RISK ASSESSMENT AND ALLOCATION IN NIGERIAN OIL AND GAS PROJECTS

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The Nigerian oil and gas industry is very active. New mega projects are coming on stream such as the exploration and production from the deep offshore as well as the construction of a Liquefied natural gas plant to increase gas utilisation. Various contractual arrangements are in place to woo local and foreign investors for exploration and development projects. However, the number, size and complexity of these projects are increasing resulting in achieving extra operational excellence and also placing more emphasis on the assessment and management of the associated risks. Therefore, the research work that underpins this paper was carried out to identify and assess significant risks in the Nigeria Oil and gas projects and addresses their proper allocation. Data were collected through a questionnaire distributed to a group of experts in the local and international oil company operating in Nigeria. It has been revealed that environmental and Political risks such as Force Majeure due to militants' attack, gas flaring, gas leakage and oil spillage risks are significant. Other significant risks include financial and technological risks. These risks are largely shared between companies and the government representative.

Keywords: risk assessment, risk allocation, oil and gas, Nigeria.

INTRODUCTION

Nigeria has 36.2 billion barrels of proven oil reserves and 182 trillion cubic feet of proven natural gas reserves as of January 2007, which makes Nigeria the seventh largest natural gas reserve holder in the world and the largest in Africa. The Nigerian government plans to expand its proven reserves to 40 billion barrels by 2010, and in view of this, the Federal government demonstrated its ability to make periodic amendments to the existing fiscal regimes, incentives and contractual agreements, in order to provide a more favourable investment climate (Oladunjoye, 2008).

With different forms of contractual arrangements in place, the Nigerian oil and gas sector provides large opportunities to foreign investors and local companies with know-how and technical capacity to contribute with added value in joint ventures. However, Nigeria is a difficult market to operate in and one of the most important single factors to ensure success in this oil and gas projects is by thorough risk assessment and management. Risk identification and analysis is a critical step in any investment decision. The project objectives, or the measure of the project success or failure, are often defined in terms of cost, schedule and technical performance (Kerzner, 2003; Dobson, 2004; Kishk and Ukaga, 2008).

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Risk assessment and management, on the other hand is intended to increase the likelihood of attaining these objectives by providing a systematic approach for analysing, controlling and documenting the identified threats both during the planning and execution of a project.

According to APM (2006), all projects are inherently risky because they are unique, constrained, complex, based on assumptions, and performed by people. As a result, project risk management must be built into the management of projects and should be used throughout the project lifecycle. Exploration and production of hydrocarbons, in particular, is a high risk venture; hydrocarbon volumes and types (oil/gas), total investments and operating costs to explore and develop prospects based on engineering designs, taxes and royalties included in fiscal regimes, market destination and product selling prices, are variables taken into account in oil and gas projects (Seba, 2008).

In making investment decisions, present and potential investors in Nigeria oil and gas industry are expected to consider the significant risks associated with oil and gas projects since the risks differs from countries to countries due to the economic, political, social, environmental and cultural conditions. It is essential that oil producing companies and contractors identify these sources of risk and uncertainty in order to (1) assess and determine the significant risks inherent to the projects and decide which projects are more risky; (2) plan for the potential sources of risk in each project and its phases; and (3) manage each source during project implementation. Risk identification and allocation are influential factors in risk handling decisions (Wang *et al.*, 2004; Kishk and Ukaga, 2008). Therefore, there is a need to assess and determine the risk significance that are known to the planning and execution of the oil and gas project in Nigeria and also addressed its proper allocation to the appropriate contracting party.

The objective of the research work that underpins this paper was to identify and assess the significance risks in the oil and gas projects in Nigeria and to investigate their proper allocation. In the following section, the research methodology is introduced. Then, the data gathered is analysed and discussed. Finally, the research work is summarised, conclusions are drawn.

RESEARCH METHODOLOGY

Questionnaire Design

A questionnaire survey has been designed on the basis of an extensive literature review of various risk categories. Questionnaires were used because of their convenience and cost and time effectiveness when compared to face-to-face interviews given that the population companies are scattered in various parts of Nigeria. Besides, they are less intrusive than telephone or face-to-face surveys which may result a better response rate as was identified in the pilot study.

The questionnaire consists of three sections. The first section was intended to gather information about the respondents' profile. The second section relates to questions on the probability and the impact of various risks within oil and gas projects. The third sections relates to the proper allocation of these risk.

Sampling Technique and Data Quality

The use of a random sampling technique for data collection would require the whole population to be known (Fellows and Liu, 1997). However, the overall number of

companies currently involved in oil and gas projects in Nigeria could not be determined. Therefore, a convenience rather than a random sampling technique was used for data collection.

