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Research Paper

Analysis of Common Incidents Risk Factors Associated with Selected Oil and Gas Companies in Niger Delta

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ABSTRACT
The study was carried out to review incident characteristics and risk assessment of selected Oil and Gas facilities in the Niger Delta region. There is prevalence of incidents irrespective of robust HSE Management systems, safety procedures, various types and levels of risk assessments, routine audit and inspections, hazards and effect management processes and other safety programmes implemented by various companies. Common risk factors associated with the occurrence of the incidents/hazard exposures as identified by the respondents. Technology risk, public opposition, environmental damage risk, force majeure, unforeseen weather/geotechnical conditions, Latent defect risk, Change in law/regulation, political violence/government instability, change in government and political opposition, planning risk, construction risk, delay in project approvals and permits, behavioral & cultural Influences, lack of awareness were factors that were identified to be significantly associated (arithmetic Mean > 2.5) with the occurrence of work related incidents. If quality risk assessment is conducted in the Niger Delta Oil and Gas Industries with much consideration to the common identified risk factors, it will help to reduce accident and thereby preventing human and financial losses, improve company reputation and also less negative impact on the environment.

KEYWORDS: *Common incidents, risk factors, oil and gas companies, Niger Delta*

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I. INTRODUCTION

Nigeria's oil and gas industry operates mainly in the Niger Delta and undertakes the design, procurement, construction, installation and commissioning of various oil and gas processing facilities. Various contractors and subcontractors with several million exposure hours are responsible for the major aspects of projects, production and installations. Seismic work and geodetic surveys, dredging, shore protection and process recycling operations, platforms, modules, compressors, vessels, substations and outstations, electrical installation, piping & tube laying, plants, plant maintenance and general operations, are included in the scope of activities. High risk activities include diving, piping fitting, soldering and manufacturing, scaffolding, sandblasting, painting and x-ray operations, excavations and trenches, concrete operations, cable laying and termination, hydro testing, lifting operations, confine space activities, land and water transport. There are various types of accident prevention programmes in the modern workplace that range from simple to complex process. The most widely utilized techniques in accident prevention include failure minimization, fail-safe design, isolation, tag lock-out, risk screening, personal protection devices, redundancy, time replacement, etc. This is a single component of a wider safety program.

The petroleum and gas sector recognizes that high health, safety and environment (HSE) standards are an integral part of efficient management objectives and contribute to the company's operational efficiency and profitability. Sufficient resources and commitment are made available to ensure a continuous development of employee competence, appropriate supervision, instructions, monitoring, and the provision of any required expert advice in project execution and throughout operation phase. The amount of lost time due to work-related injuries is an important area for assessing the impact of accidents on a particular organization. Around 35,000,000,000 hours in a typical year have been lost in accidents, according to the National Safety Council. This time loss of injury does not include extra time lost after an injured person returns to work for medical checks.

The aim of creating a powerful HSE management system for industry is to prevent accident loss, minimize risks to workers, visitors, the public, plant and equipment and reduce risks which could have a negative impact on the environment. The goal of HSE is to reduce the risk of dangerous events in the working environment. An organization's main objective is to ensure good productivity through reductions in undesirable costs of work-related injuries/diseases that might result from medical treatments, time loss or a delayed operation, compensation, and legal proceedings. However, several unanswered questions came to mind after a close examination of the HSE key performance indicators over time. These obvious questions cannot be overlooked. Why are recordable incidents still happening in Oil and Gas companies in the Niger Delta region notwithstanding all management efforts and commitments, all employees, regulatory authorities and other stakeholders' involvement in the drive for zero incidents? Can we see where efforts can be directed after a thorough assessment of the characteristics of the incidents and the risk assessment of Oil and Gas facility implementation in the Niger Delta region?

