recommended by the International Maritime Bureau to prevent piracy had been effective to some extent. Since global economic survival depends on a continuous reliable supply of petroleum products, it is therefore imperative to mitigate security threats in this industry worldwide.*

Keywords— Oil transportation, oil Security, maritime piracy, terrorist attacks, oil transit chokepoints, counter piracy measures.

I. INTRODUCTION

The credibility of the oil industry is dependent partly on responsibility for health, safety, and the environment, which are taken seriously by the organizations along the supply chain. Indeed, the oil industry for several years has been confronted with challenges of compliance to health, safety, and environmental standards set in the production and transportation of crude oil. (Briggs, C. 2014). However, it is also critical to protect the other components along the supply network. Large quantities of crude oil freight are transported around the globe, and selection of transport mode and route as well as general security management are not necessarily at the optimum level. Some of the potential threats to oil facilities and their transportation systems are due to deliberate actions by terrorists and others (Bajpal & Gupta, 2006).

The event of September 11, 2001, and the continued threat of terrorism have led to security-focused legislation that directly impact the transportation industry. The trade Act of 2002 contains requirements mandating the advance electronic filing of all import and export cargo information for all modes of transportation (Coyle, et al 2009). In direct response to the September 11, 2001, terrorist attack, several international organizations and countries have developed or are developing programs that entail guidelines and best practices for ensuring supply chain security of cargo, processes, and personnel involved in every movement through the supply chains. Singapore Customs (2006).

In recent years, leaner just-in-time globalized supply chains are becoming increasingly vulnerable to both natural and man-made disruption. For example, the terrorist attacks on September 11, 2001, not only impacted the way goods are shipped and services delivered. More importantly, through the grave loss of life, many relationships between suppliers and customers were affected (Sheffi 2005). The attack did not change the threat or the risk: the risk of disruption just became apparent, causing supply chain executives to become worried about supply chain disruptions as security concerns, terrorist attacks, and the transformation of supply chain into lean, complex, and globally dispersed entities has increased the risks of disruption. Firms are vulnerable not only to attacks on their own assets, but also to attacks on their suppliers, customers, transportation providers, communication lines, and other elements in their eco-system (Sheffi 2001).

Vulnerability in the global supply chains are forcing companies to monitor their supply chain partners closely, keep supply chains flexible, and integrate disruption risk management into every aspect of the supply chain operation. Consumers and suppliers are dispersed around the world, making it more and more evident that no supply-chain can be

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effective and efficient without information and information technology. (Briggs 2015).

In spite of government responses to disruptions, it has been confirmed historically that such responses inadvertently pose more unthinkable impacts on supply chains other than the disruption itself. For example, the closure of U.S. airspace and delays at the borders immediately after the September 11, 2001, attack were more disruptive to the supply chain than the actual attacks (Rice &Caniato, 2003a). The FBI defines terrorism as "the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives."The number of international terrorist incidents has increased in recent years, and the potential threat posed by terrorists has increased (Hudson, Majeska, Savada, & Metz, 1999).

Piracy has been an international non-traditional safety issue of maritime transportation that leads to loss of billions of US dollars every year. Guo, Z.Y (2009). Furthermore, their geographical scope of pirate activity is continuously expanding. Indeed, piracy and armed robbery against ships remain a real and ever-present danger to those who use the seas for peaceful purposes. IMO (2012). Huang (2012) took piracy as one of the three main factors that threaten China's maritime safety. Huang, et.al (2013) also regarded piracy as an important risk factor when assessing risk of crude oil transportation.

Post 9/11, the biggest risk in the oil industry remains security threat that ranges from exploration and development security to pipeline security, maritime transport security, to protection of product distribution and the retailing sector. Due to rising security threats, offshore platforms are subject to increased physical protection as part of the framework of critical infrastructure in the United States and other countries. Based on this, large offshore facilities operating on the Outer Continental Shelf (OCS) of the United States are required to meet strict security regulations established by the United States Coast Guard and Department of Homeland Security. The Maritime Regulations, 33 CFR part 106.105 requirements were developed under the authority of the Maritime Transportation Security Act (MTSA), which among other things requires the development of security plans designed to deter, to the maximum extent practicable, transportation security incidents resulting in a significant loss of life, environmental damage, transportation system disruption, or economic disruption in a particular area (Honeywell International Inc. 2008).

Reports from the Department of Homeland Security (DHS), the U.S. Department of State, and the Federal Bureau of Investigation (FBI) have indicated that the petroleum industry may be a target of terrorism due to the inherent nature of the products used and its importance to the national infrastructure (American Petroleum Institute 2005). Attacks on oil installations have become the weapon of choice for the international terrorism, irrespective of the political system and social-financial boundary conditions of the society under attack (Steinhausler, Furthner, Heidegger, Ryndell, &Zaitseva, 2008). Several pirate attacks including oil tankers are regarded as robbery on the high seas as pirates board and rob ships while in port, or with speedboats while tankers or vessels are underway.

Terrorist attacks, though not so often, can cause damages and disruption along the crude oil supply network. Specifically, the petroleum industry may be a target for terrorism due to the following characteristics: 1) the physical and chemical properties of the products handled at petroleum sites, 2) the importance of petroleum to the national economy, 3) the importance of petroleum to national security, and 4) the symbolism of the industry as a cornerstone of capitalism and western culture (American Petroleum Institute, 2005). Regrettably, prominent terrorist leaders have consistently made it clear that the petroleum industry is one of their principal strategic targets. They have for several years, denounced the West's "theft" of oil and resources from the Middle East and Africa; therefore, the strategy to attack oil interests is part of an overall "bleed-until-bankruptcy" plan against the West and nations that are cooperating with the West and its corporate sector. The goal is to cut supplies or reduce them through any means (Goslin, 2008).

II. REASEARCH METHODOLOGY

The International Maritime Organisation recommends a series of measures to be used by vessels travelling at sea to prevent and disrupt pirate attacks. Indeed, several research are published examining the effectiveness of these measures but are not precise on how these measures are being employed by ships. The approach to this study is confined to published reviews on petroleum industry supply chain risks analysis, maritime piracy and terrorist activities around the globe. This study examines the oil industry supply chain risk, the impact of maritime terrorist attacks on vessels, and effort to protect maritime pirate attacks. Some data presented are collected from International Maritime Bureau Annual Reports from 2011–2015 and from my previous published research on petroleum industry supply chain risks leveraging analytic hierarchy process.

Management decision making problems often involve criteria/objectives/attributes. Multiple-Criteria Analysis

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(MCA) is a collection of methodologies to compare, select, or rank multiple alternatives that involve incommensurate attributes (Levy and Gopalakrishnan, 2009). It organizes the basic rationality by breaking down a problem into its smaller constituent part and then guides the decision maker through a series of pairwise comparison judgment to express relative strength or intensity of impact of the elements of the hierarchy (Saaty and Kearns, 1985). The analytic hierarchy process (AHP) provides a framework to cope with multiple criteria situations involving intuitive, rational, quantitative and qualitative aspects (Alberto, 2000).

AHP has been successfully used to solve several transportation problems (Vreeker et al., 2002, Lirn et al., 2004, Chang and Yeh, 2001, Poh and Ang, 1999, Tzeng and Wang, 1992). The AHP has also been a helpful methodology used in solving decision problems in studies such as, supplier selection, forecasting, risk opportunities modeling, plan and product design, etc. (Siddharth, Subhas&Deshmukh, 2007), and has been universally used in solving multi-attribute decision-making problems (Saaty, 1980). Dey et al., (2001) used AHP for cross country petroleum pipeline selection. Dey, (2004b) used AHP in decision support system for inspection and maintenance: a case study of oil pipelines. Nataraj, (2005) used AHP as a decision-support system in the petroleum pipeline industry. Briggs, (2010) and Briggs, et.al (2012) used AHP as a risk assessment tool for the upstream crude oil supply chain.

Procedure

AHP application to the upstream petroleum supply chain risk entails three broad phases: 1. Structuring the complex decision problem as a hierarchy, displaying the ultimate objective or the overall goal of risk management, the various risk factors and the alternative criteria of the decision maker. The structure of the hierarchy is organized by placing the objective at the first level, criteria second level, and decision alternatives at the third level as shown in figure 1.The identified decision criteria (risks) are: exploration and production,environmental and regulatory compliance,transportation, availability of oil resource, geopolitical and reputational risks. The alternative or preferred options of managing the risk specified at level three are:accept and control the risk, terminate and forgo activity, transfer or share risk.

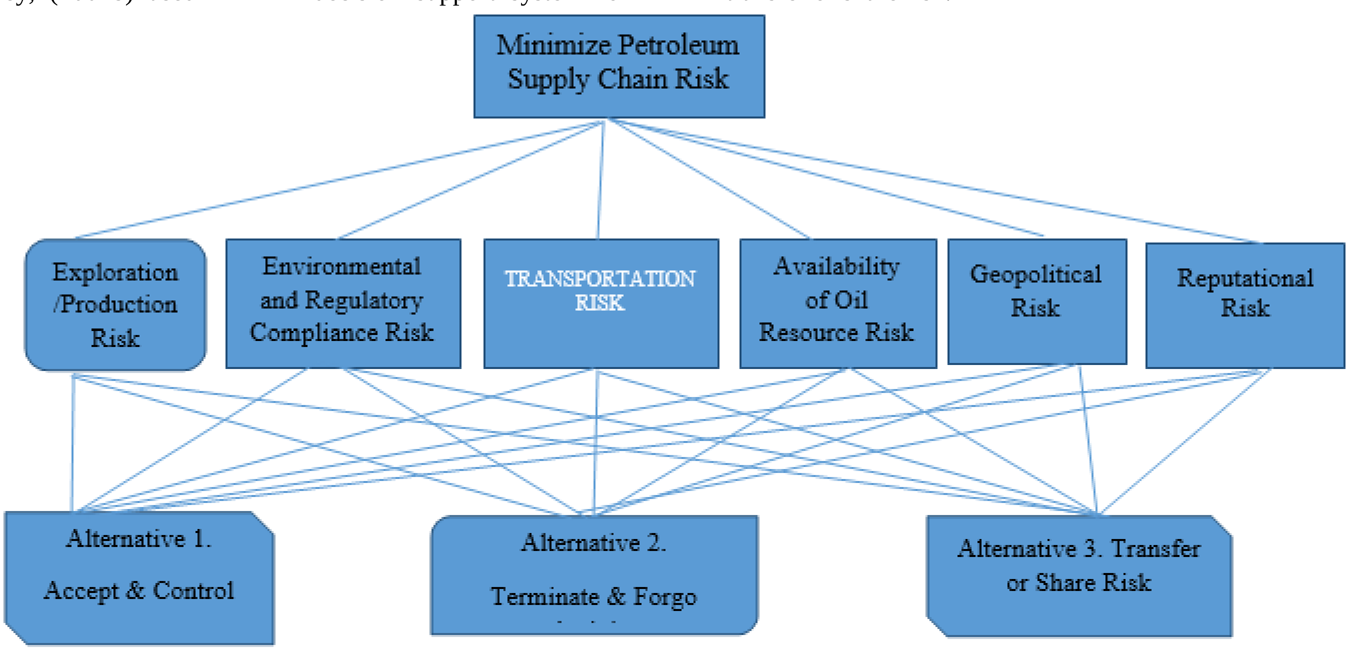

Fig.1: Hierarchy of the Petroleum Supply Chain Risk

Adopted from Briggs et.al (2012). Managing and Mitigating the Upstream Petroleum Industry Supply Chain Risks: Leveraging Analytic Hierarchy Process.