The validity of the collected survey data can be reasonably assumed as all survey respondents have been involved in risk management and allocation within oil and gas projects in Nigeria.

Questionnaire Content Validity

To minimise the possibility of the respondents not understanding the terminology and layout of the questions, the questionnaire was piloted on three respondents within the international oil and gas industry operating in Nigeria and two respondents within the local oil and gas industry as well as other two respondents within the oil servicing sector. Based on their feedback some alterations were done.

Questionnaire Administration

All the questionnaires were sent through e-mail and equally made available on website domain. This allowed quicker administration and easier compilation and analysis of responses. Out of 51 distributed questionnaires, 31 were returned with a good response rate of 61%. Twenty seven out of the 31 were complete and provided suitable data for the sections of the questionnaire relating to risk impact and allocation. These represented 11 local companies and 16 international companies.

Method of Data Analysis

The data analysis was carried out in two folds using SPSS for Windows and Microsoft Excel. SPSS was used to generate the frequency (f_i) of the response category index for the probability and impact.

Risk significance was determined using risk ranking method and the likelihood-impact matrix method. The relative importance index (RII) for each risk was calculated for probability, impact and rating using the frequency data for each response categories generated from SPSS. The relative importance index is the calculation of the mean frequency of each responses category index for the probability and impact. It is calculated as follows

$RII = \frac{\sum_{i=1}^{n} w_i f_i}{\sum_{i=1}^{n} f_i}$, where f_i is the frequency of the i^{th} response and w_i is the weight assigned to the i^{th} response.

Spearman rank correlation coefficient was also used to determine the strength of relationship between the probability and impact ranking for the risk rating. It is a measure of correlation between two series using the ranks rather than the actual values (Kottegoda, 1997; Coakes *et al.*, 2001).

ANALYSIS AND DISCUSSION

Risk Significance

Table 1 shows the relative importance index for each risk based on the risk likelihood, impact and rating. Spearman's Rank Order correlation has also been calculated to be 0.884. This high value indicates a strong association between the two sets of ranking.

Table 1: Overall Relative importance indices for various risks.

Risk Description	ID	Likelihood RII	Impact RII	Rating RII
Force majeure due to militants attack	R24	4.593	4.556	20.922
Gas flaring	R23	4.185	4.482	18.756
Risk to local environment due to gas leakage and oil spillage	R21	4.111	4.296	17.663
Cost overruns from budgeted cost	R11	4.074	4.148	16.9
Cash call problems from partners	R10	3.926	4.074	15.995
Inadequacy of existing technology and equipment	R20	3.963	4	15.852
Crude oil price	R12	3.667	4.037	14.802
Inflation rates (Domestic and Foreign)	R13	3.889	3.704	14.403
Availability of capital	R7	3.778	3.593	13.572
Armed conflict	R30	3.37	3.815	12.857
Risk to groundwater because of drilling operations	R22	3.333	3.852	12.84
Change in foreign interest rate	R9	3.519	3.63	12.771
Facilities construction time	R18	3.593	3.407	12.241
Formation Damage	R6	3.259	3.482	11.347
Environmental law and policies	R25	3.407	3.259	11.106
Equipment procurement time	R17	3.074	3.37	10.361
Local currency depreciation	R14	2.926	3.519	10.295
Blow out during drilling	R4	3.556	2.815	10.008
Change in domestic interest rate	R8	3.185	3.074	9.792
Determination of production mechanism	R19	3	3.222	9.667
Facilities development before drilling	R16	2.963	3.148	9.328
Restriction of production and oils export for political reasons	R31	2.704	3.296	8.912
Presence of sealing fault or a pinch-out	R3	2.741	3.111	8.527
Determination of the production capacity before hand	R15	2.815	2.852	8.028
Unexpected natural calamity due to earthquakes, and pipelines explosion	R26	2.482	3	7.445
Change in tax structure, royalty agreement and MOU	R28	2.333	2.963	6.914
Lack of hydrocarbon in recoverable quantities	R1	2.444	2.667	6.518
Domestic price control	R29	2.37	2.704	6.409
Nationalisation of E&P venture	R27	2.296	2.37	5.443
very low permeability in reservoir	R2	2.259	2.407	5.439
Loss of Drill pipe/equipment	R5	1.815	2.148	3.898

As shown in Table 1, the most significant risk is Force Majeure due to militants attack. This has been a key risk in the Nigeria with several recent oil outages in Nigeria. The second significant risk is that of gas flaring. This is especially true as Nigeria is the world's highest natural gas flaring country.

