

# A Safety Culture Improvement Model for West Africa's Offshore Sector

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## To cite this article:

Chinedum Onyemechi, Abiodun Sule, Kenneth. U. Nnadi, Chinemerem Igboanusi. A Safety Culture Improvement Model for West Africa's Offshore Sector. *International Journal of Economy, Energy and Environment*. Vol. 1, No. 3, 2016, pp. 74-79.

doi: 10.11648/j.ijeee.20160103.14

**Received:** July 24, 2016; **Accepted:** November 28, 2016; **Published:** December 29, 2016

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**Abstract:** The work analyzed safety paradigms presently being applied in the solution of West Africa's security and safety problems and proffered solutions based on improved safety culture principles. In the study the safety orientation attributes of offshore vessel operators in West Africa were measured with a view to improving safety in offshore support vessels, Floating, Production, Storage and Operations (FPSO) vessels operating in the region. The contributions of safety orientation to the greening of the blue economy were also analyzed. Also analyzed in the work were accident rates in the sub region in recent times. The work suggested methods for improving operating safety climate in West Africa's maritime domain. The contributions of continuous learning as well as other safety paradigms were analyzed with a view to reducing accident rates in the sector.

**Keywords:** Safety Culture, Safety Climate, Offshore Sector, West Africa, Nigeria, Safety Orientation, Blue Economy

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## 1. Introduction

The subject of safety culture came with Chernobyl incident in Ukraine and since then has been adopted in several industries including the maritime sector. The Chernobyl accident was attributed to the lack of a safety culture thus igniting sectoral research on this subject in many industries including maritime, oil and gas and offshore sectors. A safety climate approach to the study of safety cultures has been adopted in recent times in the study of offshore environments. According to Rasmussen and Tharaldsen [1] West Africa's offshore sector is relatively large and extends from the coasts of Liberia in West Africa to Angola in Central Africa located in what is currently called the Gulf of Guinea. The region geologically possesses the same rich sedimentary rock foundations also found in Brazil and as such are seen to be historically similar. The region is part of the deep offshore triangle consisting of West

Africa, Brazil and the Gulf of Mexico viewed as holding the largest reservoir of deep offshore oil in planet earth. The offshore sector of West Africa has thus attracted sizeable investments in FPSOs, offshore support vessels and similar structures in recent times all attending to massive development of the sector. It is thus necessary that safety regulations should grow in the sector in line with attracted monetary investments in the sector. This has however not been the case as the issue of safety is left primarily in the hands of the operators and health and safety regulatory agencies with little know how in maritime safety administration. Though maritime safety administration exists in the zone, it is expected that safety regulations should grow in the offshore sector through safety research studies aimed at preventing accidents. This however is yet to be realized.

### 1.1. Research Objective

The objective of this work is to design a safety culture

improvement model that will improve West Africa's offshore safety climate using appropriate techniques drawn from related offshore sectors from the rest of the world.

### 1.2. Theoretical Framework

This research work is based on the theories of safety culture and safety climate research methods applied in the offshore engineering sub sector. The parameters for the research are purely human factor related parameters.

## 2. Literature Review

Methods applied in offshore safety research in recent times includes but are not limited to the under mentioned the triangulation method, leading and lagging indicator model [2]. The safety culture of an organization has been defined as the product of individual and group competencies and patterns of behaviour that determine commitment to, and the style and proficiency of, an organization's health and safety management [3]. Theories affecting individual behavior in the work place has been found to include the theory of reasoned action TRA and the theory of planned behaviour TPB. TRA was designed to predict easily performed, volitional behaviors. The model was however limited in its explanatory power. TPB is based on the proposition that an individual's behavior is a direct function of behavior intention and perceived behavioral control intentions are themselves shaped by attitudes, subjective norms, and perceived behavioral control. [4], [5] In the workplace, the attitude of the individual worker to safety will be shaped by the perceived attitude of the management towards safety.

Other models of safety culture includes Schein's three layer model of culture which separates the individual's attitudes into three levels thus: basic assumptions, espoused values and artifacts. Basic assumption is the core of the individual's behavior in the organization. It results in the organization sharing a common value. Safety culture as defined by IAEA refers to "that assembly of characteristics and attitudes in organizations and individuals, which establishes that, as an overriding priority, plant (offshore vessel) safety issues receive the attention warranted by their significance' [6]

Other approaches to offshore safety assessment has included but not limited to fault tree analysis (FTA), fuzzy logic approach, preliminary hazard analysis, failure modes and effects analysis (FMEA), event tree analysis, hazard operability studies (HAZOP), failure mode, effects and criticality analysis (FMECA).