The prioritization process is accomplished by assigning number from a scale developed by Saaty to represent the importance of the criteria. A matrix with pairwise comparisons with these attributes provides the means for calculation. The decision-maker evaluates each criterion against all others and expresses a preference between each pair as equal, moderate, strong, very strong, and extremely preferable (important). These judgments are translated into

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numerical values on a Saaty's scale of 1 to 9. shown in Table 1, with 1 being equal importance and 9 being very strongly important (Saaty, 2000).

Table.1: Saaty's 1-9 Scale of Relative Importance for Pair-Wise Comparison(Saaty, 2006)

Identity of Importance	Definition	Explanation
1	The two objectives are equally important	Two activities contribute equally to the objective
3	One objectiveis moderately more important than the other	Experience and judgment slightly favor one activity over another
5	One objective is strongly more important than the other objective	Experience and judgment strongly favor one activity over another
7	One objective is very strongly more important than the other objective	An activity strongly favor one over another; its dominance demonstrated in practice
9	One objective is absolutely more important than the objective	Importance of one over another affirmed on the highest possible order
2,4,6,8	Intermediate Values	Used when compromise between the priorities are needed

In the upstream petroleum industry supply chain risk analysis, the AHP is a useful technique to accommodate the multiple dimensions and conditions that constitute supply chain risk.

1. Establishing the pairwise comparison matrix A is as follows: Let $C_1, C_2, \ldots C_n$ represent the set of elements, and a_{ij} represents the quantified judgment on a pair of elements C_i and C_j. Here, the element a_{ij} of the matrix refers to the relative importance of the i^{th} factor in response to the j^{th} factor yielding an n × n matrix A as follows:

$$A = [a_{ij}] = \begin{array}{c} \\ C_1 \\ C_2 \\ C_n \end{array} \begin{array}{c} \begin{array}{ccc} C_1 & C_2 & C_n \end{array} \\ \begin{bmatrix} 1 & a_{12} & a_{1n} \\ \frac{1}{a_{12}} & 1 & a_{2n} \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & 1 \end{bmatrix} \end{array} \quad (\text{Eq.1})$$

$$1 \leq i, j \leq n$$

Here, $a_{ii} = 1$ and $a_{ij} = 1/a_{ji}$ for all i,j = 1, 2, 3 ….n. Therefore assigning the elements $C_1, C_2 \ldots C_n$ to the numerical weights $W_1, W_2, \ldots$ Wn, reflects the recorded respondent judgments obtained. For example, from the Saaty's scale value of 1-9 in Table 1, if arespondent compares two elements, exploration/production risk (C_1) to environmental and regulatory compliances risk (C_2) and specified that C_1 is very strongly more important than C_2 then the numerical weight assigned to this pairwise comparison, $a_{12} = 7$, indicating that C_1 is 7 times more important than C_2, forall $a_{ij} = 1$. However, if $a_{ij} = \alpha$ then for consistency,it is required that $a_{ji} = 1/\alpha$. Therefore, if $a_{12} = 7$, then $a_{21} = 1/7$ must hold.

2. Due to reciprocity, the application of the AHP, requires that if $a_{ij} = \alpha$, then $a_{ji} = 1/\alpha$, with $1/9 \leq \alpha \leq 9$. Since the matrices of the pairwise comparisons of an element at one level determine the achievement of the preceding level's objectives, the pairwise comparisons of the attributes at level 2 with one another in relation to their importance to the objective at level 1 in the hierarchy will require only n (n-1)/2 comparisons to build the matrix with a dimension n × n. Therefore, in the case of the petroleum industry, at level 2, the pairwise comparisons of the six attributes (risk factors) will result in a 6 × 6 pairwise comparison matrix.

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Then at level 3, for each of the 6 attributes, the same procedure when used for pairwise comparison of the threealternatives will result in six matrices of size 3× 3. When the input matrices of the respondent's judgments are compared to themselves, the principal diagonal elements are all at unity, confirming that each element has equal importance. Therefore, if the elements *i* and *j* are judged to be equally important, then $a_{ij} = a_{ji}$and a_{ii}=1, indicate that the lower triangle elements of the matrix are now the reciprocals of the upper triangle elements.

3. The AHP measures how consistent the evaluator's judgment is, by utilizing the consistency ratio (CR), which is the ratio of the consistency index over random index. Considering A as a consistency matrix, the relations between weight $W_i$and judgments $a_{ij}$are represented as $W_i/W_j = a_{ij}$ (*for all i, j* = 1, 2 . . . n) with assigned relative weight entering the matrix as an element a_{ij}, with a reciprocal entry $1/a_{ij}$at the opposite side of the main diagonal will present the matrix of the pairwise comparison as follows:

$$A = [a_{ij}] = \begin{bmatrix} w_1/w_1 & w_1/w_2 & w_1/w_n \\ w_2/w_1 & w_2/w_2 & w_2/w_n \\ W_n/w_1 & w_n/w_2 & w_n/w_n \end{bmatrix} \quad \text{(Eq. 2)}$$

AHP stipulates thatsince the evaluators do not necessarily know the vector of the actual relative weights, it is difficult to accurately construct the pairwise comparison of the relative weights of matrix A, rendering this observed matrix A to have inconsistencies. Several estimations made by evaluators may have created series of inconsistencies that need to be checked. Therefore, the weight W can be estimated from the following equation:

$$\Delta A * \Delta W = \lambda_{max} * \Delta W \quad \text{(Eq.3)}$$

Where ΔA denotes the observed matrix of pairwise comparisons, $\lambda_{max}$is the maximum or principal eigenvalue of ΔAand ΔW is the vector estimator of W. According to Saaty (1980) since the maximum eigevenvalue$\lambda_{max}$is always greater than or equal to *n* (the number of elements) it should be an acceptable estimator of *n*. Conversely, when the observed value of ΔA is consistent, the value of the maximum eigevenvalue$\lambda_{max}$is always greater than or very close to *n*, allowing for the construction of the consistency index CI, and consistency ratio CR as follows:

$$C\,I = (\lambda_{max} - n)/(n - 1) \quad \text{(Eq.4)}$$
$$C\,R = (CI / ACI) * 100. \quad \text{(Eq.5)}$$

Here ACI represent the average index of randomly generated weights.The AHP measures how consistent the evaluator's judgment is by utilizing the consistency ratio (CR), which is the ratio of the consistency index over the random index (RI) using equations 4 and 5 and the approximated random indices from Table 2.

Table.2: Approximated saaty's AHP Random Indices (RI).

Size of matrix (n)	1	2	3	4	5	6	7	8	9	10
Random Indices(RI)	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

A consistency ratio (CR) which estimates the extent of inconsistency in each pairwise comparison matrix must be below a specific threshold. According to Saaty (1980), a deviation in consistency ratio of less than .10 or 10% is acceptable without adverse effect on the result, but considered to be inconsistent if greater than .10 or 10% and therefore the judgment is expected to be revised.

4. Aggregating the weights of the decision elements to provide a set of ratings for the decision alternative. Finally, the sensitivity analysis option of the Expert Choice enables the decision maker to graphically explore to what extent the overall priorities are sensitive to changes in the relative importance (weight) of each attribute or criteria.

Data Collection

In order to achieve the objectives of this study a survey questionnaire technique approach was used to collect data to specify the order of importance of the upstream petroleum supply chain risks. The questionnaire was designed to collect

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opinion of subject matter expert (Risk Managers) in the petroleum industry requiringthem to respond to several pairwise comparisons where two categories at a time are compared with respect to the major goal.

Geometric mean scores were computed from the individual expert scores on Saaty's 1-9 scale provided by the petroleum executives. The Expert Choice 11.5 software package (2000-2004) based on AHP is used to estimate the weights of importance of the six major risk, as well as test the inconsistency among the individual expert's preferences.These judgments are entered employing Saaty's pairwise comparison scale in Table 1. The decision makers evaluates each criterion against all others and values of relative importance is assigned to more important criteria and the reciprocal to the lesser important. For example, comparing the geometric mean values of geopolitical risk to all other risk criteria, it shows the lowest value, indicating less important risk for the petroleum industry to manage.

Table.3: Geometric Mean of Combined Experts' Judgment Pairwise Comparison Matrix of Major Objectives with Respect to the Goal

	Exploration/ Production Risk	Environmental and Regulatory Compliance Risk	Transportation Risk	Availability of Oil Resource Risk	Geopolitical Risk	Reputational Risk
Exploration/ Production Risk	1	1.231144	1.048122	1.490182	2.085348	1.799592
Environmental and Regulatory Compliance Risk	.812252	1	.0581811	.933033	1.334188	1.474768
Transportation Risk	.954087	1.718772	1	2.724154	2.839053	1.987134
Availability of Oil Resource Risk	.671059	1.071773	.51186	1	1.533675	1.533675
Geopolitical Risk	.479536	.686201	.35223	.652029	1	.797577
Reputational Risk	.691503	.835959	.578068	.698827	1.253797	1

III. EMPIRICAL RESULT

Data Analysis

The pair-wise comparison of all the risk criteria generates a priority matrix as given in table 4, while figure2, show that Transportation Risk, (.263), Exploration/Production Risk (.198) and Environmental/Regulatory Compliance Risk (.161) are the top three major risk areas in the upstream petroleum supply chain, followed by availability of oil resource risk (.150), reputational risk (.124) and geopolitical risk (.105).