II. AIM

The aim of this publication therefore is to review common incidents risk factors associated with Oil and Gas Industries in the Niger Delta

III. OBJECTIVE

The objectives of this work is to:

1. Identify common risk factors associated with incident in the Oil and Gas companies in Niger Delta region
2. Analyze the defects in the risk assessment methods adopted in different organization in Niger delta Oil and Gas operations

IV. LITERATURE REVIEW

Theoretical Framework

Theories of Accident Causation

Efforts and demand for legislation to encourage health and safety are primarily expressed in improvements in safety. Improvement is expected in the short and long term as a result of a proper understanding of the cost effectiveness and resulting productivity gained by a secure and healthy workforce (Goetsch, 2005). Legislation, track records, and public opinion all favoured management in recent years. Industrial workers' working conditions have vastly improved in recent years. A worker's chances of dying in an industrial accident are now less than half of what they were 60 years ago. The estimated death rate from work-related accidents is about 4 per 100,000, according to the National Safety Council (NSC), which is less than a third of the rate 50 years ago. According to DeCamp and Herskovitz (2015), incidents happen every day and affect almost everybody in some way. Heinrich's Domino Theory, Ferrell's Human Factor Model, Petersen's Accident/Incident Model, Systems Model, Reason's Swiss Cheese Model, and Combination Theory of Accident Causation are among the common theories in practice.

Conceptual Framework

The Concept of Risk

Whether in finance, oil and gas, safety engineering, health, transportation, security, or supply chain management, the programme of risk is very important (Althaus, 2005). Its significance is a source of concern across board. Some industries seem to have figured it out long ago, such as the nuclear industry, which has relied on Kaplan and Garrick's (1981) concept (triplet scenarios, effects, and probabilities) for more than three decades. In general, a risk is characterized as the possibility or probability of an adverse effect as a result of a hazardous situation (Asante-Duah, 2017). It entails a thorough examination of all applicable scientific data in order to determine the probability, existence, and degree of harm to human health as a result of exposure to environmental stressors.

Indeed, the distinction between danger and risk is taken into account when assessing risk possibilities and/or scenarios. The chance of harm as a result of exposure to a danger is what separates risk from hazard in general. According to Asante-Duah (2017), an incident is considered a danger if it has the potential to cause an adverse effect in any situation, while risk represents the likelihood that an adverse effect will occur in actual or realistic circumstances, taking into account the potency of the particular situation, even or task and the extent of exposure to that substance. The overall process of risk recognition, risk analysis, and risk evaluation is known as risk assessment. Projects, human tasks, operations, and particular threats may all be measured at the organizational or departmental level. In different situations, different tools and techniques may be suitable (Valis and Koucky, 2009). Risk evaluation entails determining the nature of threats, as well as their causes, effects, and probabilities.

The Oil and Gas Industry faces a huge challenge in terms of employee health and safety. Oil production disruptions caused by fires and major incidents can result in substantial financial losses as well as possible risks to humans and the environment. The probability of a particular consequence occurring is referred to as danger. As a result, risk management is regarded as an important component of effective management practice. Risk management is a rational and comprehensive approach to determining the context, defining, assessing, treating, tracking, and communicating risks associated with any operation, function, or process so that organizations can reduce losses and optimize opportunities. As a result, risk management entails recognizing opportunities and preventing or minimizing losses (Osabutey, Obro-Adibo, Agbodohu and Kumi, 2013).

Risk management is a multi-step interactive process that, when completed in order, allows for continuous improvement in decision-making. Its goal is for both parties to understand and agree on what the risks are and how they will be handled in order to maximize efficiency, increase company value, and minimize financial losses (Osabutey et al., 2013). Its goal is to enhance performance by detecting risks before they are misshandled and excalated, mitigating them, and managing the product lifecycle.

