

# DEVELOPMENT OF SUSTAINABLE ENVIRONMENTAL, HEALTH AND SAFETY FRAMEWORK FOR OIL AND GAS PROJECT IN NIGERIA

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## Abstract

Development of sustainable environmental health and safety framework for oil and gas project in Nigeria became very necessary because of practical issues regarding regular occurrence of industrial accidents arising from exposure to numerous industrial hazards that manifested due to in the industries does non sustainable health safety and environmental (HSE) guidelines that are not strong enough to enforce compliances, full monitoring, implementation and post investigation into HSE operational standards as well as validation to ensure specified quality standards are met during industrial processes. Proactive Health safety and environmental standards improvement approach was developed to help minimise the rate of accident occurrence. This was done, putting into consideration, HSE based organizational structure for oil and gas industry operations that would exhibit high level compatibility with proactive HSE standards improvement approach. Questionnaire were designed to verify industrial safety total compliance using safety priority indicators for survey development guide as benchmark. Results indicated that less than 21% agreed that there is total compliance in their industry, 27% strongly agreed, 31% disagreed and 21% strongly disagreed. Secondary data also showed that numerous accidents at fatality occurred between 2010 -2015 from federal ministry of petroleum records which conforms to the records from primary data and necessitates the formulation of sustainable HSE guideline for oil and gas facility development project specifically for achieving sustainable HSE standard operations in the oil and gas industry.

**Index Terms- Sustainable health, safety, Environment, Standard, Project, Development.**

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## 1 Introduction

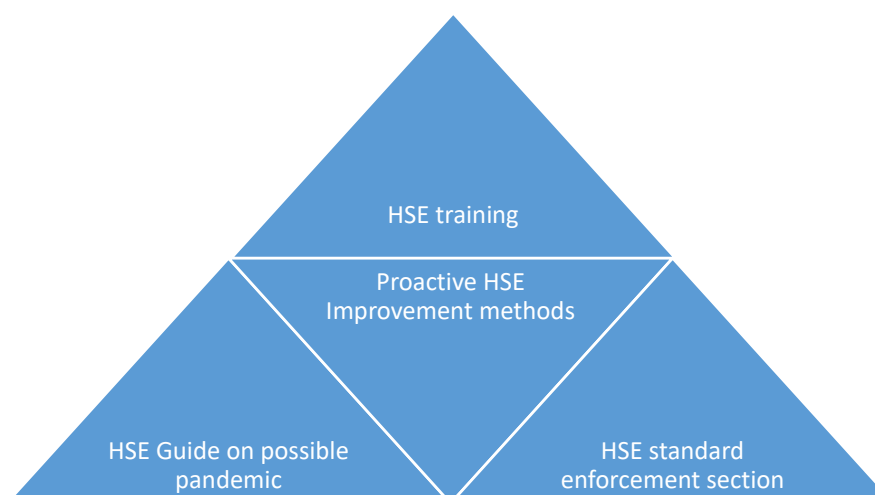
This research is basically focused on developing a sustainable health safety and environmental framework in Nigeria's oil gas sector so as to drastically reduce the high rate of industrial accidents linked to fatality. Lapses that trigger these accidents as well as endanger lives of workers, their health and environment at large would have to be verified. This verification would give us advantage towards developing sustainable framework geared towards achievement of best HSE standard of operation

that would help to reduce exposure to risk of death and industry related hazards that triggers heavy injuries thereby reducing the morale of workers and corresponding economic output in the oil and gas sector. Therefore, it is expected that the already existing HSE situation analysis would be carried out to validate if its' compatibility with global best practices and to verify why the oil and gas industries still have high records of fatalities in line with their operations despite the fact that HSE specifications are still enforced and as well operational in these industries. Due to the fact that enforcement of HSE specifications enhances successful workflow for high productivity and economic output, it becomes very vital to develop a sustainable HSE standard practice strategy. Thus, Petronas Gas Berhad [1] specified that 'HSE is a major part of sustainability framework'. They also stated that all risk associated with health safety and environment within all business should be managed through strict compliance to all regulatory requirements of HSE. The organization also noted that 52% reduction in HSE incidents was recorded in 2016 and as a result of this, 4.4 million safe man-hours were also recorded, while loss time injury frequency (LTIF) of 0.5 was recorded in 2017. Therefore, the organization had improved with zero fatality incident, recorded LTIF of 0.14 with 10.9 million safe man -hours. It is also pertinent to note that increased efforts should be made to enforce HSE compliance behaviour on different levels of workers with no exceptions thereby involving third party service providers for sustainable development. Thus Department of Petroleum Resources, petroleum regulatory agency of Nigeria [2] specified the guidelines for compliance with oil industries technical safety control (TSC) requirements for facility development projects as well as modifications strategies. This guideline involves legal provisions and scope which is developed around the mineral oil safety regulations 1987 that must be given consideration before carrying out any oil and gas facility development project in Nigeria. Furthermore, project safety information document cannot be overlooked since it will come in form of project design and documentation, with contents that would display possible technical safety control review/studies.