Table.4: Priority Matrix for the Major Objectives

Objective	Priority	Rank
Transportation Risk	.263	1
Exploration /Production Risk	.198	2
Environmental and Regulatory Compliance Risk	.161	3
Availability of Oil Resource Risk	.150	4
Reputational Risk	.124	5

Geopolitical Risk	.105	6
Inconsistency Ratio	**0.03**	

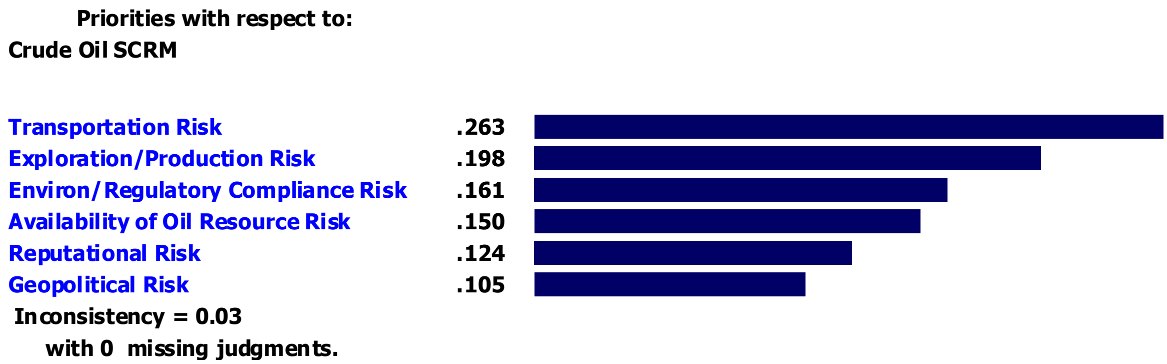

Fig.2: Comparing the Priority Matrix for the Major Objectives

This indicate that transportation risk is the most important risk to mitigate in the upstream petroleum industry with a priority of .263 (26.3%), this result confirms the drastic changes, challenges and uncertainties in the supply chain, followed by exploration and production risk .198 (19.8%), environmental and regulatory compliance risk .161 (16.3%), availability of oil resource risk .150 (15.0%), while reputational risk is .124 (12.4%) and geopolitical risk is .105 (10.5%) indicating that the latter two are less important priorities to be considered. With inconsistency of 0.03 which is less than .10 indicating reliable expert opinions.

However, the normalized priorities associated with Figure 2 are indicated below in figure 3.

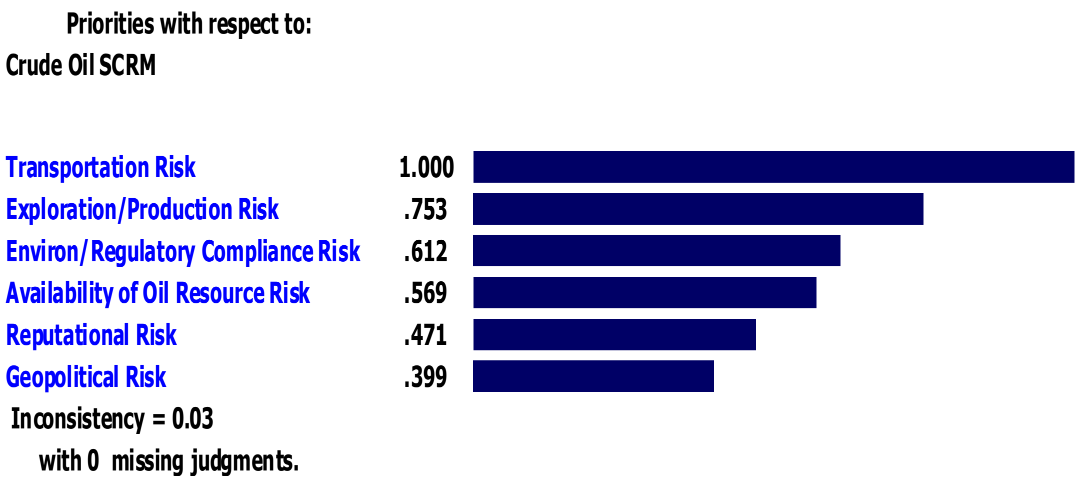

Fig.3: Normalized Priorities

It can be seen here that transportation risk still shows the highest priority.Table 5 below, shows the results of the composite scores that are associated with the alternative priorities: accept and control risk, transfer or share risk, and terminate or forgo activities.

Table.5: Priority of Objectives with Respect to Alternative Options

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Objective Priority		Alternative Priority		
		Accept & Control Risk	Transfer or Share Risk	Terminate or Forgo Activity
Transportation Risk	.263	.413	.327	.260
Exploration and Production Risk	.198	.550	.240	.210
Environmental & Regulatory Compliance Risk	.161	.413	.327	.260
Availability of Oil Resource Risk	.150	.500	.250	.250
Reputational Risk	.124	.413	.327	.260
Geopolitical Risk	.105	.413	.327	.260
Composite Score		.446	.303	.251

IV. SYNTHESIS RESULTS

To determine the overall preferences for the risk management policy options the priorities are synthesized. The global or overall priorities shown in table 5 and figure 4 depict the rankingof the alternative policies as follows: accept and control risk (.446), transfer or share risk (.303), and terminate or forgo risk (.251). When normalized, the priorities for the alternative policies add up to 1.00 shown in Figure 4 (the ideal synthesis with respect to the goal), which indicate that accepting and controlling risk is the most important risk management policy option among the three policy options, with an overall priority score of .446 with inconsistency of 0.03.

However, Figures 4-A to 4-B still verify the fact that accept and control risk still ranks number one in the alternative policy option in respect to managing the upstream crude oil supply chain risk.

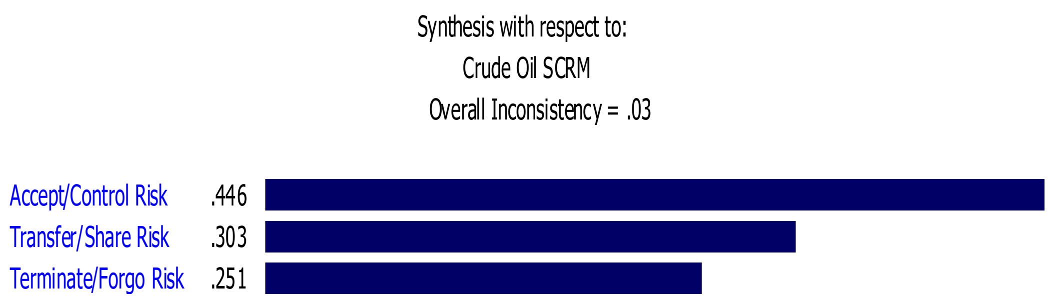

Fig.4: Ideal Synthesis with Respect to the Goal

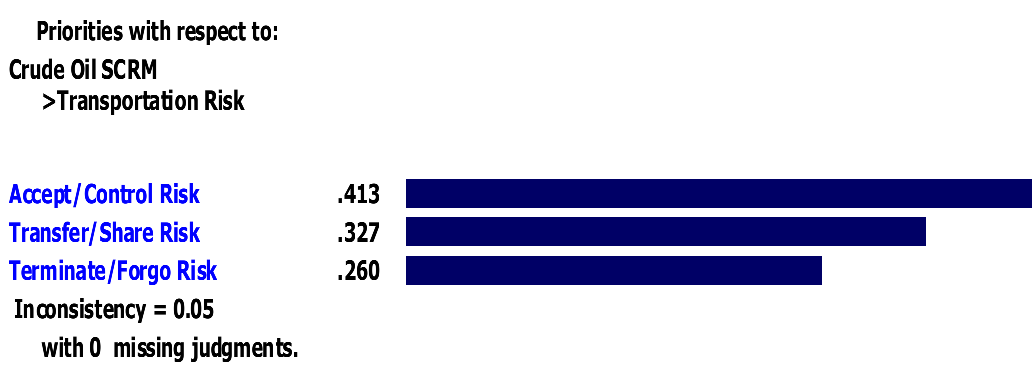

Fig.4-A: Ideal Synthesis with respect to transportation risk

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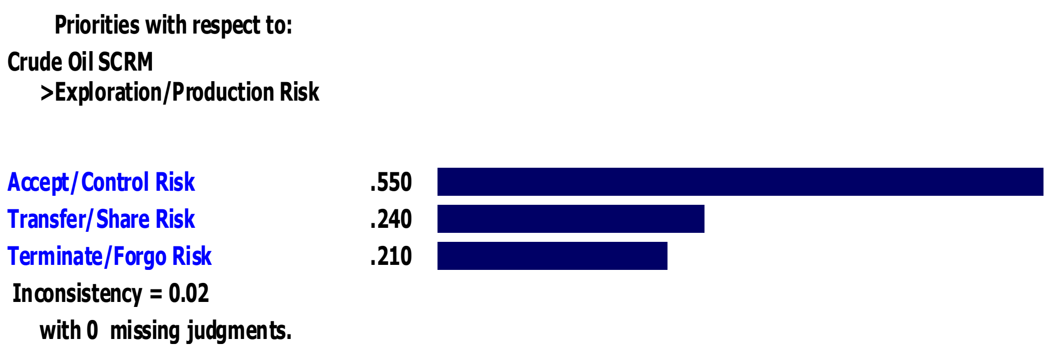

Fig.4-B: Ideal Synthesis with Respect to Exploration/Production Risk

V. SENSITIVITY ANALYSIS

The sensitivity analysis enables the decision maker to graphically explore the response of the overall alternative policy options and to changes in the relative importance (weight) of each attribute or criterion.