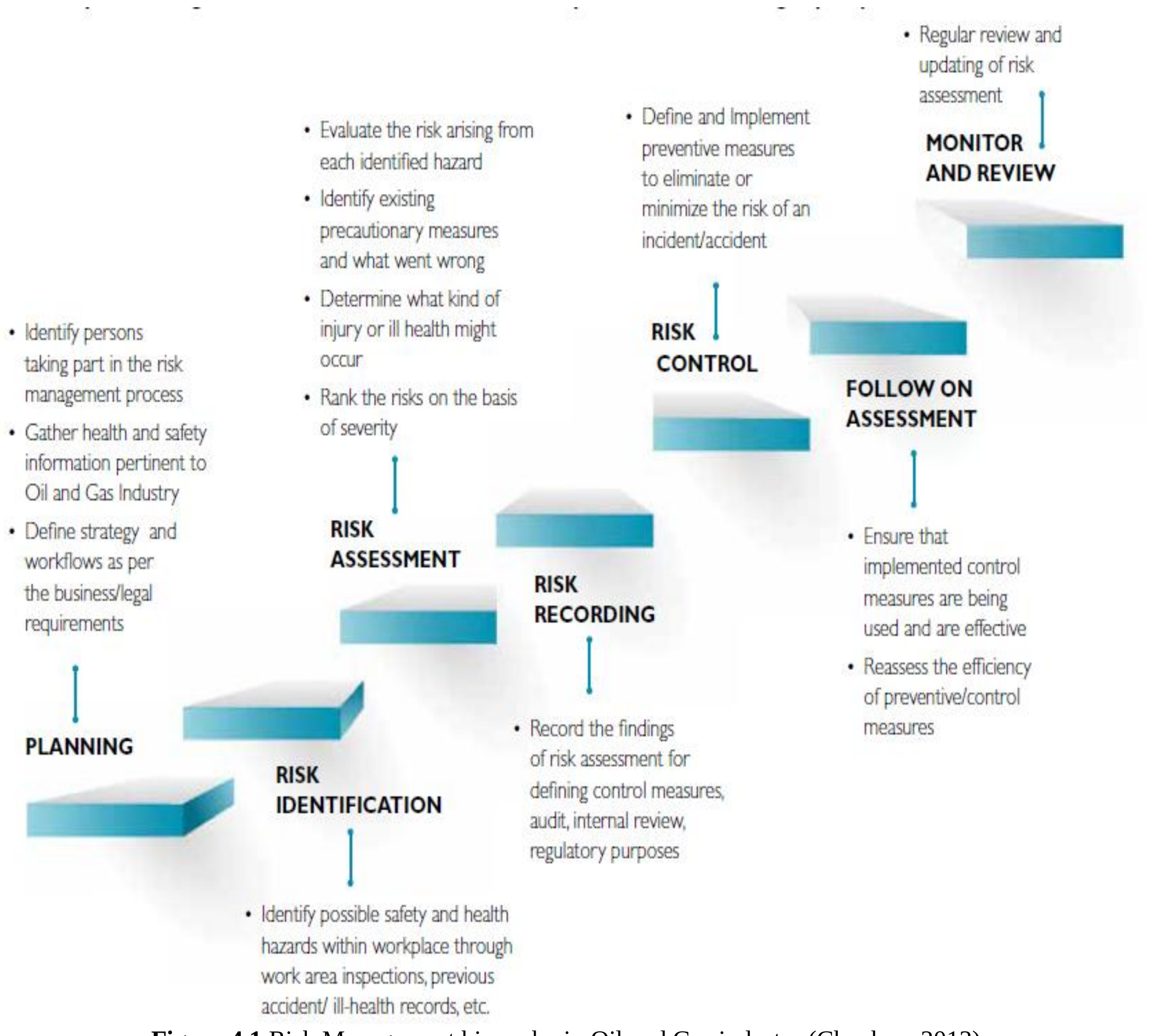

Figure 4.1 Risk Management hierarchy in Oil and Gas industry (Chauhan, 2013).