Havold [7] has suggested a replacement of safety culture and safety climate with the term safety orientation for purposes of benchmarking. In his words 'Safety Orientation should be considered a practical safety culture assessment instrument, indicating the degree of orientation towards safety in a group or an organization'. He further defined safety orientation to consist of the cultural and contextual factors that create the attitudes and behaviour that influence occupational health and safety. In his words, organizations

with a positive safety orientation are characterized by a perception of the importance of health and safety, and by confidence in the efficacy of their chosen measures to create the necessary behaviour for avoiding or limiting accidents and to continuously improve health and safety." [8]

Osofisan and Orji [9] applied fuzzy logic controller (FLC) for crude oil flow rates and tank levels for monitoring flow and tank level management at Escravos Tank Farm in Nigeria.

## 3. Methodology

The methodology applied in the research was drawn from the backdrops of economics and strategic management incorporating an improved triple helix concept adapted into West Africa's offshore support sub sector. The method is an efficiency frontier compliant method aimed at keeping West Africa's offshore technology sub sector functioning all the time with best available technology in the industry.

## 4. Report of Findings

### M. T WALVIS 14

Major incidents in West Africa's offshore sector include the case of MT Walvis 14 which happened October 1999 at Eket Offshore. The incident involved a small fresh water tanker which was loading fresh water from an offshore production platform. In the cause of the loading dangerous gases entered into the cargo tank through the water hose when one of the crew members lit a cigarette on the main deck causing explosion.

In this case the proper interpretation for the incident occurrence was absence of a proper safety culture. Had the crew members been constantly subjected to good safety culture training, the incident could have been avoided.

### M. T. WALVIS 15

In this incident the vessel M. T Walvis 15 which was located in Eket offshore in July 2000 witnessed an explosion caused by fire in the forward store. The incident was caused by static electricity generated after two operational deep freezers, an oxygen bottle and a full acetylene bottle locked in the forward store developed leakages from their compressors thus leading to an explosion.

Here, the incident can be attributed to the absence of a firm technical safety culture. The incident was avoidable if this training was applied to build a solid safety climate in the vessel.

Some incidents in the world offshore environment which were caused by safety culture related attributes includes some of the following:

Alexander L. Kjeiland-Norwegian Continental Shelf (1980)

The found major causes includes deficiencies and errors in the execution and control of all phases of the platform (planning, building, and operations)

Secondly, regulations pertaining to manning boat maneuvers and drills were clearly not met on board. There

was also poor execution of emergency drills. The number of fatalities was 123

Ocean Ranger–North Atlantic (1982)

Major causes of the incident as was discovered include design factors, lack of safety management systems (lack of proper emergency procedures, lack of manuals and technical information, inadequate training). Human error and decision-making were also found as major causes of the incident. A second major cause of incident was failure to interpret significance of events leading up to disaster. Reported number of fatalities was 84

Petrobras P36–Roncador Field, Brazil (2001)

The reported major cause of the incident includes conducting inspection of tank and void space without following the specified procedures. The vessels two seawater pumps were not active due to repairs without a contingency measures in place. Lastly, deficient emergency situation

procedures and training was discovered. Reported number of fatalities was 11.

#### 4.1. Safety Culture Improvement Model for West Africa's Offshore Environment

This work having studied several incidents leading to accidents in West Africa's as well as the world's offshore environment is not left in doubt as to the similarities between the safety incidents and safety culture related incidents. The several incidents involved were all caused by absence of existing safety culture in the organizations involved. Equipment failure frequency will certainly be reduced where an organizational safety culture exists. Human factors when properly trained will positively impact on the prevalent safety culture and climate built by an organization.