Dynamic Sensitivity Analysis

The dynamic sensitivity analysis is a horizontal bar graph that is used to increase or decrease the priority of any criterion to observe the change in the priorities of the alternative policy options. Changing the weights of the criteria depends on the direction in which the criterion is expected to change according to the decision maker in the case of the upstream oil industry. For example, if the decision maker changes the weight of transportation risk while all other criteria remain the same, this may or may not change the risk management policy options, that is if increasing or decreasing the criterion priorities on the left column will change the priorities on the right column as depicted in Figure 5.

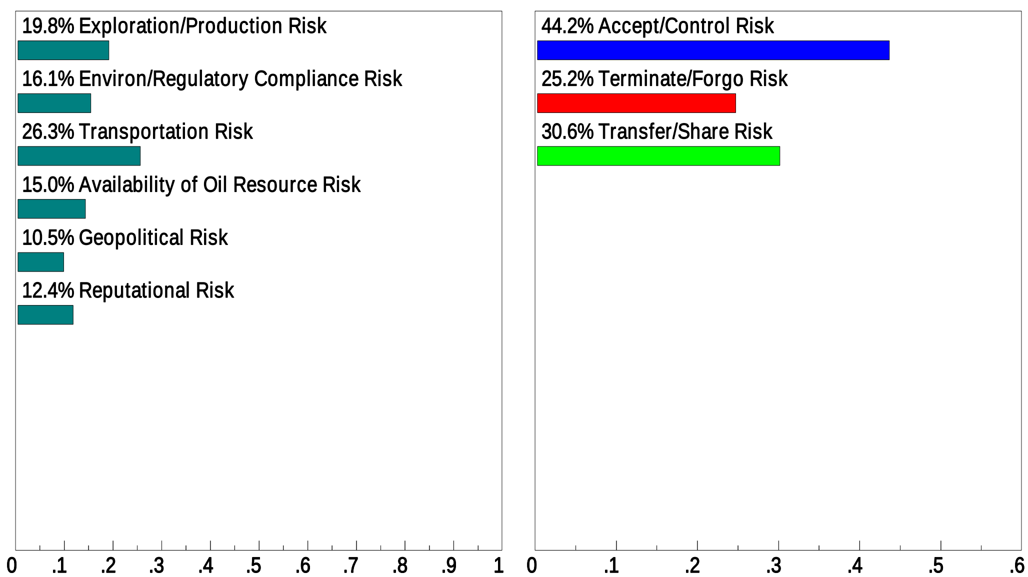

Figure.5: Dynamic Sensitivity Analysis

In scenario 1, increasing the criterion weight with respect to geopolitical risk from 10.5 in Figure 5 to 20.5 in Figure 5-A, did not change the ranking of the alternatives and that accept and control risk still remain the number one alternative.

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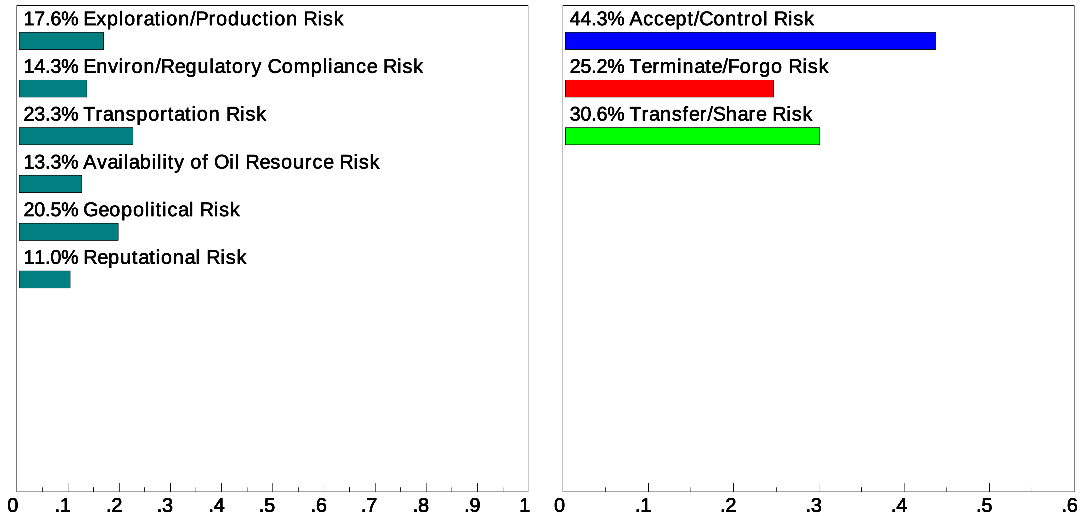

Fig.5-A: dynamic sensitivity analysis: scenario 1. With respect to geopolitical risk

Also in scenario 2, Figure 5-B decreasing the criterion weight from 10.5 in Figure 4 to 5.0 in Figure 5-B, still renders the ranking of the alternative insensitive.

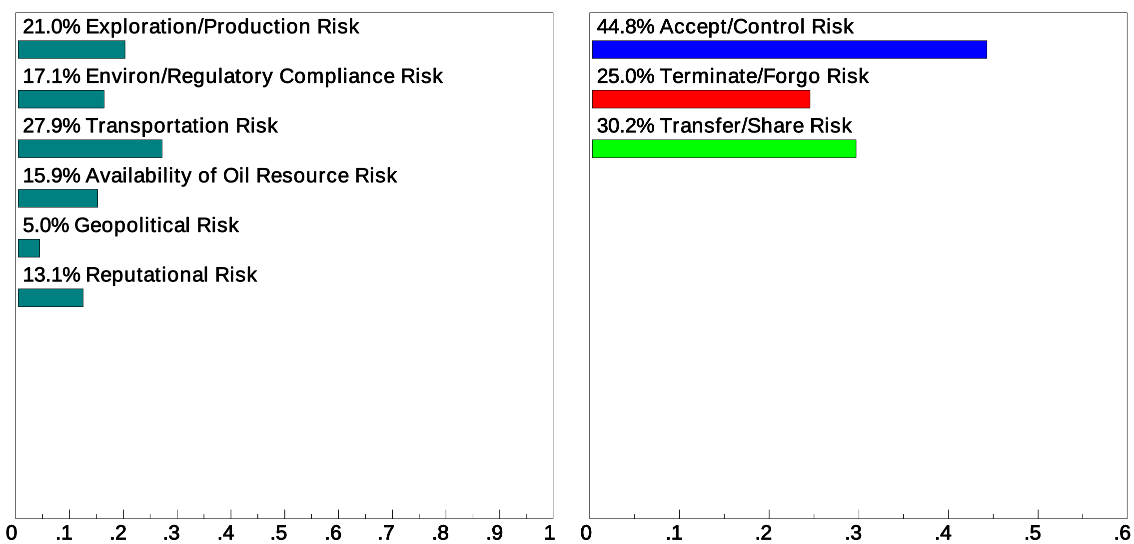

Fig.5-b: dynamic sensitivity analysis: scenario 2. With respect to Geopolitical risk

In scenario 3, increasing the criterion weight with respect to reputational risk from 12.4 in Figure 5 to 22.5 in Figure 5-C, did not change the ranking of the alternatives and that accept and control risk still remain the number one alternative.

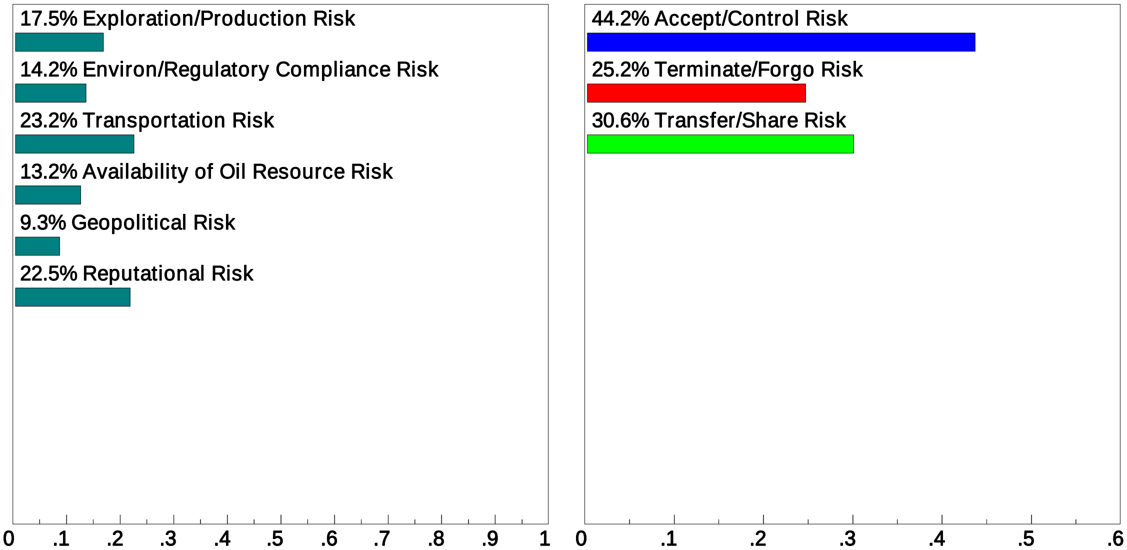

Fig.5-C: Dynamic sensitivity analysis: scenario 3. With respect to Reputational risk

Also in scenario 4, Figure 5-D,decreasing the criterion weight from 12.4 in Figure 4 to 9.8 in Figure 4-D still renders the ranking of the alternative insensitive.