V. METHODS

Research Design

The cross-sectional descriptive study design was adopted as it provides for cost effectiveness, efficiency and ease of accessing better information from the target audience in the path of the study. The study assessed the occurrence of different incidents in line with the common risk factors and the identified defects in the risk assessment methods as identified by individuals working in selected Oil and Gas companies in Port Harcourt, Nigeria. Data for the research were obtained from group of persons from major Oil and Gas companies within the target region. Questionnaire for the study were structured as the main instrument used for accurate data gathering

Study Area

The Niger Delta region measures about 29,900 square kilometers, comprising the area covered by the natural delta of the River Niger and the areas to the east and west. Niger Delta region comprises nine states, which are Abia, Akwa Ibom, Bayelsa, Cross Rivers, Delta, Edo, Imo, Ondo and Rivers". The Niger Delta is classified as a tropical rainforest with ecosystems comprising of diverse species of flora and fauna both aquatic and terrestrial species. 2,370sq/km of the Niger Delta consists of rivers, creeks, estuaries, and stagnant swamps cover approximately 8600sq/km, the Delta mangrove swamp spans about 1900sq/km as the largest mangrove swamp in Africa (Uzoma and Mgbemena, 2015). For the selected area and types of industries, the research is concentrated on selected Oil and Gas facilities in Akwa Ibom, Bayelsa, Delta and Rivers States, both in onshore and offshore locations

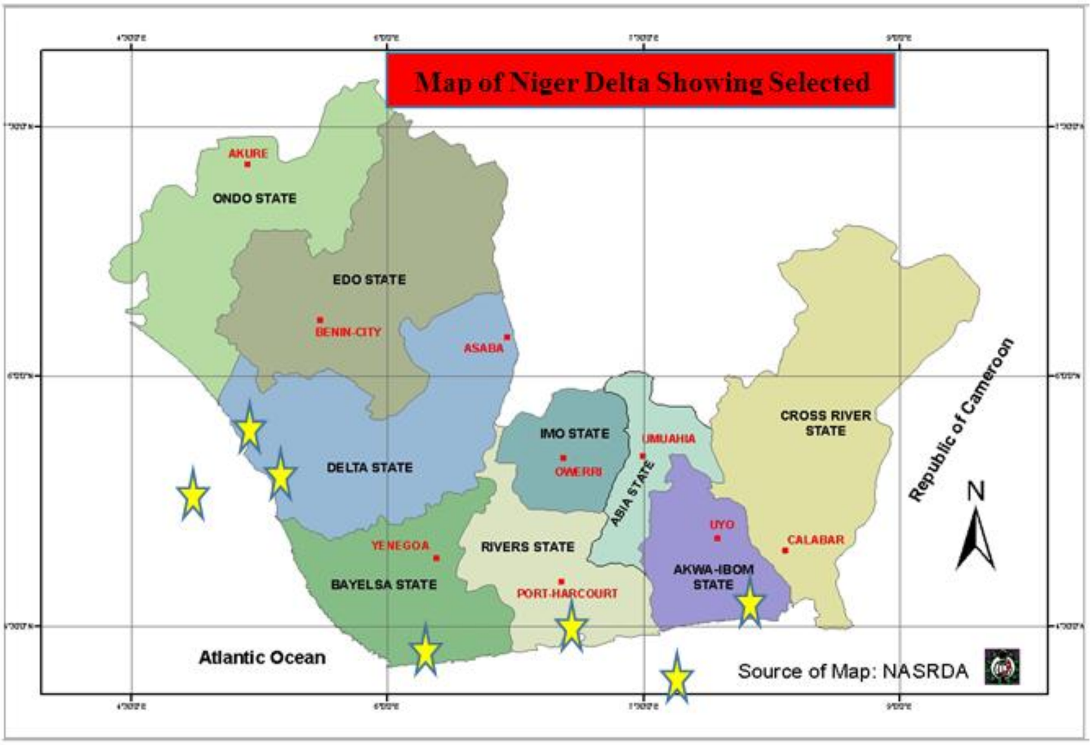

Figure 5.1 Map of Niger Delta Source: (Ana, 2011) ☆ - Sample Locations

Population for the Study

The study population is made up of persons within 18 years of age up to 60 years and above, which include male and female working in selected four Oil and Gas companies in Niger Delta. Their role played in the various organizations are management, supervisory and junior staff cadres with varying years of experiences classified into four categories. The companies are designated as companies A, B, C and D. The choice of these companies is due to their involvement Oil and Gas exploration, drilling and production with their facilities spread across onshore, swamp and offshore in the Niger Delta region.