According to American petroleum institute, health and safety [3] workers in the oil and gas industries are expected to ensure that safety standards of the company are applied in the process of carrying out their duties, to help safe guide the workers and workplace environment from possible accident and other workplace environmental hazards that may erupt in the absence of keeping safety precautions, in line with the company's requirements.

## **2 Proactive Health safety and environmental standards improvement approach**

Workers should apply sustainable health safety and environment standards that would prevent heavy injuries and loss of lives with work place.



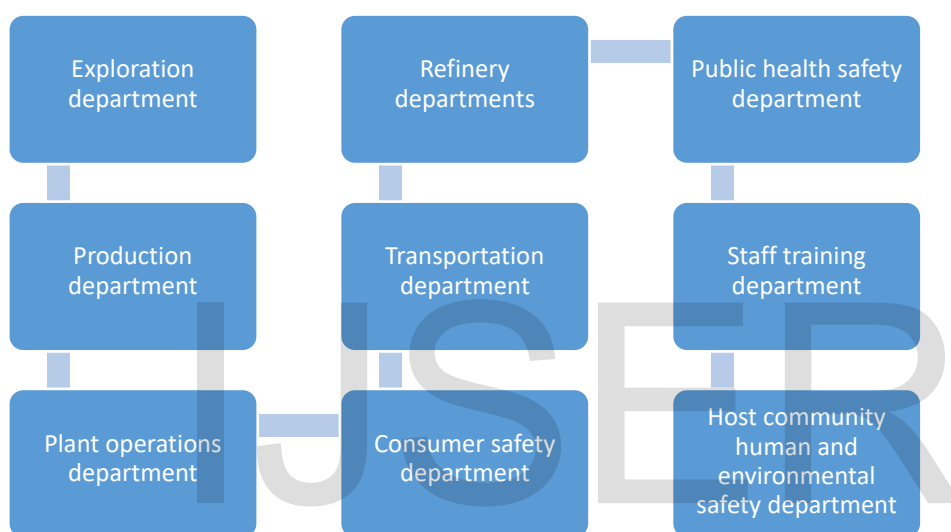
**Figure 1: Proactive Health safety and environmental standards improvement approach**

Oil and gas industries are required to conduct regular trainings on Health safety and environment standards that should be operational for occupational safety of their organizations as a proactive measure to ensure the staff have good knowledge of HSE for sustainable operational field best practice that would drastically reduce exposure to hazards that can lead to injuries and increase mortality in the company. Furthermore, there should be a guide to workers on safety measures to be applied within periods of possible pandemic in other to prevent and reduce possible spread within the industries as well as avoid deaths that may arise as result of such pandemic.

## **2 Health Safety and Environment based organizational structure for oil and gas industry operations**

The oil companies are expected to incorporate an enforcement unit into their HSE section to make sure that all HSE standards stipulated by the company becomes operationally applicable within such times they are expected to be applied. These HSE guidelines should be departmentalized to ensure compliance across board depending on the company's organizational structure. Therefore if an oil and gas industry has departments like, exploration department, that should consider exploration and drilling safety standard of operations, production department, which should consider safety standard methods of operations in the production process, transportation department, which should consider safety standards in different modes of transportation of both raw materials and final products, Refinery department, that should consider safety standards of operations in oil and gas products refining like application of alternative refining product additives of less harmful impact on workers in the industry, plant operations department should consider the application of safety standards during plant operations to ensure safety of plant operators, consumer protection department, considers notification of the hazardous impacts of products to consumers and safety measures that consumers should follow to avoid such impact, transportation department which should consider application of safety standards in transportation of both raw materials, machines and final products to ensure safety

of the divers, workers as well as masses, public health safety department which should be responsible for training of staff and enforcement of HSE standards in the industry, staff training department which should be responsible for regular training of staff on HSE standards and how to abide by the rules to avoid being victims of accidents and death within work environments, likewise Host community human and environmental safety department that should be responsible for training and giving orientation to host communities on possible HSE measures they should abide by according to the company's HSE standards for safety from accidents and deaths from the industries. This structural organizational flow, would make it possible and easier to enforce HSE standards as well as track and measure safety improvements in the oil industry. The diagram below displays the possible organizational structure of an oil industry.