The risk to local environment due to gas leakage and oil spillage is the third most significant risk. This might be because in some areas, pipes are laid above ground and run directly through villages where leaks have rendered the land economically useless.

Cost overrun is also an important risk (ranked 4th). Oil and gas project costs have risen dramatically over the last five years and companies can no longer emphasise completing projects over containing costs. Offshore oil and gas projects are particularly at risk of cost overruns due to poor integration planning in light of labour shortage issues, changes to the regulatory environment, and increasing emissions standards (Oladunjoye, 2008).

Cash call problems from partners is an economic risk that is ranked 5th. The largest oil producers (International Company) are most affected by joint venture partner cash calls. Apart from huge investments foreign companies still need to spend big capital to maintain the operating fields which are joint ventures with the Nigerian National Petroleum Corporation (NNPC), and this could be brought to a standstill because of lack of cooperation by NNPC for further development.

Inadequacy of existing technology and equipment is an engineering/technology and facilities risk that is ranked 6th. Since the country's own technological capabilities were limited and in order to meet the industry demand, the government encouraged the transfer of foreign technology embodied in capital goods and turnkey plants by assigning low protection to the capital goods industry.

Crude oil priced is ranked 7th. This is a common risk because it is associated with the present global credit crisis. This risk might be associated with financial risks area in projects but the cause could be traced to political problems associated with the oil producing countries, especially the developing countries.

Inflation risk (domestic and foreign) is also a financial risk which is ranked 8th. In 2006, inflation was as high as 10%. Another significant financial risk is the availability of capital for projects (ranked 9th). This is mostly affected by the local companies because of the lack of funds and the huge capital required for Oil and gas project execution. Recently, Nigeria government awarded 24 of the 200 fields classified as marginal by operators due to low ranking in their investment portfolio and/or remoteness to existing facilities to 32 local companies and this have not been fully developed mainly due to funding problems.

Armed conflict is a political risk that is ranked 10th. This is also associated with the Force Majeure due to militants attack earlier discussed earlier. This is the risk associated with the rebel group in the host communities seeking for the control of exploration activities. There favoured tactics reportedly include sabotaging oil production in the Delta region as well as kidnapping foreign workers.

To compare the perceptions of experts working in international companies with those in local companies, the responses survey has been analysed based on different response categories (international and local). The top twelve risks according to international and local companies are presented in tables 2 and 3, respectively.

As shown, both top twelve lists share eleven risks. Though, their perceptions were different for the environmental risks. This might be due to the ease of project execution by the local companies relative to international companies in the oil troubled environment. Force Majeure due to militants attack is ranked first by international companies while gas flaring is rank first by local companies. The reason for the former may be due to the incessant attacked from the rebel experienced by the major international companies operating in the Niger delta region. Inadequacy of existing technology and equipment is ranked 2nd and 4th by international and local companies, respectively. Cash call problems from partners is ranked much higher by local companies (2nd) than international companies (5th).

Table 2: Top twelve risks according to international companies.

Risk Description	ID	Rank	RII Rating
Force Majeure due to militants attack	R24	1	21.101

Inadequacy of existing technology and equipment	R20	2	19.137
Environmental law and policies	R25	3	17.797
Gas flaring	R23	4	17.750
Cash call problems from partners	R10	5	17.250
Armed conflict	R30	6	16.757
Cost overruns from budgeted cost	R11	7	15.996
Risk to environment due to gas leakage and oil spillage	R21	8	15.258
Inflation rates (Domestic and Foreign)	R13	9	15.141
Availability of capital	R7	10	14.059
Crude oil price	R12	11	13.078
Change in foreign interest rate	R9	12	12.469

Table 3: Top twelve risks according to local companies.

Risk Description	ID	Rank	RII Rating
Gas flaring	R23	4	17.750
Cash call problems from partners	R10	5	17.250
Availability of capital	R7	10	14.059
Inadequacy of existing technology and equipment	R20	2	19.137
Force Majeure due to militants attack	R24	1	21.101
Cost overruns from budgeted cost	R11	7	15.996
Inflation rates (Domestic and Foreign)	R13	9	15.141
Risk to environment due to gas leakage and oil spillage	R21	8	15.258
Environmental law and policies	R25	3	17.797
Crude oil price	R12	11	13.078
Change in foreign interest rate	R9	12	12.469
Formation Damage	R6	3.259	3.482

Availability of capital is ranked 3rd by local companies while ranked 10th by international companies. This might be due to the ease of sourcing for funds by international relative to local companies. Cost overruns from budgeted cost is ranked 6th by local companies while ranked 7th by International companies. This may be due to the size of the projects undertaking by international companies relative to local companies. Crude oil price is ranked 10th by both companies. Environmental law and policies is ranked 3rd by international companies versus 9th by the local companies.