Table 5.1 Population of selected oil and gas companies for the study

S/N	Company	Population	Percentage %
1	A	108	45.00
2	B	35	14.58
3	C	45	18.75
4	D	52	21.67
Total		**240**	**100.00**

Sample and Sampling Technique

A total of two hundred and forty individuals were selected for the study. The study sample was calculated with the sample size for proportions formula and is given in Equation 3.1;

$$n = \frac{\left[z^2 \times p \times (1 - p)\right]}{e^2} \qquad \text{Cochran (1977)} \qquad \text{Equation 5.1}$$

and Z is the critical value of the Normal distribution (1.96), p = proportion of personnel that have experienced work-related incidents in the Oil and Gas sector as previously reported by Bergh et al., (2018) to be 17%, e is the margin of error (5% = 0.05).

n= (1.96 x 0.17 x (1 - 0.17))/0.05^2 = 216 + 10% attrition rate = 238

This research utilized convenience sampling method which is a form of non-randomized sampling method. This method clearly selects people that are readily available for the sample population because of their availability and ease of convenience. This method does not apply probability theory and involves human decision in selecting samples. Subjects were chosen based on ease of accessibility to the researcher using the convenience sampling method.

Method of Data Analysis

The data collected was inputted into an electronic spreadsheet (Excel) and analyzed with the Statistical Package for Social Sciences (SPSS). The data on work-related incidents was presented using summary statistics (frequency, percentages, mean and standard deviation). The risk factors associated with the work-related incidents and the identified defects of the risk assessment methods were assessed using the 4-point Likert scale and arithmetic mean of ≥2.5 was considered as accepted. The distributions of Hazard exposure and risk assessment methods by the demographic information was analyzed using the Chi-Square statistic. All analysis was done at 95% confidence interval and a p value less than 0.05 was considered significant

VI. RESULTS AND DISCUSSION

Demographic distribution of respondents

Table 4.1 shows the demographic distribution of the respondents. There were 223 (92.9%) male and 17 (7.1%) female respondents. The age distribution showed that 6 (2.5%) were <20 years old, 11 (4.6%) were 20 – 29 years, 71 (29.6%) were between 30 -39 years, 82 (34.2%) were between 40 – 49 years, 52 (21.7%) were between 50 – 59 years and 18 (7.5%) were ≥60 years.

Table 6.1: Demographic distribution of respondents

	Frequency (n=240)	Percent (%)
Gender		
Male	223	92.9
Female	17	7.1
Age group (years)		
<20	6	2.5
20 - 29	11	4.6
30 - 39	71	29.6
40 - 49	82	34.2
50 - 59	52	21.7
≥60	18	7.5
Rank		
Management Cadre	31	12.9
Supervisory role	121	50.4
Junior Staff	88	36.7

Years of Employment		
1 - 5 years	51	21.3
6 - 10 years	71	29.6
11 - 15 years	57	23.8
>15 years	61	25.4

Incidents in the Oil and Gas Companies

Figure 6.1 shows the distribution of the incidents occurring experienced by the respondents at the place of work. The most common was Burns/contact with hot surfaces (22.5%) followed by chemical incidents (20.0%), slips, trips and falls (15.8%) and the least occurring incident was psychosocial (2.5%).