**Figure 2: HSE based organizational structure for oil and gas industry operations**

According to Henry [4] application of these outlined oil and gas industry HSE standards structure would only help in reduction of risk of exposure to industrial hazards but would not eliminate such risk like, caught in accident, where a worker's cloth may get trapped in a revolving machine with a corresponding injury or death. Other form of accidents may include; car collision, fires from explosion, falls and job related health issues. Frank et al [5] identified these different forms of accidents in the oil industry terminals as major causes of injuries and death due to unconformable design leading to substandard construction and application of weak managerial and maintenance strategy in the industrial operations systems. Kaassis and Badri, [6] Gul, [7]; Aneziris et al., [8] specified that Occupational safety risk assessment (OSRA) methods are mostly applied when trying to determine causes as well as nature of accidents and state of work environments in various sectors of any system. Gul et al [9] stated that for safe and healthy work environment to be sustained in an industry, there is need to determine the presence of hazards of external sources so as to help in the risks management to reduce impact of hazards of high damaging frequencies. Thus, Zielińska and Bajdur [10] specified

that hazard that trigger accidents at work place, when prevented, have significant impact on safety, health protection and work environment management for European Union. Therefore standards of work conditions should be improved to enhance safety performance practices that would reduce accidents and deaths of workers and deplete the environment. Such improvement was recorded by the European Union as stated by Zielińska, [11], that more than 3.2 million non-fatal accidents that resulted in not less than four official days of not being in attendance at work in the EU-28. The total number of non-fatal accidents at work in the EU-28 decreased between 2010 and 2015, to about 370 thousand lesser calculated to a percentage of 10.3 %. Safety improvements in oil and gas industry should be a priority in this research since it is expected that development of HSE framework would guide both employers, employees and all third parties that would have transactions in these industries. International Association of Oil & Gas Producers; IOGP [12] specified that there should be improvement in safety in the industrial organizations through exploration of present and past work processes, done through standard monitoring directing the management, to the specifics for safe industry operations. This research goes on to make inquiries into the reasons for continuous occurrence of accidents despite all orientations giving to the oil and gas industries globally, over occupational health and safety processes that should be operational in their individual industries. Thus, Suxia et al [13] explained that, the inception of very fatal accidents in global industrial clusters, presently and within the previous years could be attributed to weak or none implementation of occupational health and safety management systems. Furthermore, International Labour Organization 'ILO' [14] reported that "employees' health and safety" situation in 2015 should draw the attention of actors in HSE on need for adherence, improvement and enforcement of HSE regulations for the purposes of occupational health and safety guarantee for workers. They further stated that more than 2.3 million occupational accidents occurred annually on the global work space with an estimated death of more than 6000 employees recorded per day.

### **3 Materials and Methods**

This research was carried on oil and gas industry in Nigeria Using department of petroleum resources as source of information regarding the level of fatality that emanated with the industry from 2013 to 2020.

Questionnaire were also distributed to private oil and gas company workers to verify their level of HSE compliance so as to assess the safety standard of the company. This would be based on safety indicators that may be private to the company. Results from the questionnaire would be analysed using excel spread sheet. . Figure 3 below shows priority safety indicators that would guide us in checking the performance of the industry's safety specifics.



Figure 3: Safety priority indicators for survey development guide

Process safety is an organized standard framework for management of the industry's operating systems integrity as well as processes that takes care of substances of hazardous component while Environmental safety refers to an organized system that monitors and enforces and manages all process that its malfunctions will expose the industries to possible environmental hazards that may incur clean up or remediation as well as specific government penalties for polluters. Furthermore, personal safety framework guides and directs operations like construction processes, driving operation, geophysical processes, lifesaving regulations, lifting and hoisting towards safety best practices for sustainable industrial development and economic breakthrough. The last which is transport safety framework, guides and directs all transport operations, both aviation and land transport towards favourable best safety practices that would reduce accidents occurrences to the barest minimum. IOGP [15] Report 690, stated in the Offshore Helicopter Recommended Practices (OHRP) that practices capable of assisting safe, effective, and efficient management of offshore commercial helicopter transport operations that contains industry best practices that was collaboratively developed between Oil and Gas Companies, Aviation Industry Associations, and Helicopter Operators and it is expected that adoption such framework will enforce effective management of major material risk that may expose offshore personnel to safety issues.

Development of sustainable framework would be done through understudying the already existing frameworks based on oil and gas industry safety reports that yielded the numbers of accidents and fatalities in the companies. This would help us to find a means of filling the gaps that caused high number of fatality casualties to be recorded over time in the oil and gas sector in Nigeria and further develop a sustainable framework that would ameliorate the situation. This is required because, despite the fact that there is an existing framework, high level fatalities are still recorded by the oil and gas sector in the past years and it calls for serious concern which should incorporate environmental safety because of its potency in reducing all dispersing environmentally related ill health on all exposed workers to environmental related hazards. Thus, Pinskaya et al [16] stated that, in critical analysis of the content in developing methods of industrial enterprises within environmental systems, they made identification of the importance taking into consideration, strategies that showcases current stage in environmental responsibility differentiated by the desirability scale, and environmental living conditions in where these enterprises are located. This will help all stake holders to monitor, regulate and enforce Environmental regulatory compliance for sustainable HSE systems in the oil industries.

#### 4 Results

Table 1 below displays records from department of petroleum resources DPR [17] oil and gas annual report emanating from HSE section on accident report industry-wide within 2010 to 2015.