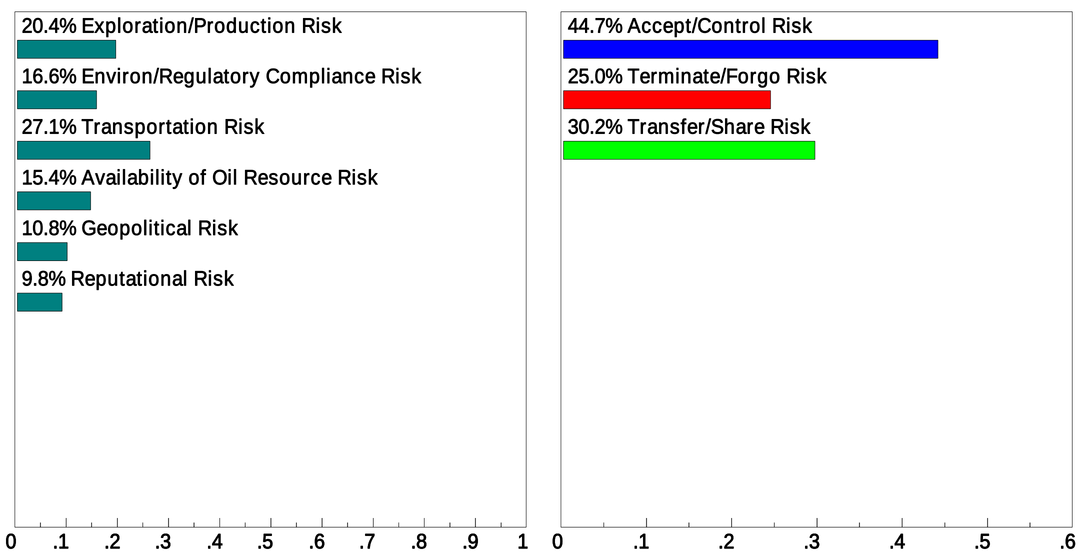

Fig.5-D: Dynamic sensitivity analysis: scenario 4. With respect to Reputational risk

Results from the dynamic sensitivity analysis, Figure 5, with respect to the major goal, also verifies that accept and control risk with a priority of 44.2% is the most preferred risk management policy option, followed by transfer or share at 30.6%, and terminate or forgo at 25.2%. In most comparison processes it is obvious that some inconsistencies would occur. However, Saaty (1980) specify that an inconsistency ratio of about .10 (10%) or less may be considered acceptable without adverse effect on the result. The overall inconsistency ratio for the aggregate response is .03 which is below the Saaty's recommended threshold for an acceptable inconsistency. It is important also to note that, the results also indicate inconsistency ratios for the different decision alternatives. With respect to; transportation risk inconsistency is .05, exploration and production risk is .02, environmental and regulatory compliance risk is .05, availability of oil resource risk is 0.0, reputational risk is .05

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while geopolitical risk is .05. Overall, the respondent judgments indicate reliable expert judgment.

Additionally, to gain more in-depth insight of the problem and result, sensitivity analysis options of the Expert Choice Software was performed to further study the effect of changing the weights of criteria on the overall weight of the alternatives. Based on the results of such analyses, transportation risk is most prominent while accepting and controlling risk is also the most prominent alternative risk management option. In the oil industry, accepting and controlling risk for example; reputational risk, became an issue as a result oil spill.

Companies in the oil industry have a long history of neglecting environmental issues but consequently as a result of public outcry, accepted the risk of oil spill and put in place some appropriate controls to reduce their reputational risk as much as possible. Transportation risk in the oil industry could be managed to an acceptable level.

However, these companies in the industry today deal with several issues such as; globalization, regulatory compliance, increased environmental pressures, mergers and acquisitions that combine make operational risk management a complex and difficult task for the oil industry. Recent events have suggested that greater clarity is needed in terms of who is responsible for managing risks, especially transportation and exploration/production. Briggs et.al. (2012).

VI. TRANSPORTATION RISKS

Since global economic survival depends on a continuous reliable supply of petroleum products, it is therefore imperative to mitigate security threats in this industry worldwide. The identified upstream crude oil supply chain risks include: 1) exploration and production risk, 2) environmental and regulatory compliance risk, 3) transportation risk, 4) availability of resource risk, 5) geopolitical risk, and 6) reputational risk.

Approaches to manage oil industry transportation risk specify some man-made incidences which are due to malicious intent; therefore, it is important that, the assessment of transportation risk in the oil industry must include terrorism scenario on the different transportation modes. To manage transportation risk in the oil industry, the individual national government should among others: develop risk management control strategies (prevention deterrence; preparedness; response recovery; stringent international and U.S. regulations) on oil transportation.

Although simple in concept, implementing these processes in the oil industry transportation sector could also be challenging. Collaborative interest can also mean collective security and corporative protection of the flow of oil, which benefits both producing and consuming nations. A shortfall or slack in this endeavor may play into the hands of insurgents and international terrorists that seek to alienate, divide, and defeat national interests, especially industrialized western nations. Briggs, C. et.al(2012).

VII. MARITIME OIL TRANSPORTATION

The crude oil supply chain involves thousands of miles along water and land. As a result, separate entities assume responsibilities for securing different links, which makes the entire supply chain extremely difficult to secure. The extraction points are often in remote and isolated rural areas, making crude oil transportation to worldwide markets difficult and, therefore contributing to infrastructure vulnerability. Transportation risks therefore include, terrorist attacks on crude oil pipelines, terrorist attacks on maritime transportation (piracy). Unfortunately, there are increasing signs of collaboration between terrorism and piracy (Luft&Korin, 2003).

In today's global economy and deregulated environment, the contribution of transportation services is becoming increasingly important to the international supply chain structure. Transportation is an essential part in the execution of the supply chain, providing the link between nodes from suppliers to final consumer destinations. Global transportation of oil links both upstream and downstream activities, and plays an important role in global oil industry supply chain management. Today's increasing global oil reserves are pushing exploration and production to the far ends of the earth; as a results the need for reliable transportation is becoming increasingly necessary to transport crude oil through the great distances from the oil field to the refineries then to the consumer markets. (Briggs,2014).

O'Rourke and Connolly (2003) and Devlet (2007) assert that marine transportation is the primary means of crude oil transportation and that crude oil transportation accounts for about 35% of the annual tonnage of all sea cargoes. It is increasingly evident that crude oil tankers plyingunpoliced waters around the globe have become a favorite target for terrorist attacks that could lead to massive oil spill.Transportation of hazardous materials has been a widely-discussed concept in transportation and environmental literature (Glickman, 1988; Jamei, Hobeika, & Rice, 1988; List &Abkowitz, 1986; Rothberg, 1986). According to National Research Council (NRC 1976), there seems to be a clear focus on land or rail transportation with minimal work done in marine environments. To realize the

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marine board's recommendation, the development of a National Marine Oil Transportation System Model (NMOTSM) that would allow quantification of oil transported within the geographic boundaries of the United States has been undertaken.

Transportation of oil is undoubtedly the link between the upstream and downstream production processes and also plays an important role in the global oil industry supply chain. Literature about the physical geography of oil production and consumption has determined a spatial differentiation between producing and consuming countries, which results in a rapidly growing imbalance in demand and supply that can only be resolved by investing in massive transportation infrastructures, such as supertankers and storage facilities, pipelines, and barges.

The current separation between the location of oil reserves and the location of oil consumption necessitates that crude oil be transported great distances to the consumer market. This has lead to the development of an increasingly complex transportation system that allows crude oil to be delivered virtually anywhere in the world.

Major oil routes now stretch from the Middle East to Japan, from South America to Europe, and from Africa to the United States. Transportation of crude oil occurs via supertankers, barges, trucks, and pipelines (Burger, 1997). These transportation systems have always been the Achilles' heel of the oil industry, but have become even more so since the emergence of global terrorism. Tankers and pipelines are very vulnerable targets; however, dealing with the issues of crude oil transportation either by maritime means or overland pipelines has become a serious domestic and international concern due to risks and challenges along the supply chain. The logistics network is highly inflexible, which arises from the production capabilities of crude oil suppliers, long transportation lead times, and the limitations of modes of transportation. Every node in the network, therefore, represents a major challenge (Jenkins & Wright, 1998).

The giant oil fields of the Middle East, for example, are thousands of kilometers from the countries of consumption in North America, Europe, and Asia; therefore; they need very large crude carriers, and ships capable of carrying 300,000 tons or more of crude oil. Marine transportation is one of the key drivers of global economic growth and competitiveness in the market it serves. In the oil market, tankers are used for the transportation of crude oil from fields in the Middle East, the North Sea, Africa, and Latin America to refineries around the globe. Oil tankers are the dominant mode of global or transcontinental oil transportation due to their extreme flexibility, low costs and efficiency; however, other complementary modes, such as trucks, and railcars are also used where the origin and destinations are land-locked.

Navigation by water is usually constrained by the maximum draft of coasts, rivers, and waterways. Infrastructure constraints to port landside access are characterized by deficient bridges, freeway access ramps, railway grade crossings, and tunnels and underpasses, as well as congested or inadequate roadways serving marine terminals. Roadway access is a major problem for marine transportation because of congestion in major truck routes serving marine terminals (Transportation Research Board, 1998). In 2005, a report by Maritime Administration (MARAD) evaluated the status of U.S. ports and waterways and concluded that the domestic marine transportation supply infrastructure will become more constrained in the future.

As imports of petroleum products are projected to increase by over 80% by volume between 2004 and 2030 according to EIA, anticipated demand growth will challenge a marine transport system that is already operating, in some instances, at the limit of its capacity (U.S. Government Accountability Office, 2007). The oil industry is involved in a global supply chain that involves domestic and international transportation, value-chain strategic warehouse management, order and inventory visibility and control, materials handling, import/export facilitation, and information technology. This means, in effect, that shippers and the oil companies are jointly and mutually involved and intertwined with each other, end-to-end in transportation management from the moment an order is placed by the vendor to the day it is unloaded from the supply basket on the offshore platform (Christopher, 2007). Indeed, the link in the oil industry's productive chain is the carriers transporting the hydrocarbon (Petrotecno Instituto Agentino del Petroleo y del Gas, 2004). Petroleum and petroleum product move on tankers, but oil companies own only a small fraction and charter the remainders, which allow them to keep their own fleet completely utilized. They rely on others to supply the remainder of their needs. There are two types of charters, voyage or spot charter, when the crude owner charters or leases tankers from owners of independent tankers. When using voyage or spot charter, the crude owner leases the tanker for a specific voyage between origin and destination, and the time charter specifies duration of time, in months or years. At present, the oil tanker charter market has become two tiers, with rates for vessels used to haul oil to the U.S. being higher cost associated with potential oil spills (Wood, Barone, Murphy, &Wardlow, 2002).

Crude oil tankers are built in different sizes that fit the size of the trade route. However, because of the length of voyage,

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ports, and canal constraints, tanker sizes have changed over the years. For example, the closure of the Suez Canal in 1956 forced crude oil tankers to take longer routes around Cape of Good Hope. Although not a chokepoint, the Cape of Good Hope is a major global trade route. Crude oil flows around the Cape accounted for about 9% of all seaborne-traded oil. EIA estimates about 4.9 million bbl/d of seaborne-traded crude oil moved around the Cape of Good Hope in both directions in 2013, shown in table 6accounts for about 9% of all seaborne-traded oil.Panama Canal Authority (PCA). (2014).