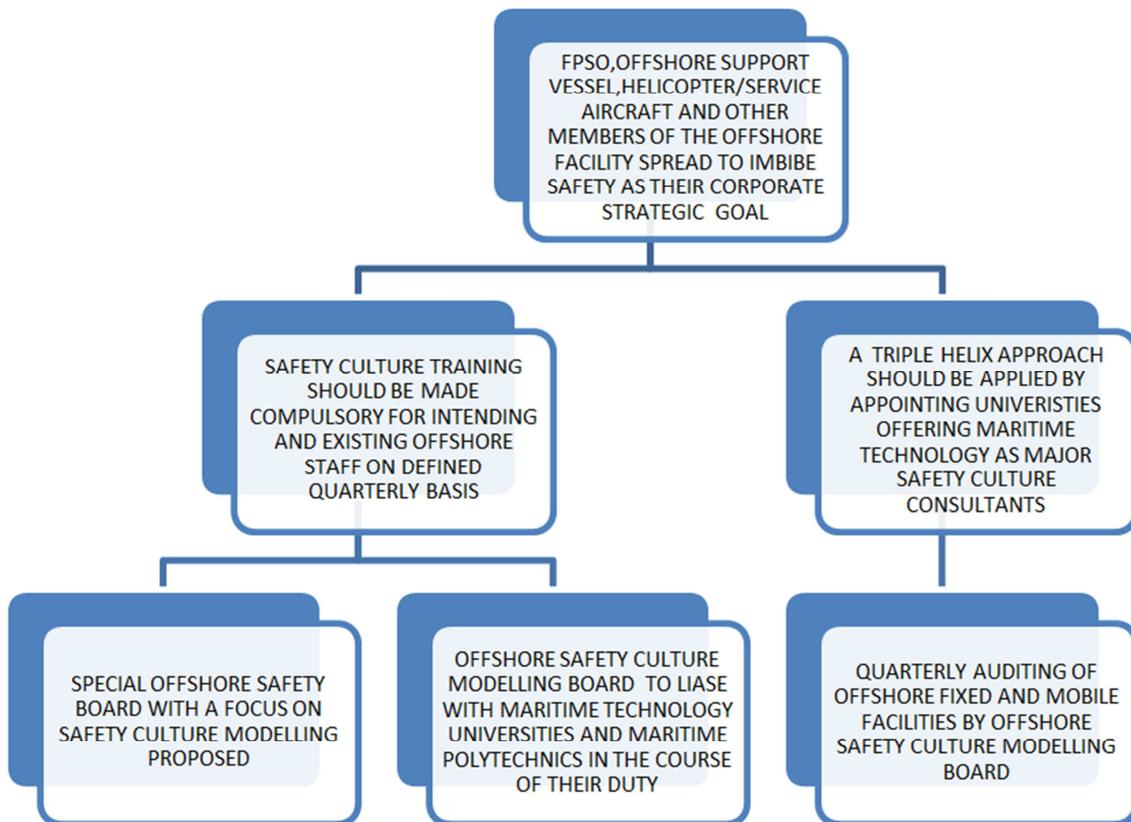


Figure 1. Proposed safety culture improvement model for West Africa's offshore sector.

The safety culture model West Africa's offshore environment is an infrastructure based model that is designed to imbibe a safety culture on the basic offshore environment namely the ship (includes all floating, fixed and mobile infrastructures operating in the offshore environment).