**Table 1: Accident report industry-wide within (2010 to 2015)**

Incident Date	Incidents	Work Related	Non Work Related	Fatal Incidents	None Fatal Incidents	Work Related Fatal Incidents	Non Work Related Fatal Incidents	Fatality
2010	50	24	26	21	29	6	15	25
2011	53	29	24	19	34	6	13	19
2012	49	27	22	27	22	12	15	35
2013	57	29	28	18	39	7	11	30
2014	40	15	25	15	25	1	14	22
2015	49	24	25	32	17	14	18	86

Source: DPR Federal ministry of Petroleum (2015)

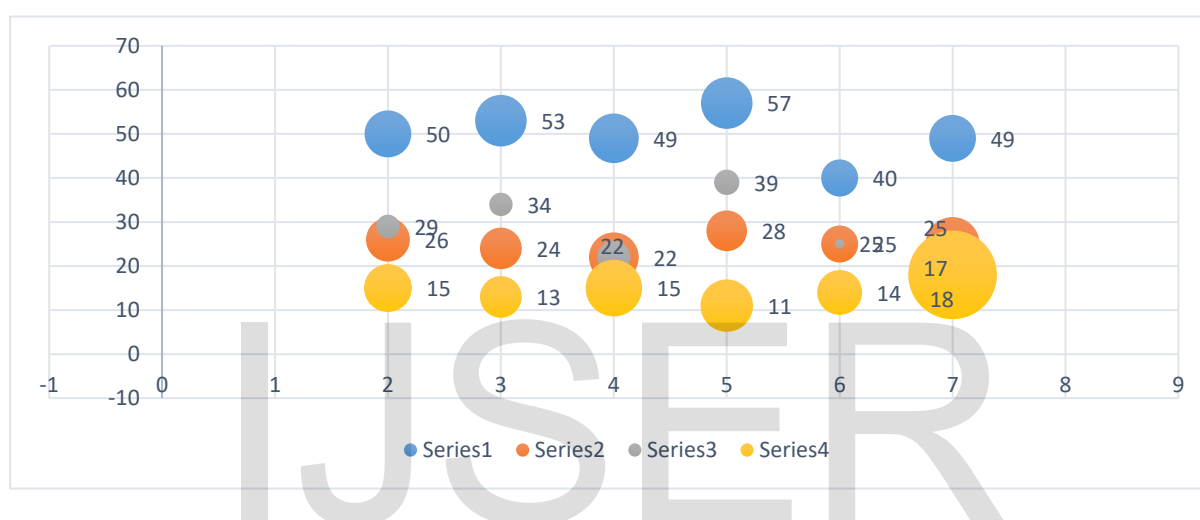


Figure 4: Accident report industry-wide within (2010 to 2015)

**Table 2: Accident Report – Upstream (2010-2015)**

Incident Date	Incidents	Work Related	Non Work Related	Fatal Incidents	Nonfatal Incidents	Work Related Fatal Incidents	Non Work Related Fatal Incidents	Fatality
2010	41	18	23	17	24	3	14	18
2011	44	21	23	17	27	5	12	17
2012	48	26	22	26	22	11	15	34
2013	45	17	28	16	29	5	11	28
2014	32	8	24	13	19	0	13	14
2015	35	11	24	23	12	6	17	50

Source: DPR Federal ministry of Petroleum (2015)

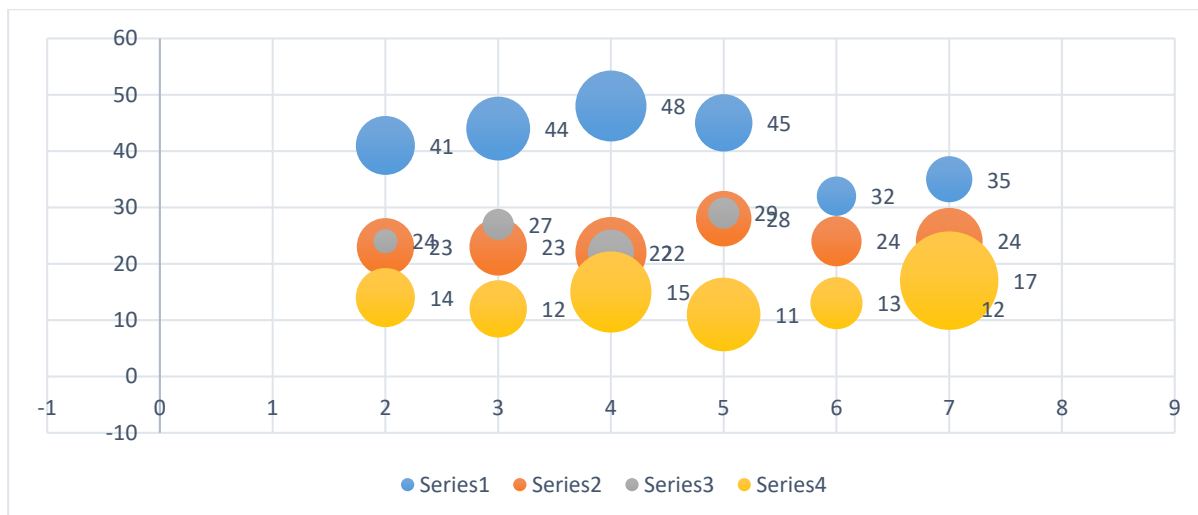


Figure 5: Upstream accident report 2010-2015

Table 3: Accident Report – Downstream (2010-2015)