Table.6: Crude Oil Transit via the Cape of Good Hope

Million bbl/d	2011	2012	2013
Total flows	4.7	5.3	4.9
Eastbound	2,9	3.7	3.6

Note: Estimates may not add up to their totals due to differences in rounding.
Source: U.S. Energy Information Administration analysis based on Lloyd's List Intelligence

The Suez Canal and SUMED Pipeline are strategic routes for Persian Gulf oil and natural gas shipments to Europe and North America. These two routes combined accounted for about 8% of the world's seaborne oil trade in 2013.According to the Suez Canal Authority, in 2013, nearly 3.2 million bbl/d of total oil transited the Suez Canal in both directions. The majority of the oil was sent northbound (1.9 million bbl/d) toward European and North American markets, and the remainder was sent southbound (1.3 million bbl/d), mainly toward Asian markets.Oil exports from Persian Gulf countries (Saudi Arabia, Iraq, Kuwait, United Arab Emirates, Iran, Oman, Qatar, and Bahrain) accounted for 79% of Suez Canal northbound oil flows. The largest importers of northbound oil flows through the Suez Canal in 2013 were European countries (68%) and the United States (16%). Oil exports from European countries made up the majority (66%) of Suez southbound oil flows, followed by North Africa (Algeria and Libyacombined made up 16%). The largest importers of Suez southbound oil flows through the Suez Canal were Asian countries (74%).The United States is the primary country of origin and destination for all commodities going through the Panama Canal; however, it is not a significant route for U.S. petroleum trade. Although petroleum and petroleum products represented 18% of the principal commodities that crossed through the Panama Canal, it is not a significant route for global petroleum and petroleum product transit. Panama Canal Authority (2014).

Every port is unique in terms of its facility configuration, operation, cargo types, and service parameters, thus selecting a market obviously depends on transport cost and intrinsic or physical capacity. The physical capacity of a waterway might be measured in terms of the number of barges that could be locked through in the course of a year, while the capacity of ports can be measured in terms of its intrinsic or practical capacity. Indeed, the intrinsic capacity is the level of throughput that can be attained under ideal conditions of berth utilization and zero bottlenecks at various sections of the port used for cargo storage and transfer (Transportation Research Board, 1998).

To avoid canal constraints and gain economies of scale, Very Large Crude Carriers (VLCC's) were built to carry over two million barrels of oil on every voyage from the Middle East in high volumes (more than two million barrels per ship) over long distances and to Europe and Pacific Asia. However, small tankers are used for shorter journeys, such as from Latin America to the United States. Long-haul crude creates an incentive to develop larger-size tankers to lower shipping costs through economies of scale, up to the largest tanker that could pass through the Suez Canal, the Suezmax tanker. Most tankers carrying crude oil are loaded to their deadweight, but not necessarily their volumetric, or cubic, capacity (Tusiani, 1996). Evidently, the VLCC's economies of scale outweighs the constraints imposed, although in the United States only Louisiana Offshore Oil Port (LOOP) is equipped with highly mechanized equipment with high productivity to load and unload liquid-bulk cargo, such as crude oil and petroleum products (Transportation Research Board, 1998).

Marine tankers are classified into six different categories as shown in Table 7, from the modest coastal tanker to very large crude carriers (VLCC) or ultra large crude carriers (ULCC) supertankers.Most of the crude oil carriers that currently travel through the Strait of Hormuz are VLCCs carrying crude oil to markets in East Asia. A few smaller oil tankers make "quick" runs to India and other closer destinations. But, of course, tankers are flexible; nearly any ocean-going tanker can transport crude oil from the Persian Gulf to any part of the world, depending on market condition.(The Robert S. Strauss Center for International Security & Law, 2008).

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Oil tankers are also classified based on their carrying capacity in deadweight tons (DWT), which is the total weight of the ship (including cargo, crew, provisions, etc.) minus the weight of the ship if it were empty. Very large crude carriers (VLCC), first developed in the 1960's, have a capacity of over 200,000 DWT and can carry two million barrels of oil. Ultra large crude carriers (ULCC) can carry in excess of 325,000 DWT, roughly four million barrels of oil. Other categories of tankers include; Medium Range (MR), Panamax that carries up to 500,000 barrels (the largest tankers that can fit through the Panama Canal), Aframax, carries up to 750,000 barrels while the Suezmax has a capacity 1,000,000 barrels of oil(the largest tankers that can fit through the Suez Canal) (The Robert S. Strauss Center for International Security & Law, 2008).

Table.7: Various Classifications of Crude Oil Tankers

Size/Classification	DeadweightTonnage(DWT)	Average Dimension (Length, Height, Draft in feet)
Medium Range	25,000-50,000	675 / 100 / 55
Panamax	25,000-70,000	675 / 100 / 55
Aframax	75,000-120,000	810 /150 / 60
Suezmax	120,000-200,000	950 / 150 / 60
VLCC	200,000-325,000	1240 / 200 / 100
ULCC	320,000-550,000	1240 / 200 / 100

Source: The Robert S. Strauss Center for International Security & Law, 2008.
Note*: The Medium Range and the Panamax can fit through the Panama Canal while the Aframax and the Suezmax can fit through the Suez Canal.*

In 2013, 1.4% of total global maritime petroleum and petroleum product flow through the Panama Canal. According to the Panama Canal Authority, 877,000 bbl/d of petroleum and petroleum products were transported through the canal in fiscal year 2014, of which 748,000 bbl/d were refined products, the remainder being crude oil. About 78% of total petroleum, 688,000 bbl/d, went southbound from the Atlantic to the Pacific. EIA (2014).The relevance of the Panama Canal to the global oil trade has diminished, as many modern tankers are too large to travel through the canal. Some oil tankers, such as the ULCC (Ultra Large Crude Carrier) class tankers, can be nearly five times larger than the maximum capacity of the canal. To make the canal more accessible, the Panama Canal Authority undertook an expansion program planned to be completed by 2015. The expansion will be able to accommodate a fully loaded Aframax tanker at 120,000 deadweight tons,USEIA (2014), but will not be able to accommodate carriers the size of VLCCs or larger.

World oil transit chokepoints are a critical part of global energy security due to the high volume of crude oil traded through their narrow straits (Energy Information Administration, 2008). The world's two most strategic chokepoints are the Strait of Hormuz leading out of the Persian Gulf and the Strait of Malacca linking the Indian and Pacific Oceans. Other important passages include Bab el-Mandab, which connects the Arabian Sea with the Red Sea; the Panama Canal and the Panama Pipeline connecting the Pacific and the Atlantic Oceans; the Suez Canal and the Sumed Pipeline linking the Red Sea and the Turkish/Bosporus Straits joining the Black Sea and the Caspian Sea region to the Mediterranean Sea (Energy Information Administration, 2008). Most of these critical chokepoints are located in areas where Islamic fundamentalism is prevalent. For example, the Strait of Hormuz and its three tiny islands of Abu Musa, Greater Tunb Island, and Lesser Tunb Island are controlled by Iran; Bab el-Mandab is controlled by Yemen, the ancestral home of bin Ladin. Part of the 500-miles long Strait of Malacca courses through Indonesia's oil rich province Aceh, inhibited by one of the world's most radical Muslim populations (Energy Information Administration, 2008).

The U.S. Energy Information Administration (EIA) defines world oil chokepoints as narrow channels along widely-used global sea routes, some so narrow that restrictions are placed on the size of the vessel that can navigate through them. Chokepoints are a critical part of global energy security because of the high volume of petroleum and other liquids transported through their narrow straits. In 2013, total world petroleum and other liquids production was about 90.1 million barrels per day (bbl/d). EIA estimates that about 63% of this amount (56.5 million bbl/d) traveled via seaborne trade. EIA (2013).Oil tankers accounted for 30% of the world's shipping by deadweight tonnage in 2013, according

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to data from the United Nations Conference on Trade and Development (UNCTAD). (2013).

International energy markets depend on reliable transport routes. Blocking a chokepoint, even temporarily, can lead to substantial increases in total energy costs and world energy prices. Chokepoints also leave oil tankers vulnerable to theft from pirates, terrorist attacks, shipping accidents that can lead to disastrous oil spills, and political unrest in the form of wars or hostilities.

The seven chokepoints identified in table 3below are part of major trade routes for global seaborne oil transportation.

Table.8: Volume of Crude Oil and Petroleum Products Transported through World Chokepoints, 2009-2013

Location	2009	2010	2011	2012	2013
Strait of Hormuz	15.7	15.9	17.0	16.9	17.0
Strait of Malacca	13.5	14.5	14.6	15.1	15.2
Suez Canal and SUMED Pipeline	3.0	3.1	3.8	4.5	4.6
Bab el-Mandab	2.9	2.7	3.4	3.7	3.8
Danish Straits	3.0	3.2	3.3	3.1	3.3
Turkish Straits	2.8	2.8	3.0	2.9	2.9
Panama Canal	0.8	0.7	0.8	0.8	0.8
World maritime oil trade	**53.9**	**55.5**	**55.6**	**56.7**	**56.5**
World total oil supply	**84.9**	**87.5**	**87.8**	**89.7**	**90.1**

Notes: All estimates are in million barrels per day. Data for Panama Canal is by fiscal years.

Sources: U.S. Energy Information Administration analysis based on Lloyd's List Intelligence, Panama Canal Authority, Eastern Bloc Research, Suez Canal Authority, and UNCTAD, using EIA conversion factors.

Disruptions to these routes could affect oil prices and add thousands of miles of transit in alternative routes. By volume of oil transit, the Strait of Hormuz, leading out of the Persian Gulf, and the Strait of Malacca, linking the Indian and Pacific Oceans, are the world's most important strategic chokepoints. The Cape of Good Hope, is not a chokepoint but is a major trade route and potential alternate route to certain chokepoints. EIA(2014).