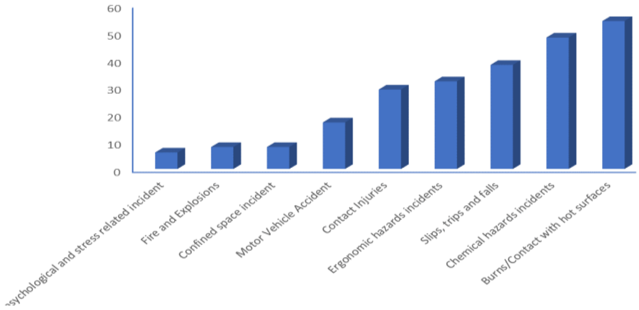

Figure 6.1 Distribution of Incidents in selected Oil and Gas sectors

Common risk factors associated with incidents in Oil and Gas companies

Table 6.2 shows the factors associated with the occurrence of the incidents/hazard exposures as identified by the respondents. Technology risk, Public opposition, Environmental damage risk, Force majeure, Unforeseen weather/geotechnical conditions, Latent defect risk, Change in law/regulation, Political violence/government instability, Change in government and political opposition, Planning risk, Construction risk, Delay in project approvals and permits, Behavioral and Cultural Influences, Lack of Awareness were factors that were identified to be significantly associated (arithmetic Mean > 2.5) with the occurrence of work related incidents.

Table 6.2: Factors associated with incidents in Oil and Gas companies

Factors	SA (4)	A (3)	D (2)	SD (1)	Mean (R)
Material/labor shortage or non-availability	59(236)	58(174)	63(126)	60(60)	2.48
Technology risk	67(268)	54(162)	64(128)	55(55)	2.55*
Archaeological discovery/cultural heritage	53(212)	61(183)	68(136)	58(58)	2.45
Public opposition	62(248)	63(189)	65(130)	50(50)	2.57*
Lack of skilled experts	132(528)	52(156)	40(80)	16(16)	3.25*
Supply, input or resource risk	62(248)	53(159)	56(112)	69(69)	2.45
Environmental damage risk	62(248)	65(195)	65(130)	48(48)	2.59*
Design/construction/operation changes	59(236)	55(165)	55(110)	71(71)	2.43
Force majeure	62(248)	60(180)	62(124)	56(56)	2.53*
Unforeseen weather/geotechnical conditions	68(272)	63(189)	59(118)	50(50)	2.62*
Latent defect risk	49(196)	135(405)	42(84)	14(14)	2.91*
Conflicting or imperfect contract	59(236)	54(162)	69(138)	58(58)	2.48
Change in law/regulation	68(272)	63(189)	62(124)	47(47)	2.63*
Organization and coordination risk	56(224)	61(183)	60(120)	63(63)	2.46
Imperfect law and supervision system	55(220)	65(195)	54(108)	66(66)	2.45
Lack of supporting infrastructure/utilities	69(276)	55(165)	58(116)	58(58)	2.56
Corruption	56(224)	64(192)	57(114)	63(63)	2.47
Development risk	50(200)	59(177)	59(118)	72(72)	2.36
Political violence/government instability	56(224)	65(195)	68(136)	51(51)	2.53*

Variation in foreign exchange rate and convertibility issues	54(216)	59(177)	64(128)	63(63)	2.43
Design and construction deficiencies	67(268)	47(141)	58(116)	68(68)	2.47
Availability/performance risk	58(232)	50(150)	63(126)	69(69)	2.40
Change in government and political opposition	61(244)	67(201)	53(106)	59(59)	2.54*
Unfavorable national/international economy	62(248)	60(180)	51(102)	67(67)	2.49
Planning risk	66(264)	119(357)	35(70)	20(20)	2.96*
Construction risk	59(236)	62(186)	60(120)	59(59)	2.50*
Delay in project approvals and permits	65(260)	61(183)	53(106)	61(61)	2.54*
Poor decision-making process	64(256)	56(168)	53(106)	67(67)	2.49
Land acquisition	60(240)	47(141)	64(128)	69(69)	2.41
Government interference	55(220)	60(180)	63(126)	62(62)	2.45
Behavioral and Cultural Influences	56(224)	126(378)	43(86)	15(15)	2.93*
Lack of Awareness	68(272)	126(378)	27(54)	*19(19)*	3.01*

Defects in the risk assessment processes adopted in the different organizations

Table 6.3 shows the distribution of the different flaws associated with risk assessment methods reported by the respondents. The most significant flaws associated with the risk assessment processes as identified by the respondents include; Planning, risk recording, risk control, site visit, implementation, monitoring and review (arithmetic means ≥2.5).