Incident Date	Incidents	Work Related	Non Work Related	Fatal Incidents	Non Fatal Incidents	Work Related Fatal Incidents	Non Work Related Fatal Incidents	Fatality
2010	9	6	3	4	5	3	1	7
2021	9	8	1	2	7	1	1	2
2012	1	1	0	1	0	1	0	1
2013	12	12	0	2	10	2	0	2
2014	8	7	1	2	6	1	1	8
2015	14	13	1	9	5	8	1	36

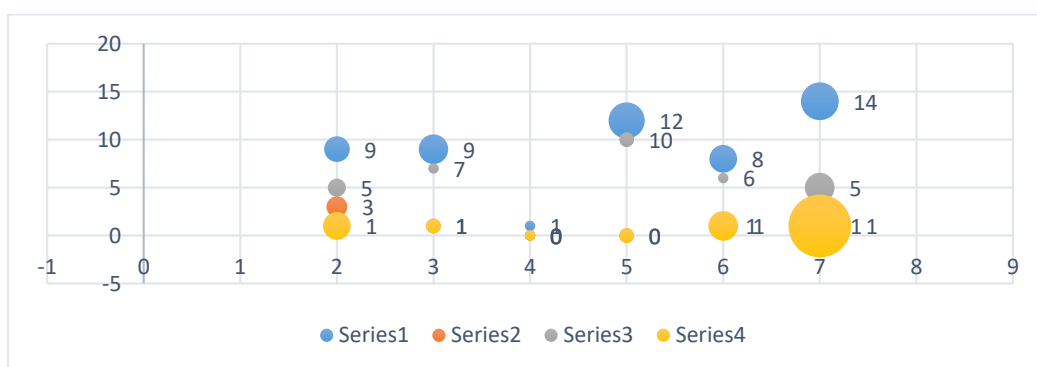


Figure 6 : Downstream accident report 2010-2015

Table 4: Oil spill Incidence summary Report

Year	Number of Spills	Quantity Spilled (Barrels)



<b>2010</b>	<b>537</b>	<b>17,658.10</b>
<b>2011</b>	<b>673</b>	<b>66,906.84</b>
<b>2012</b>	<b>844</b>	<b>17,526.37</b>
<b>2013</b>	<b>522</b>	<b>4,066.20</b>
<b>2014</b>	<b>1087</b>	<b>10,302.16</b>
<b>2015</b>	<b>753</b>	<b>32,756.8681</b>

Source: DPR Federal ministry of Petroleum (2015)

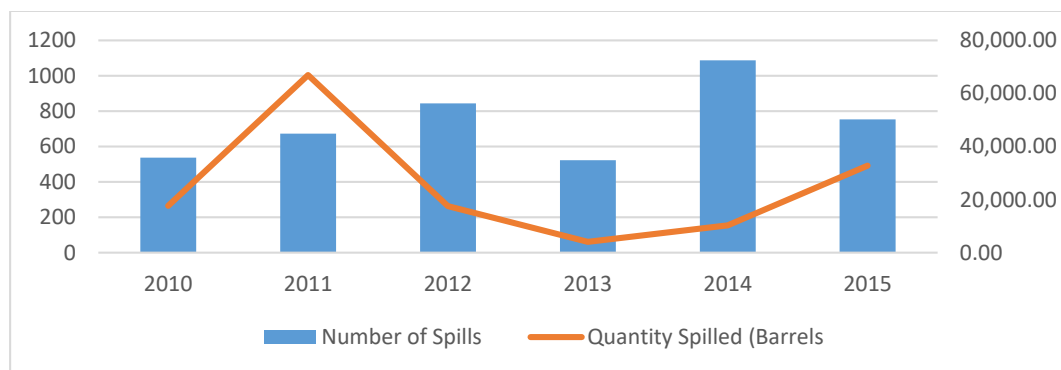


Figure 7: Number and Quantity of Oil spills, between 2010 to 2015 (Barrels)

Table 5: Total gas production, reinjection, utilized, flared and percentage gas flared

Year	Total Gas Production	Gas Reinjection	Total Gas Utilized	Total Gas Flared	Percentage Gas Flared
<b>2008</b>	2,580,396,612	507,947,176	1,909,610,576	670,786,036	26.00
<b>2009</b>	2,228,116,241	599,618,597	1,691,747,917	536,368,324	24.07
<b>2010</b>	2,819,681,845	751,705,008	2,274,953,012	544,728,832	19.32
<b>2011</b>	2,966,653,187	703,579,860	2,462,708,911	503,944,277	16.99
<b>2012</b>	2,996,036,072	724,648,283	2,530,779,433	465,256,639	15.53
<b>2013</b>	2,811,981,383	758,079,412	2,384,010,015	427,971,368	15.22
<b>2014</b>	3,048,546,486	808,503,665	2,654,706,650	393,839,836	12.92
<b>2015</b>	3,003,179,000	743,029,000	2,672,247,000	330,933,000	11.02