VIII. TERRORIST ATTACKS ON MARITIME OILTANKERS

Global transportation of crude oil links both upstream and downstream activities, and plays an important role in global oil industry supply chain management. It is increasingly evident that crude oil tankers plying unpoliced waters around the globe have become a favorite target for terrorist attacks. The attack in 2000 on the USS Cole in Yemen was a clear indication that, although it was swift as a battle ship, with enhanced weapon and operational capabilities to defend itself and fend off enemy vessels and assaults, it has been vulnerable to terrorist boat attack. Due to this indefensible nature of vessels on high seas, terrorists/pirates have found it relatively easy to attack crude oil tankers. On today's globalized planet, the vast oceans and crowded littoral waters present a dichotomy of essential personal and economic sustenance on the one hand, and on the other, the very real security challenge of immense areas of ungoverned or weakly controlled space. For both dimensions of the challenge, maritime security is essential (Fallon, 2005).

The United Nations' Convention on the Law of the Sea (UNCLOS) places focus upon acts of piracy that occur on high seas, "areas which are outside the primary jurisdiction of any one nation." Article 101 of UNCLOS defines piracy as a) " any illegal act of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed: (i) on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft; (ii) against a ship, aircraft, persons, or property in a place outside the jurisdiction of any State; (b) any act of voluntary participation in the operation of a ship or of an aircraft with knowledge of fact making it a pirate ship or aircraft; (c) any act of inciting or of intentionally facilitating an act described in subparagraph (a) or (b)" (United Nations' Convention on the Law of the Sea,1982). Soon after UNCLOS was adopted, it became clear that its conception of piracy did not cover many of the violent crimes committed on the seas.

On October 7, 1985, four armed stowaways onboard the Italian cruise liner *AchilleLauro* hijacked the ship and killed one American passenger. The apparent political motivations for the attack, the location of the attack in Egyptian waters, and the fact that the attack originated from the target ship rather than from a separate ship, placed the attack outside the UNCLOS definition of piracy and, presumably, beyond the purview of universal jurisdiction. The United States, and

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other states that may have had an interest in prosecuting the attackers, were apparently left without the authority under international law to do so (Barrios, 2003). After the AchilleLauro attack, the international community, through the UN and its International Maritime Organization (IMO), promulgated the Rome Convention, which established a legal basis for prosecuting maritime violence that did not fall within the UNCLOS piracy framework.

The Rome Convention made it unlawful to seize or take control of a ship by force or the threat of force, to perform an act of violence against a person on board a ship if it is likely to endanger safe navigation of that ship, to destroy or damage a ship or its cargo if it is likely to endanger safe navigation, to place devices or substances on a ship that are likely to destroy that ship, to knowingly communicate false information to a ship that would endanger safe navigation, and to injure or kill any person in connection with any of the above acts.

The Rome Convention authorizes and, under certain circumstances, requires party states to establish jurisdiction over the perpetrators, either extraditing the perpetrators to another interested signatory state or prosecuting the alleged offenders themselves. Barrios. (2013).The maritime piracy attacks that transpire off the Horn of Africa are severely disrupting international trade.As many countries in regions affected by piracy are also major hydrocarbon producers and suppliers of global energy market, maritime piracy affects the industry and tanker trade as well as energy security. Aly Elmaghawry. (2009).Piracy attacks off the coast of Somalia threatens the oil industry in the region, such as Bahrain, the Islamic Republic of Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates and Yemen. With nearly 45% of global crude oil production being carried in tankers, well-functioning and secure strategic transit points such as the Gulf of Aden are critical for global energy supply and security. UNCTAD (2013).

Maritime piracy in the Gulf of Guinea, the leading sub-Saharan African oil producing region is unfolding in the context of renewed geostrategic interest in the region. With implications of maritime piracy for oil production and investment, tanker trade as well as energy security involving major stakes and potentially significant costs, oil companies in the Gulf of Guinea are investing heavily in maritime security to protect installations. These additional security expenditures born by oil companies could however, undermine the feasibility of oil related investment project, discourage potential, raise the cost of doing business and in some cases, drive out some established companies could.By threatening the profitability of energy exploration, maritime piracy puts at risk existing and future investment both in terms of level and quality in the West African oil industry as well as in East Africa. Lisa Otto (2011). It is worth noting however, that in 2009 for example, China's investment in the mining sector in sub-Saharan African countries accounted for about 1/3 of the country's foreign direct investment. UNCTAD (2012).

Terrorist attacks on supertankers in any of these chokepoints may result in explosion and spreading stain and burning crude oil that could shut down the channel for several weeks, resulting in a profound impact on global markets and the maritime insurance industry (Luft&Korin, 2003). In Nigeria for example, the July 2009 incident forced Royal Dutch Shell, (RDSa.L), U.S. oil company, Chevron (CVX.N) and Italy's Agip (ENI.MI) to shut down around 300,000 barrels per day production for seven weeks following the attack, lifting global oil prices (Hannington&Tume, 2009). The International Maritime Bureau (IMB) reports the emergence in Southeast Asia of a 'new brand of piracy' in which the attacks are motivated by political agendas rather than a traditional motive to rob. Actual attacks by terrorists have thus far been limited to temporary seizures of vessels and crewmen, but officials express concern over the case in which large crude oil tankers could be hijacked and used as weapons with which to block commercial waterways (Barrios, 2003). Table 9 shows some types of vessel attacks between January 2011 to December 2015.

Table.9: IBM piracy report: types of vessels attacked, January-December, 2011-2015.

Types of Vessel	2011	2012	2013	2014	2015
Total year end including other vessel types	439	297	264	245	246
Chemical/ Product	100	76	82	86	62
Crude oil tanker	61	32	39	24	20
Liquefied Natural Gas (LNG)	0	2	0	1	0
Liquefied Petroleum Gas (LPG)	6	10	9	13	4

Source: International Commercial Crime Service (ICC); International Maritime Bureau (2016). Piracy and Armed Robbery against Ship.

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Crude oil tankers are high investments to the tanker industry as well as the oil industry; therefore, any emergency arising from activities such as deliberate threats from terrorists is considered a critical security and safety risk that must be properly addressed.

The trend of some attacks and concerns are as follows:

- October, 2002: Boat crashed into oil tanker off Yemen coast. (BBC News, 2002).
- October 6,2002: Boat bomb attack against French oil tanker MV Limburg off Ash Shahir port (Number 10.gov.uk, 2005).
- April 1998: The Petro Ranger, a Malaysian-registered oil vessel was seized outside the territorial waters of Singapore.
- August, 2003: Pirates boarded the Malaysian-registered fuel tanker Penrider near the Aceh province of Indonesia. In order to release of the ship and the crew the pirates demanded$100,000 to be paid in ransom.
- April, 2008: Seoul, South Korea, a Japanese oil tanker was damaged in an attack in the Middle Eastern waters off the coast of Yemen (Fackler, 2008).
- April, 2008: Armed pirates attacked and damaged a huge oil tanker off the Somali coast (Agence France Presse, 2008).
- November, 2008: Somalia terrorist-linked pirates seized the Very Large Crude Carrier (VLCC) Sirius Star, a Saudi owned crude oil super-tanker 450 miles South East of Mombasa, Kenya. (Kimery, 2008).
- July 17, 2009: Militants launched two attacks on oil tankers in Northwest Pakistan carrying fuel supplies to NATO forces in neighboring Afghanistan. (Saukvally.com, 2009).
- January, 2009: The tanker MT Meredith, loaded with 4,000 tonnes of diesel, was badly damaged in a terrorist attack by the Movement for the Emancipation of the Niger Delta (MEND). (Al-Jazeera English News, 2009).
- July, 2009: Nigerian main rebel group sabotaged an oil tanker at the Lagos depot outside the Niger Delta (Hannington&Tume, 2009).
- July 2009: Somali pirates hijacked an Indian ship and used it to launch an unsuccessful attack on very large crude carrier (VLCC) 'The Elephant' (NASDAQ, 2009).
- October 13, 2013, pirates reportedly kidnapped crew members of a U.S.-flagged oil supply ship off the Nigerian coast (DoD News 2013)
- December, 2013: A Ukrain captain and Greek engineer were abducted from their oil tanker off the Nigerian coast. Reuters, December 17, 2014.
- November 2016:Cilacap, Anchorage Indonesia. Four robbers armed with knives boarded an anchored LPG Tanker from the poop deck using a hook attached to a rope. They took hostage the duty AB and forced him to guide them into the engine room. The robbers then took the duty oiler hostage and threatened them with a knife. The robbers stole engine spares and escaped. The hostage crew later raised the alarm. Incident reported to the local agents and authorities. ICC (2016).
- December, 2016. Qua Iboe Anchorage, Nigeria. Eight robbers in a skiff approach and attempted to board an anchored tanker using a long ladder. Duty officer on the bridge noticed the attempt and informed the Master. Alarm raised and crew mustered in the accommodation. Master requested immediate assistance from the local Naval Security patrol boat. Upon seeing the approaching patrol boat, the robbers abort the attempted boarding and moved away. ICC (2016).
- December, 2016. MuaraBerau Anchorage, Samarinda, Indonesia.Three robbers boarded an anchored bulk carrier. Alarm raised and crew mustered. Seeing the crew alertness, the robbers escaped with stolen ship's stores. Port control and PFSO informed. Authorities boarded the ship for investigation. ICC (2016).
- November, 2016. Cotonou, Outer Anchorage, Benin. Owners of a reefer ship reported that they had lost contact with their ship which was at anchor. The IMB PRC relayed the message to the authorities in the region and the Nigerian Navy dispatched two warships to locate and intercept the vessel. As the warships approached the hijacked ship it was reported that 15 pirates escaped along with three kidnapped crew. The remaining crew managed to sail the ship to a safe port. ICC (2016).
- March 13th2017 Somali pirates seized a Comoros-flagged oil tanker which was heading to Bossaso port, the region's commercial hub, with its eight Sri Lankan crew members aboard. On Thursday, March 16, 2017 the pirates released the ship without conditions after negotiations by local elders and officials. Abdi Guled (2017).

Terrorist attacks that have been carried out to date on oil infrastructure have caught oil producers unprepared. For example, al-Qaeda's February 24, 2005, attack on the Aramco facility in Abqaiq and Saudi Arabia sent shock waves through the world's financial markets. On the same

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day, the price of oil on international markets jumped nearly $2.00 per barrel, despite the attack's complete failure (Cohen, 2007). Most analysts agree that the February attack, an additional attempt on March 28, 2005, and a 9/11-style assault in April 2007, all of which were successfully averted, were merely trial runs in a much longer campaign designed to disrupt the global economy in general, and the oil industry in particular (Stratfor Global Intelligence, 2006).