Likelihood-Impact Matrix

Some authors contend that multiplying the probability and impact values might be misleading (e.g. Andi, 2006). Alternatively, a risk likelihood-impact matrix can be used to identify significant risks in a rational and efficient manner (Vose, 2000). Figure 1 shows the likelihood-impact matrix. Using the mean values (dotted lines in the figure), 12 risks are identified as significant using the mean values. These results are in good agreement with those in Table 1.

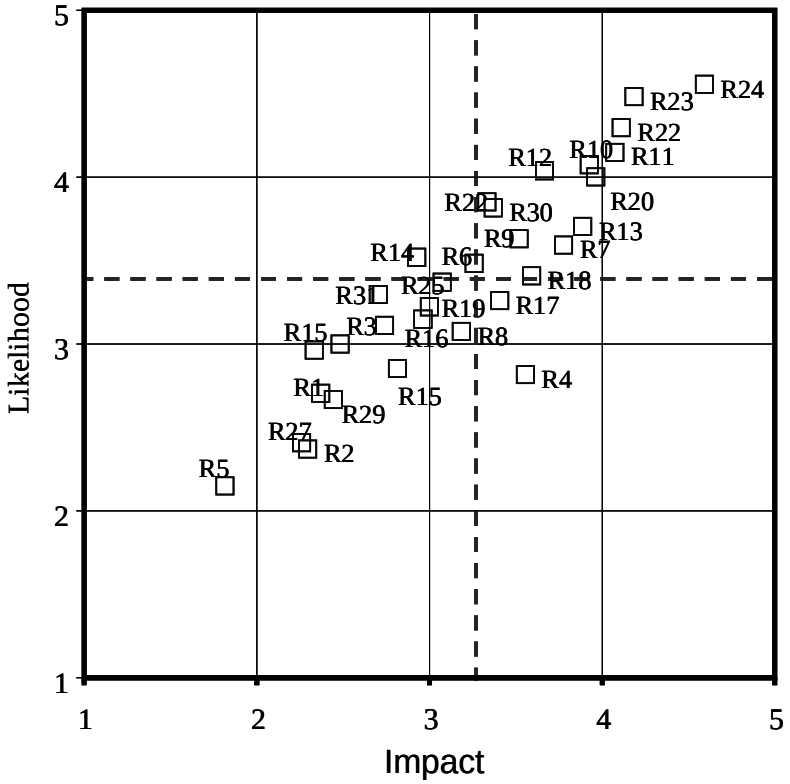

Figure 1: Probability-Impact Matrix.

Risk Allocation

The reasonable and acceptable allocation of risks assumed by the company or contractors in a given contract is essential to managing risks successfully (Lam *et al.*, 2007). This can be done when risks are understood and their consequences are measured. Although risk allocation can vary depending on unique project goals, two fundamental rules should always be followed. First, allocate risks to the party best able manage them. Secondly, allocate or share risk when appropriate to accomplish project goals.

This is especially true in the newly introduced Production Sharing Contract (PSC) arrangement to supplement the previous Joint Operating Agreement (JOA) under which international companies are operating with NNPC, with varying percentages of stakes in their respective acreages. A JOA typically take the form of a joint venture. The companies involved in the JOA form a third company that is jointly owned.

The Production Sharing Contract is an agreement between the company and the host country (represented by NNPC) regarding the percentage of production each party will receive after the participating parties have recovered a specified amount of costs and expenses. The contractor undertakes the initial exploration risks and recovers costs if and when oil is discovered and commercially extracted. Under the PSC, the contractor has a right to only that fraction of the crude oil under the cost oil (oil to recoup production cost) and equity oil (oil to guarantee return on investment). The contractor can also dispose of the tax oil (oil to defray tax and royalty obligations). The balance of the oil, if any (after cost, equity, and tax), is shared between parties.

Table 4 shows the respondents allocation of each risk together with its recommended allocation. The principle of analysis is similar to that employed by Bing *et al.* (2005). The recommended allocation is based on a majority vote (> 50%). If over 50% of the

respondents are in favour of allocating the risk factor to the contractor, then the allocation approach of this risk is categorised as ‘‘allocated to the contractor’’. Similar principles are applied to ‘‘allocated to the company’’ and ‘‘shared between the company and contractor’’. If none of the frequencies is over 50%, the risk factor is regarded as being “undecided”, i.e. is dependant on individual project circumstances.