Source: DPR Federal ministry of Petroleum (2015)

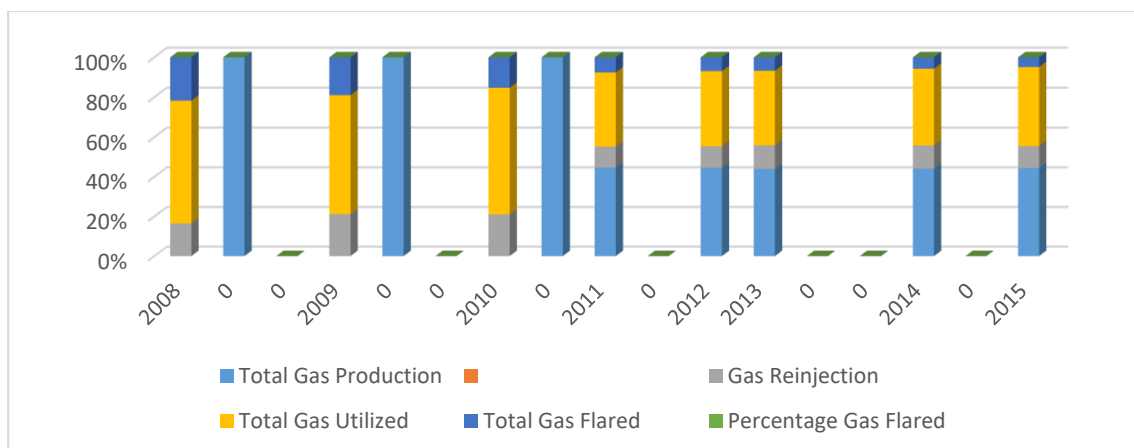


Figure 7: Total gas produced, utilized, re-injected, flared and percentage flare

**Table 6: Industrial safety compliance questionnaire based on safety compliance indicators**

Safety Indicators	Agree	Strongly Agree	Disagree	Strongly Disagree
Process safety	15	20	32	13
Environmental safety	12	23	29	16
Personnel safety	25	28	15	12
Transport Safety	14	17	22	27