Table 6.3: Average scores of stages of risk assessment

Stage	SA (4)	A (3)	D (2)	SD (1)	Mean
Planning	58(232)	122(366)	50(100)	10(10)	2.95*
Risk Identification	53(212)	54(162)	66(132)	67(67)	2.39
Risk assessment	67(268)	43(129)	66(132)	64(64)	2.47
Risk Recording	58(232)	63(189)	62(124)	57(57)	2.51*
Risk Control	65(260)	125(375)	37(74)	13(13)	3.01*
Follow-on Assessment	61(244)	56(168)	57(114)	66(66)	2.47
Site Visit	63(252)	59(177)	53(106)	65(65)	2.50*
Experienced Team Involvement	58(232)	53(159)	56(112)	73(73)	2.40
Implementation	67(268)	104(312)	59(118)	10(10)	2.95*
Monitoring and Review	75(300)	59(177)	52(104)	54(54)	2.65*
Feedback to Risk Management	54(216)	60(180)	58(116)	68(68)	2.42

*Significant (arithmetic mean ≥ 2.5)

Discussion of Findings

Common risk factors associated with incidents in Oil and Gas companies

The outcome of the recent research work showed that the commonly identified factors associated with the occurrence of the incidents include; Technology risk, Public opposition, Environmental damage risk, Force majeure, Unforeseen weather/geotechnical conditions, Latent defect risk, Change in law/regulation, Political violence/government instability, Change in government and political opposition, Planning risk, Construction risk, Delay in project approvals and permits, Behavioral and Cultural Influences and Lack of Awareness. These are consistent with the report of similar studies carried out in Oil and Gas production (DeCamp, and Herskovitz, 2015; Díaz-de-Mera-Sanchez et al., 2015; El Bouti, and Allouch, 2018). These identified factors underscore the importance of the need for the appropriate and up to date technology to be deployed in the risk assessment and incident reduction. Environmental damage risk is also a common factor associated with the occurrence of incidents on oil installations and platforms. However, it is imperative that engineering barriers are put in place to reduce the impact of unforeseen environmental influences (Donwa et al. 2015).

Change in government policies are also reported to interfere with the effective implementation of risk mitigation frameworks and could endanger personnel and affect production output leading to loss of manpower and revenue in the unlikely occasion of incidents happening (Hale et al., 2013; Hale et al., 2015). According to (Cooper, 2000), safety culture considers employees' attitudes and behavior in relation to an organization's ongoing health and safety performance. The term safety culture first made its appearance in the 1987 OECD Nuclear Agency report (INSAG, 1988) (on the 1986 Chernobyl disaster). Safety culture is frequently identified, for example by disaster inquiries, as being fundamental to an organization's ability to manage safety related aspects of its operations successfully or otherwise. Safety culture involves attitudes, behaviors, norms, and values, personal responsibilities as well as training and development (Glendon and Stanton, 2000).

Defects in the risk assessment methods adopted in the different organizations

Risk assessment and analysis are usually conducted to properly identify the hazards inherent in every task or activities that might escalate the risk. The product of the consequences and likelihood are determined through a standard risk matrix to know if the level risk involved is low, medium or high. If the risk is rated high in terms of its likelihood of occurrence and consequences of the outcome, then, suitable controls must be implemented before activities operation is permitted. In an organization with good safety management system, it is expected that a well conducted risk assessment with experienced key personnel in attendance and a proper follow up implementation of risk assessment action points at site, it is hoped that hazard conditions that would escalate risk in operation should be reduced if not completely eliminated. However, there have been occurrence of various incidents in Oil and Gas operations as reported by the respondent in the current study. Consequently, the identified risk assessment tools did not completely eliminate the occurrence of these incidents. In light of the aforementioned situation, the most significant flaws associated with the risk assessment methods as revealed from outcome of the respondents include; Planning, risk recording, risk control, site visit, implementation, monitor and review. These flaws could have hampered the effectiveness of the risk assessment and management plans giving room for the occurrence of these incidents at the different facilities.