As shown in Table 4, 25 risk factors are either allocated or shared between the oil producing firm and the Federal government representative (NNPC). There are 11 risk factors within the company risk category. Most of these factors are related to the exploration, drilling and development of facilities, i.e. pre-production. Other risk factors within this category are related to militia attacks, armed conflicts and nationalisation. Most of these risks can be better handled by the company and the host country. Besides, there are 14 risk factors in the shared risk category. Almost all these risks are related to the production, and selling of hydrocarbons with major financial implications for both parties. The nature of all these risk factors is such that neither the company nor the contractor can deal with them alone within the context of the production sharing agreements prevailing in Nigeria today. Hence, a shared mechanism seems to be the most logical choice.

Only 2 risks: local currency depreciation and restriction of production and oils export for political reasons; are allocated to the oil servicing firm (contractor). The remaining four risk factors: cost overruns, inflation, risk to local environment due to gas leakage and oil spillage and domestic price control are undecided and should be handled on a case by-case basis. Some of these results are surprising as the contractor was traditionally allocated more pre-production risks. This issue is being further investigated by the research team and the results will be reported in a future separate paper.

CONCLUSIONS AND FUTURE WORK

The objective of the research work that underpins this paper was to identify and assess the significance of risks in oil and gas projects in Nigeria and to investigate their proper allocation. Data were collected through a questionnaire distributed to a group of experts working in the local international oil companies operating in Nigeria.

Environmental and political risks areas including force-majeure due to militants’ attack, gas flaring, gas leakage and oil spillage, risk to ground water during drilling operations and armed conflict have been found to be significant.

Other significant risks include the financial and technological risk areas such as cash call problems, inflation rates, cost overruns from budgeted cost, availability of capital, crude oil price, change in foreign interest rate, inadequacy of existing technology and equipment. However, geological and drilling risks have been found to be insignificant.

International and Local experts are in general agreement as to the significant risks of oil and gas projects in Nigeria. However, their perception perceptions were different for the environmental risks. This might be due to the ease of project execution by the local companies relative to international companies in the oil troubled environment.

Risks are largely shared between oil companies and the government representative (NNPC). This reflects the nature of various contractual arrangements which are in place for oil and gas projects in Nigeria. Some of the risks are allocated to companies with only a few risks allocated to contractors.

Further future work includes conducting a well grounded survey of risk assessment of oil and gas projects in Nigeria to triangulate the initial approach adopted in this research findings.

Table 4: Risk Allocation.

Risk Description	Company (%)	Contractor (%)	Shared (%)	Recommended Allocation
Lack of hydrocarbon in recoverable quantities	7.4	7.4	85.2	Shared
Very low permeability in reservoir	59.3	3.7	37	Company
Presence of sealing fault or a pinch-out	55.6	11.1	33.3	Company
Blow out during drilling	74.1	0	25.9	Company
Loss of Drill pipe/equipment	77.8	0	22.2	Company
Formation Damage	29.6	0	70.4	Shared
Availability of capital	22.2	0	77.8	Shared
Change in domestic interest rate	14.8	0	85.2	Company
Change in foreign interest rate	70.4	0	29.6	Shared
Cash call problems from partners	22.2	0	77.8	Shared
Cost overruns from budgeted cost	25.9	29.6	44.4	Undecided
Crude oil price	7.4	0	92.6	Shared
Inflation rates (Domestic and Foreign)	25.9	33.3	40.7	Undecided
Local currency depreciation	7.4	81.5	11.1	Contractor
Determination of the production capacity before hand	7.4	3.7	88.9	Company
Facilities development before drilling	66.7	22.2	11.1	Company
Equipment procurement time	7.4	25.9	66.7	Shared
Facilities construction time	7.4	22.2	70.4	Shared
Determination of production mechanism	7.4	0	92.6	Shared
Inadequacy of existing technology and equipment	77.8	3.7	18.5	Company
Risk to local environment due to gas leakage and oil spillage	40.7	18.5	40.7	Undecided
Risk to groundwater because of drilling operations	22.2	25.9	51.9	Shared
Gas flaring	22.2	11.1	66.7	Shared
Force majeure due to militants attack	74.1	7.4	18.5	Company
Environmental law and policies	7.4	18.5	74.1	Shared
Unexpected natural calamity due to earthquakes, and pipelines explosion	29.6	7.4	63	Shared
Nationalisation of E&P venture	81.5	11.1	7.4	Company
Change in tax structure, royalty agreement and MOU	3.7	25.9	70.4	Shared
Domestic price control	22.2	29.6	48.1	Undecided
Armed conflict	77.8	11.1	11.1	Company
Restriction of production and oils export for political reasons	3.7	81.5	14.8	Contractor

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