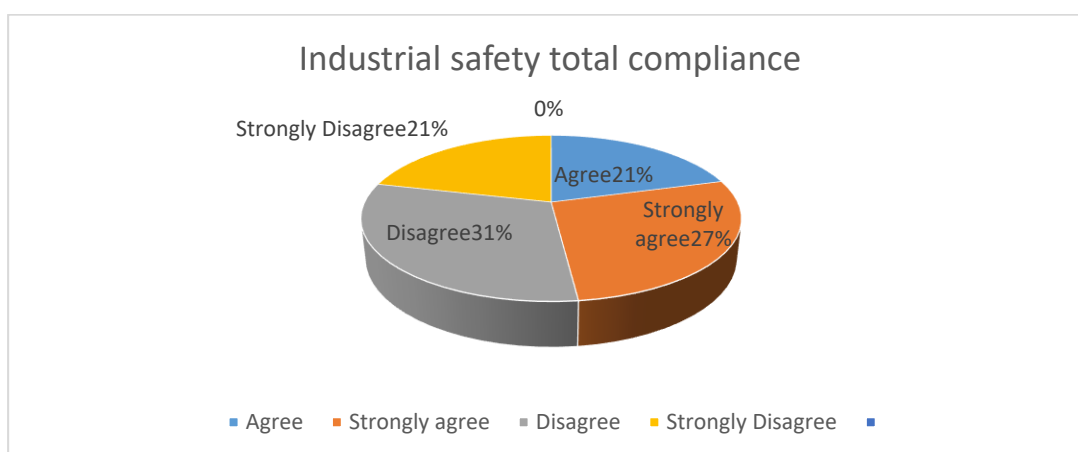


Figure 8: Industrial safety total compliance

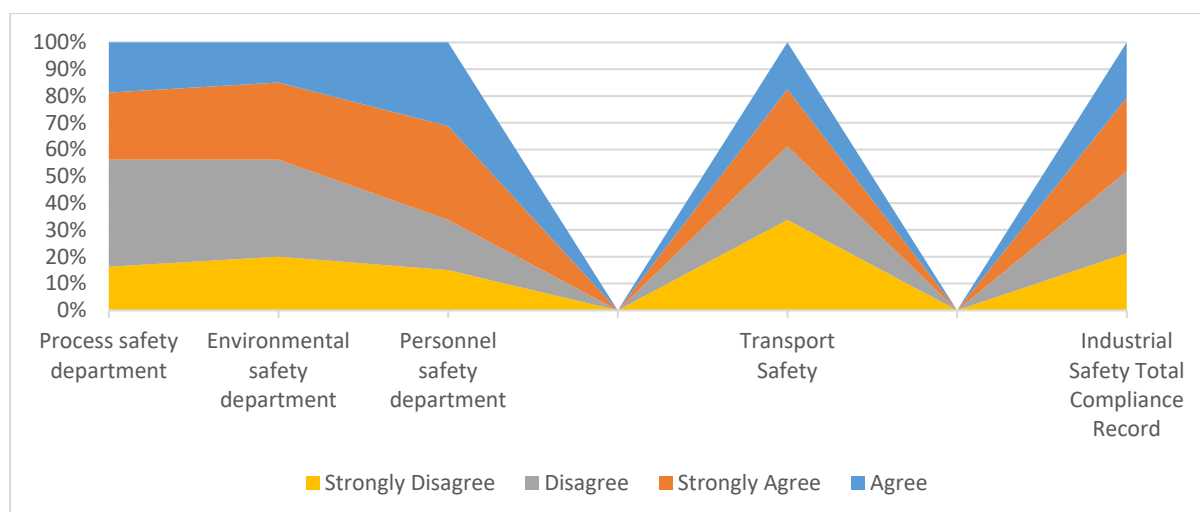


Figure 9: Percentage responses on safety compliance based on indicators

## 5 Discussion

The results secondary data for this research shows that industry wide accident report in 2010 was 50, 53 in 2011, 49 in 2012, 57, in 2013, 40 in 2014 and 49 in 2015 which show that the level of enforcement and compliance of HSE standard was not religiously applied and at such industrial accidents continued increasing as well as the level of fatality. Thus, the level of fatality increased from 25 in 2010 to 86 in 2015. The fatality report for upstream increased from 18 in 2010 to 50 in 2015. Furthermore, downstream fatality report increased from 7 in 2010 to 36 in 2015. Meanwhile, report on oil spill incident summary shows the same trend of increase in 2010 which was 17,658.10 barrels, in 2011, it was 66,906.84 barrels in 2012 it was 17,526.37 barrels in 2013, 4,066.20 barrels in 2014 it was 10,302.16 barrels and in 2015 it was 32,756.8681 barrels. This trend complied with the results from Questionnaire that verified industrial safety total compliance using safety priority indicators for survey development guide as benchmark. Results indicated that less than 21% agreed that there is total compliance in their industry, 27% strongly agreed, 31% disagreed and 21% strongly disagreed. These results show that the oil and gas industry HSE enforcement and compliance may not have been applied as required over the years and possibly, the existing HSE guidelines are not sustainably designed to drastically slash the rate of accidents and fatality. The percentage gas flared decreased from 26% in 2010 to 11.02% in 2015. Though it decreased but it was not also in compliance with the total flare out policy in Nigeria that has been stipulated before then. This result also showed a dimension of non-enforcement and compliance in the oil and gas industry.

This research would not be completed if we do not develop sustainable HSE guideline for oil and gas facility development project for Nigeria since there has been record of high industrial fatality related to accidents and other industrial hazards despite the existing regulations for HSE in the oil and gas industries. This submission is recommended to be considered in HSE management Department for sustainable efficient operational HSE management systems so as to drastically reduce oil and gas industrial operations process fatality related accidents as well as other hazards that may be associated with all departments in the oil and gas industry. Figure 8 below shows sustainable HSE guideline.