These terrorist attacks have devastating effects on national security, disrupt domestic oil supply, increase crude oil price, increase fears of environmental disaster, and subsequent possible increase in insurance premiums on tankers going through places such as the Gulf of Aden. Premiums were tripled for ships calling at ports in Yemen after the 2002 terrorist attack on French oil tanker Limburg off the Yemen coast, forcing many vessels to cancel Yemen from their schedules or divert to ports in neighboring states (Richardson, 2004b).

IX. ACTIONS TO EVADE MARITIME PIRACY

The United Nations Security Council Resolution 1816 (2008) "condemns the acts of piracy taking place off the coast of Somalia and calls for nations to take action both on land and at sea to alleviate the problem." (La'Nita M. Johnson (2014).This declaration not only condemns and deplores all acts of piracy, it also provides states with various tools to handle the issue.The International Maritime Organisation also recommends a series of measures to be used by vessels travelling at sea to prevent and disrupt pirate attacks. Some of the advice includes urging states with naval vessels to deter using high-risk routes, share information about acts of piracy with other nations and the International Maritime Organization, and calls upon states to cooperate in determining jurisdiction; to prosecuting individuals responsible for acts of piracy.The events of 11th September 2001, lead states and international organizations to completely reevaluate the threat of maritime terrorism. As a result, the United States initiated and led the drive at the IMO to adopt measures to strengthen maritime security on ships and in ports.

On January 15, 2002, the United States submitted a proposal to the 75th Session of the IMO Maritime Security Committee on measures to improve maritime security (IMO Doc MSC 75/ISWG/5/7). The proposal covered the following areas but not limited to:

Automatic Identification Systems, Ship and Offshore Facility Security Plans, Port Facility Security Plans, Ship Security Officers, Company Security Officers, Seafarer Identification Verification and Background Check, Port Vulnerability Assessments, Port of Origin, Container Examinations, Cooperation with the World Customs Organization, Information on the Ship and its Cargo and People, Means of Ship Alerting and Ship Security Equipment.Ships are to install an Automatic Identification System (AIS). The AIS system enables shore facilities to automatically identify ships and obtain basic information about them. Ships are required to carry on board a Continuous Synopsis Record, which is intended to provide an on-board record of the history of the ship with respect to the information recorded therein.Flag States are required to set security levels for their ships, and port States are required to set security levels for their port facilities. Ships constructed after July 1, 2004 are required to be provided with a Ship Security Alert System.

Although some of these and other comprehensive recommendations might make sense and seem appropriate there has been much information of their effectiveness. Indeed, effectiveness of such measures depends on States participating in and implementing these measures. R. Beckman and T. Davenport (2010). Concerns about global terrorism on crude oil transportation have exacerbated the ambitions for security needs on a global scale; areas with major security problems in the near term are located in the Middle East, Africa, Central Asia and Asia (Steinhausler, Furthner, Heidegger, Ryndell, &Zaitseva, 2008).While the IMO International Ship and Port Facility Security Code (ISPS) requires all vessels over 500 gross tons to be equipped with a ship security alert system (SSAS) to alert relevant authorities in the event of a security threat, on only one occasion was the SSAS mentioned as being used. In only a third of the cases did coalition forces respond, and it was usually just to monitor the situation; rarely was the intervention key in thwarting the attack. D. Nincic (2009). In an effort to combat piracy, the UN Security Council in 2011 passed a resolution condemning threats of piracy and armed robbery in the gulf, also, Japan contributed $1 million to an International Maritime Organization West and Central Africa Maritime Security Trust Fund to curb piracy in the gulf in March 2014. International Maritime Organization (IMO) (2014).

There have been several efforts to combat piracy around the globe. In 2012, the Togolese army in West Africa, agreed to hire private security companies to guard anchored vessels at the port of Lome,Gard (2012), while Nigeria installed anti-piracy surveillance towers along its coast in December 2013. Edd Gent, (2013). In February 2014, Cote D'Ivoire announced it would expand its navy by 40 vessels to help combat piracy within its waters. David Pugliese. (2014).

Regionally, the Economic Community of Central African States (ECCAS) launched a coordination center in 2009 to pool money financed by maritime taxes to combat piracy in the gulf. In September 2011, neighbors Nigeria and Benin launched "Operation Prosperity" in an attempt to curb piracy, which is ongoing. In an attempt to coordinate a response to attacks, an anti-piracy code was adopted by 22 West African countries in June 2013. On the international level, the U.S. Navy has donated boats and carried out training in Nigeria, while the U.S. Congress passed a bill on January 7, 2014, "encouraging increased cooperation between the United States and West and Central African countries to fight armed robbery at sea." Stephen Starr (2014). D. Rollo (2013) posit it that, these measures follow the U.S. Africa Command's ongoing efforts to train national naval forces in the region and to "promote relationships between nations to combat these illicit activities and that the acts of piracy are not just an American problem. They are not just a Cameroonian problem they're a global problem".

X. CONCERNS AND THOUGHT FOR FUTURE RESEARCH

Different approaches can be taken to identify risks and the approach taken might depend on the complexity of the industry and the volatility of the risk environment. However, the identification of the risks may result in a long list that may not be monitored or managed by risk managers. Admittedly, some of the risks may simply be monitored or managed as part of daily management routine. Some may be combined, since they address the same underlying issues, or may be managed at a different organizational level. Risk assessment assists in allocating resources and prioritization of actions based on a comprehensive picture of all significant risks in the context of the objectives of the relevant entity. Approaches to manage oil industry transportation risk specify some man-made incidences which are due to malicious intent; therefore, it is important that, the assessment of transportation risk in the oil industry must include terrorism scenario on the different transportation modes. To manage transportation risk in the oil industry the individual national government should among others: develop risk management control strategies (prevention deterrence; preparedness; response recovery; stringent international and U.S. regulations) on oil transportation. Although simple in concept, implementing these processes in the oil industry transportation sector could also be challenging.Collaborative interest can also mean collective security and corporative protection of the flow of oil, which benefits both producing and consuming nations. A shortfall or slack in this endeavor may play into the hands of insurgents and international terrorists that seek to alienate, divide, and defeat national interests, especially industrialized western nations. Considering the importance of the oil supply risk issue, a number of future potential research areas can be recognized to achieve an integral examination of the subject area. In fact, the quantification and assessment of each risk's probabilities might be an important and demanding task that probably has never been attempted. This might also be true for the impact of each of the risks as well. This study has opened the door for further studies to be conducted and to investigate the risk impact on other sectors of the oil industry.

XI. CONCLUSION

Despite increased but varying degrees of security measures taken by different nations to protect oil infrastructure, global terrorists and regional/local insurgencies, in the quest to advance their agendas have continued to target oil infrastructures around the globe. Such disruptions in the supply chain would profoundly affect business confidence (Richardson, 2004b), the price of oil, and the global economy, specifically among newly industrializing nations (Anderson, 2008). Maritime piracy is deemed as a critical security problem that attracts global attention. The increase in the number, ferocity and geographical scope of incidents of piracy and armed robbery against ships, too often resulting in death, injury or the kidnapping of seafarers, has compelled the United Nations, regional bodies, governments, military forces, shipping companies, ship operators and ships' crews, to work together in order to rid the world of the threat posed by piracy Huang, et.al (2013).

Over the years, piracy has remained a security challenge and threat to international commerce specifically, in the Southeastern part of Asia and Africa where commercial ships in these areas are susceptible to attacks by pirates due to narrow water ways. In spite of the intense counter terrorist measures, oil terrorism is increasingly becoming a matter of routine. International and regional efforts should now focus on encouraging States to participate in such measures and on examining how States can effectively implement their obligations under the relevant conventions, the UN Security Council Resolutions and the PSI. This will help ensure that an effective legal framework is established to combat maritime terrorism.Khondaker et.al (2013) suggested that, to achieve total success in combating piracy demands active global participation, with particular reference to the (i) identification of root causes, (ii) development of effective rehabilitation plans, (iii) global brain storming for comprehensive and appropriate adaptive solutions, (iv) balance between military and political efforts, (v) strong international cooperation and pirate network disintegration efforts, and (vi) development of a clear legal prosecution system with suitable mechanisms to ensure effective enforcement of the regulations.

Piracy poses significant burdens on governments and the maritime industry as they take steps to protect themselves from being attacked or hijacked. Since Over 80 percent of international maritime trade moving through the Gulf of Aden is with Europe, the United States Department of Transportation's Report (2010), suggest that, carrier has basically two courses of action against piracy in the Gulf of Aden: 1). Avoiding the area by rerouting vessels via the Cape of Good Hope, 2). Accepting the risk of operating ships through the area by enhancing vessel security.Rerouting may be a viable option for lower value cargoes, such as some bulk commodities. However, for high value consumer goods or items needed for just-in-time manufacturing, the added delay may be unacceptable to the shipper. In Countries like Nigeria, where Nigerian ports are designated port of destination for the oil trade, avoiding the area is not an option unless the shipper is willing to give up this trade altogether. Also, routing a tanker from Saudi Arabia to the United States via the Cape of Good Hope adds approximately 2,700 miles to the voyage. This longer distance will increase the annual operating cost of the vessel by reducing the delivery capacity for the ship from about six round-trip voyages to five voyages, or a drop of about 26 percent. The additional fuel cost of traveling via the Cape of Good Hope is about $3.5 million annually. United States Department of Transportation (USDT) (2010).

Findings from this study however, suggest that Enhanced Vigilance, protective measures and other watch-keeping have drastically increase the chances of thwarting pirate attacks at sea. Although there are cases of successful efforts in preventing pirate attacks on oil ships, it is profoundly disturbing to know that these measures are inevitably and prohibitably expensive for the shipping companies. Undoubtedly, there are some limitations in this paper as to the accuracies of reported number of piracy, underreported or over reported. However, findings from this study strongly supports the fact that, adopting ship protection measures recommended by the International Maritime Organisation to prevent piracy had been effective to some extent.

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