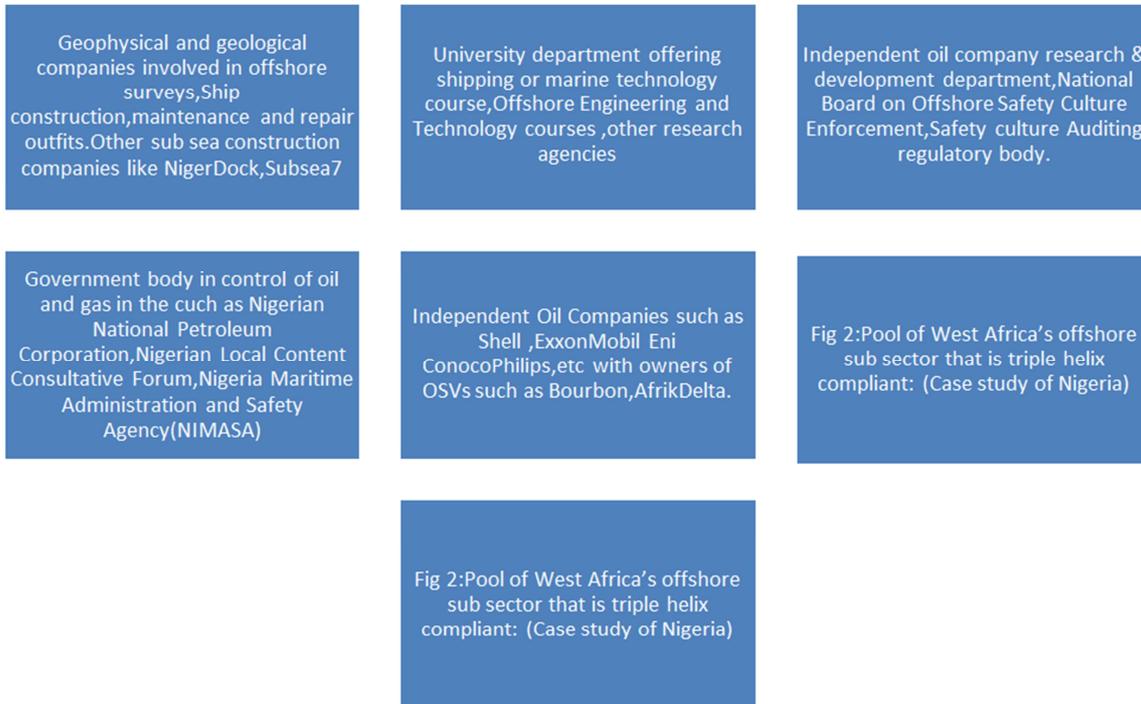
The model consists of a hierarchical structure which defines first defines members of the offshore facility spread to comprise of FPSOs offshore support vessels, helicopter and service crafts and other members of the spread. All members of the spread are required to imbibe safety as their corporate strategic goal. This action if correctly complied

with will create an offshore supply chain with an established safety culture imprints in the work environment.

The second level of the hierarchy consists of two arms with the first arm emphasizing a training culture orientation for corporate outfits involved and the second arm insisting on the application of the triple helix concept in defining members of the offshore safety cluster. The model emphasizes a compulsory training culture education for existing and intending offshore personnel on quarterly basis. Also required by the model is the triple helix approach in defining members of the offshore technology sub sector. The

sector comprises of the several components defined in Porter’s diamond model. Clusters are a group of interconnected and associated institutions in a particular field linked by commonalities. Included in the definition are universities, standard setting agencies, think tanks, vocational

training providers and trade associations. The components of West Africa’s offshore sub sector according to this definition will then include the following sub sectors as defined by the pool.



**Figure 2.** Pool of West Africa’s offshore sub sector that is triple helix compliant: (Case study of Nigeria).

Next in the hierarchy is requirement for the development of the special offshore safety board with a focus on safety culture modeling. This Board as required by the model should work in conjunction with Maritime technology Universities and Polytechnics offering offshore maritime technology in carrying out their duty. This should occur as a collaboration to enable the Board harness the best from available technology. Till date the absence of collaborative thinking in state run agencies in West Africa has affected the rate of development in the region substantially. Existing Government Boards in the region lacking such collaborations thus make normal growth with no ability to move to development efficiency frontiers in their sector. Only a collaborative association with High institutions can guarantee this kind of development. [10], [11], [12]. The maritime technology institutions on their own would be allowed to form linkages with world’s best universities in offshore safety culture auditing. The model requires that the maritime technology institutions carry the lead in this business of safety culture modeling in other to avail the industry of available best practices in the sector on a continuous basis.

The other requirement of the safety culture Improvement model is the transfer of safety culture auditing to the special safety culture modeling board. The processes of auditing are to be determined by the board who works in collaboration with the defined academic sectors to provide the best standard for the industry.

Available reports from the industry categorize safety records in three measures; large extent, mild extent and poor extent. Analysis involved three categories viz; supervisors, foremen and workmen. Two sets of people were involved employees and contractors. Other related indices applied include; measure of fatality per 100 million work hours for both employees and contractors etc. This is not sufficient.

The other safety metric applied is the LTI, Loss time injury as in the case of Niger dock said to have delivered on Usan FPSO with 1.8 million man-hours LTI free. This implies a design metric use of Loss time injury as the safety metric in application throughout the construction.

The indication of the above is that applied safety parameters likely in use in this yard is fuzzy safety evaluation making use of linguistic variables to categorize system’s safety behavior in the shipyard.