## 6 Formulation of sustainable HSE guideline for oil and gas facility development project

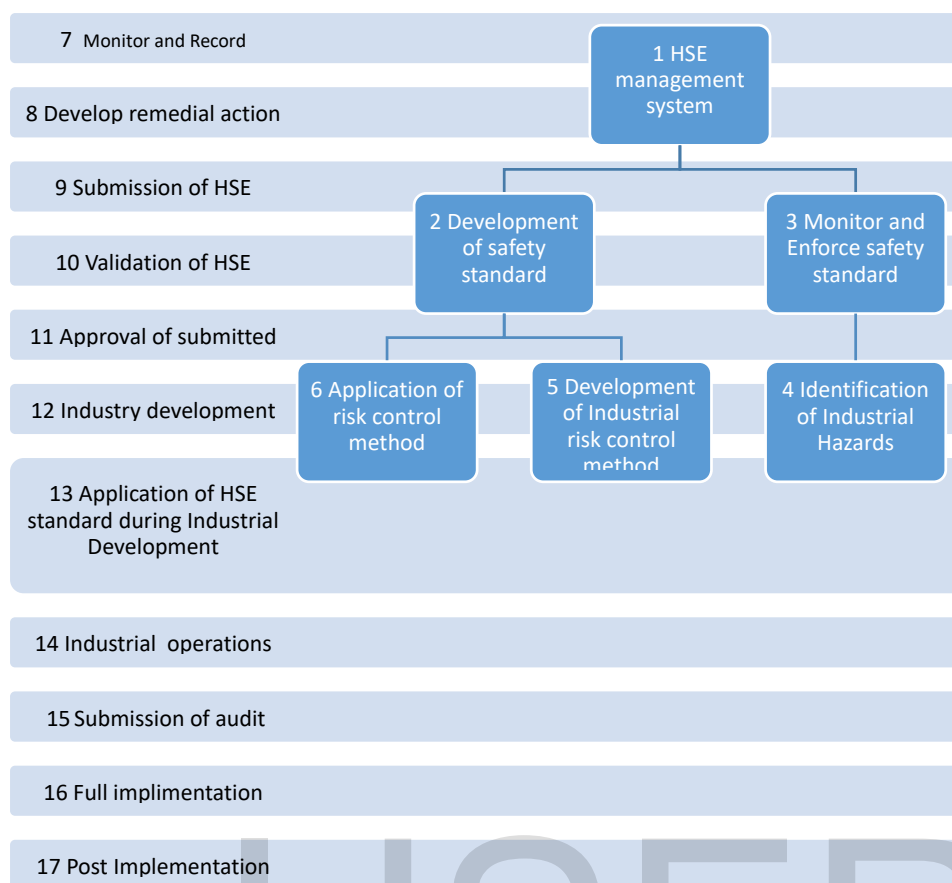


Figure 10: Formulation of sustainable HSE guideline for oil and gas facility development project

## 7 Responsibilities associated with sustainable HSE guideline for oil and gas facility development project.

HSE management system entail the involvement management system administrators who will be responsible of all sustainable HSE management and administration. These HSE administrators will take care of development of safety quality standard that would be applicable in the oil and gas industry. These HSE administrators will also develop HSE enforcement by regulatory body that will monitor and enforce compliance of safety standard while this enforcement and regulatory body will do the job of Identification of industrial hazards for notification to oil gas workers. The regulatory body will also develop an industrial risk control method and this risk control strategy will be adopted by the company for use in controlling risk of exposure to industrial hazards. Furthermore, monitoring and record of exposure to Risk of accident will be carried out for quality assurance purposes after which remedial action plan will be developed to strategize on how to remedy situations of accident for workers. Then the HSE documents containing all the above processes will be submitted to relevant regulatory agency. These submitted HSE documents will have to be validated to ascertain the possibility of the document becoming effectively functional when put into industrial use. This is expected to be done by the government agency responsible for all HSE standards in the state and as soon as the validation is concluded with positive outcome, approval of submitted document will be given for use by the industry. This will then be part of the document that oil and gas development industries will rely on for HSE certification for Industrial development. These HSE standard will then be applied during industrial operations while such application of HSE standard methods of operation will minimise accident and fatality. Furthermore, Industrial operations audit for HSE compliance will

be established to allow Auditors verification of HSE compliance in the oil and gas industry while submission of audit report and recommendation for continuity or restriction order will be done then, document containing audit report submission will be presented to stakeholders who will apply report recommendation on industry workers that may have defaulted to reduce accident to a highly minimal level. Therefore, once all the above mentioned processes are completed, full implementation of HSE regulation for oil and gas facility development project will kick off while post implementation stage will be carried out to ensure sustainability of HSE standard method of operation in the oil and gas industries in Nigeria.

Considering the United Nations sustainability Framework [18] Formulation of sustainable HSE guideline for oil and gas facility development project was done using Identify drivers of action on HSE sustainability for effective new HSE sustainability strategy through performance of self-assessment to establish the state of HSE sustainability in oil and gas industry and indicate chances of adoption of new HSE sustainability strategy through development of action plan for effective new HSE sustainability option by Identification and assembling the new HSE sustainability structure.

## **8 Conclusion**

This research has therefore, achieved developing a sustainable health safety and environmental framework for Nigeria's oil gas sector that is expected to drastically reduce the high rate of industrial accidents linked to fatality. Different safety indicators, like environmental, personnel safety, process safety and transportation safety were also identified. Lapses that trigger these accidents as well as endanger lives of workers, their health and environment at large were also verified. This verification gave us advantage during development of sustainable framework that would be exemplary towards achievement of HSE best practice of standard of operation that would help to reduce exposure to risk of death and industry related hazards that triggers heavy injuries thereby reducing the morale of workers and corresponding economic output in the oil and gas sector. Therefore, already existing HSE situation analysis was also carried out to help in validating its' compatibility with global best practices. It was also verified that oil and gas industries still have high records of fatalities in line with their operations despite the fact that HSE specifications are still in place and operational in the industry. HSE enforcement in these industries was quite low which may have been the reason for regular occurrence of fatal accidents in the industry. Thus if enforcement of HSE specifications was actually working as expected, it would enhances successful workflow for high productivity and economic output. Therefore it became very vital to develop a sustainable HSE standard practice strategy as a sustainable framework in the oil and gas industry.

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