Managing risks on projects is a process that includes risk assessment and mitigation strategy for those risks. Risk assessment includes both the identification of potential risk and the evaluation of the potential impact of the risk. A risk mitigation plan is designed to eliminate or minimize the effect of the risk events—occurrences that have a negative impact on the project. A job that is poorly plan has the tendency of ending up with problems which may include incidents that could have been avoided with proper planning. Monitoring and review are a critical aspect of every risk assessment plan as it assesses the relevance, implementation, effectiveness, efficiency, utility, attribution and sustainability in the plan to ensure it fulfills the desired mandate/objective. Periodic review of processes which include risk assessment would help to analyze gaps and develop gaps closing plans. The identified defect in monitoring and review in the current study is consistent with the reports of similar studies which indicate that a failure in monitoring and review have been directly linked with the occurrence of incidents that have led to reduced efficiency of production and loss of revenue in the short and long term (AlKazimi and Grantham, 2015, 2015; Kim, 2016).

Conclusion

The findings of the study showed that burns/pinch point and contact injuries, chemical exposure and slips, trips and falls were the most common incidents occurring in the different companies within the study area. The occurrence of these incidents was not found to be associated with the years of experience of workers and the cadre of staff in the different facilities. The common risk factors identified with the occurrence of these incidents include; force majeure, unforeseen weather/geotechnical conditions, latent defect risk, change in law/regulation, political violence/government instability, change in government and political opposition, planning risk, construction risk, delay in project approvals and permits, behavioral and cultural influences and lack of awareness. The identified defect in the risk assessment method was found to be planning, risk recording, implementation, monitoring and review.

Recommendations

The Niger Delta Oil and Gas Industry, like the general industries, since the Evolution of Safety Management, the incident curve has been lagging at some point for years. Different researches, approach and theories have been developed to bring down the curve but have not yielded the expected result. The following recommendations are made in lieu of the study findings

I. **There is need for holistic review of risk assessment approaches**. The Integral Model of Safety should be considered at all stages of risk assessment.

1) The individual subjective and objective views and approaches in doing things must be reviewed and considered for inclusiveness. The individual intention which incudes, values, attitude, commitment, responsibility and experience. The individual behavior: Plans, actions, decisions, performance and accuracy

2) The group subjective and objective views and approach. This involves the group subjective culture of shared values, ethics, moral, myths and legends, justice and fairness. Finally, the group stands objectively about the systems such as organizational structure, work processes, policies and procedures, shared metrics and contracts

The above integral model of safety approach should be clearly understood and applied at all stages of risk assessment in Oil and Gas projects, from design, construction, commissioning, operation and decommissioning.

II. **Training and retraining of staff at different stages of risk assessment.** Ignorance, inexperience and lack of awareness has surfaced to be one of the major factor that has led to several incidents in the industry. Training could be of different levels formal, informal and on-the-job training is very important in raising the awareness level of employees. Specific task instruction must be given when necessary, especially for high risk activities. Training should be given in handling equipment that one is not familiar with

III. **Monitoring and supervision.** Many incidents that occurred in the Oil and Gas industry were linked to lack of or poor supervision. Proper supervision with competent hands will help to improve the incident curve

IV. **Behavioural based programme to be improved**. Several behavioural programme are in existence, while more programmes are being developed, the existing one should be improved and properly implement for effectiveness.

V. **Quality of Risk Assessment and implementation**. Nearly all the industries, especially in the Oil and Gas conduct extensive risk assessment of different types, ranging from front end engineering design down to construction and operation. However, the quality of risk assessment conducted and the level of implementation especially at construction and operation level should be reviewed.

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