**4.2. Building a Culture of Sophistication in Safety Culture Metrics in West Africa’s Offshore Sector**

Whatever the belief in the region, the fact remains that a culture of safety metrics assessment should be inculcated as part of safety auditing in the region. Given the low number of institutions at the tertiary level offering marine technology courses in the region, the fact remains that safety culture development in the region is still at an elementary level. This in essence impacts on the behavior of the employed workforce who is expected to invest in special knowledge

acquisition in this field, the required area of FPSO and OSV safety management, and risk analysis in this case, being the subject matter. This field of knowledge must be expressed both by auditing institutions as well as the employed workforce in offshore marine platforms.

Number of institutions fully dedicated to Marine Technology in West Africa is just 3. Number of university only 1 of which offers full degree in Marine Technology related courses. However a good number of Nigerian universities now offer departments in Marine technology related courses though number of qualified staff is yet to appreciate. They also lack the finance to attract the best from the industry as well as well equipped laboratory facilities.

In any safety management design, two major areas of consideration are important, the human equipment interface and the equipment condition itself. Any safety incident would have risen from either sector, human error or poor equipment condition or both. Models for analyzing these conditions in FPSO design and operation should adopt probabilistic metrics that can predict the probability of occurrence of an incident in the sector. Umar [13] carried out an extensive work in Nigeria's offshore sector assessing safety design conditions for the design of platforms in the sector. His approach however was centered on the safety of the equipment with hardly any assessment of safety culture in organizations in the sector. His analysis was based on fuzzy logic. He developed a design for safety based risk assessment technique for the offshore platforms. The work he produced was titled knowledge based risk assessment method (KBRAM)

This main aim of this work is to develop a "design for safety" based risk assessment technique for the offshore platforms in order to facilitate decision making. This is achieved through detailed examination of related risks, and review of relevant literatures and traditional safety assessment methods leading to the development of a new knowledge-based risk assessment method (KBRAM) through the research methodology process. The approach employed was limited and did not include a safety culture dimension thus limiting the impact of his method in the overall offshore industry. Excessively complex mathematical methodologies are good for analysis in the office but contribute little during emergency situations. He seems to be in support of this work by realizing that knowledge development in Nigeria's offshore sector is key to safe work operability in the sector.

A sophisticated safety analytical culture is best for auditing purposes it must be emphasized. This level of analysis is required by industry regulators such as Nigeria Maritime Administration and Safety Agency (NIMASA). It is indeed doubtful if this organization exercises any level of control over the sector presently. Safety in the sector presently is left to the Independent Oil Companies (IOC's). Safety in Nigeria's offshore sector should be made a priority by the maritime regulatory agency in charge. The regulatory agency should then acquire the necessary knowledge to execute auditing. This knowledge becomes easier to acquire when attached to technical universities offering maritime

technology programmes. Nigeria's Federal University of Technology Owerri has a maritime technology programme with offshore safety inclinations. Attaching this institution to NIMASA will help improve the safety level in Nigeria's offshore sector.

With the rising number of Floating, Production, Storage and Operations FPSOs in Nigeria offshore sector the role of offshore safety ought to be revisited in Nigeria. The best way to start is by developing an appropriate safety culture model such as the one presented in this paper. Ghana and other West African countries should draw up their own safety culture model using the Nigerian model presented in this paper.

*Table 1. Industry-wide Incident Report Nigeria.*

YEAR	No. of Incidents	Fatal Incidents	Fatalities
2010	62	25	54
2011	63	24	35
2012	67	34	160

As reflected in Table 1, the number of incidents together with fatal incidents in Nigeria's oil and gas sector tends to be on the rise. The implication of this is that more investments ought to be done in the area of safety management and safety awareness creation by operators in the sector. Government can assist by enforcing more safety regulation in the expanding oil production sector of Nigeria.

## 5. Conclusion

The work analyzed the state of safety in West Africa's offshore industry and arrived at the conclusion that marine safety incidents which occurred in the offshore sector in the region in recent times has been as a result of lack of institutional framework for the adoption of safety culture in the region. To this end this work was focused at giving West Africa's offshore technology sector the right institutional policy framework that would transform the sector to the efficiency frontier of development in the entire offshore technology industry. The work advanced the triple helix concept making it available in the offshore sector. Also recognized by this work is the role played by the diamond model in defining relevant necessary conditions that must exist for success in the offshore technology cluster. Members of West Africa's offshore technology cluster were also defined in the work using Nigeria as a case study.

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