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ORIGINAL RESEARCH ARTICLE

Safety Precaution Mechanism and Evaluation Model

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ABSTRACT

The increase in the human population raises some fundamental questions about the human ability to protect and take care of its safety. From the foundation of time, humans have demonstrated skills for sustainability. In doing this, there is always a high level of concern about the hazardous nature of the environment. These hazards have hitherto led to severe injuries or death among workers. One key area of the world economy is the oil and gas of which Nigeria as a nation sustained its yearly budget. This model, as developed, addresses and proffers solutions to the safety of lives as it affects the oil and gas industry staff with a heavy focus on those directly on the field. To solve this, this model employed some research measures, such as a questionnaire, to ascertain the gravity of the hazardous nature of the oil and gas industries. The data obtained were subjected to critical evaluation, as seen in the result Table 12, and the result shows an improved performance among the examined oil and gas firms in safety management. The data received aided the design and implementation of a safety precaution execution and evaluation model strong enough to mitigate hazards associated with the operational states of staff in the oil and gas industries.

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INTRODUCTION

The central tendency of a workforce is the measures taken to ensure safety. No individual would like to be seen as taking risks that would naturally impair their safety as well as the family he/she represents. The aim of a higher percentage of staff in the oil and gas industries is centered on family needs, and to ensure sustainability, safety is seen as the first critical area of focus by any systems that require a workforce to deliver on the production chain. The negligence of safety precautions by some oil and gas firms has led to untimely death or severe injuries among breadwinners and has further created a serious problem for society. Due to the prevailing circumstances existing within the oil and gas industries, this work developed a model through a critical review of the operational state of the oil and gas industries in Nigeria. As discussed in Osagie and Imoudu (2023), it was attested that safety management is a systematic approach that outlines and stipulates inform of guidelines to mitigate injuries from hazardous equipment and chemicals worth enough to cause serious damage or accidents to the workforce. The keynote to the above assertion is on the need for different industries to critically ensure that safety guidelines become one of the components of the daily transaction decision. The safety of any organization is a priority choice of any management decision to offer the best safety system to all concerned. The safety of staff should be seen as the responsibility of all, and this is because no incentive can replace the actual well-being of any employee. Injuries associated with oil and gas industries are considered high-risk injuries. The Injuries can lead to the death of the staff or make such staff disabled (non-productive) (Adebiyi *et al.,* 2018; Agyekum *et al.,* 2022).

In the work carried out by Ali *et al.* (2022), they evaluated the effectiveness of a safety management system (SMS) in a liquefied natural gas company. Emphasis was on key questions from respondents using a questionnaire that has a scaling pattern of "strongly disagree to strongly agree". The understanding of workers in this regard was retrieved as primary data to know the end product of the safety management system in the organization. The foundation of the index perception, Occupational threshold of the Health and Safety Impost Succession of the internal checklist were key components employed in validating the compliance state as it relates to the SMS. The robustness of the work was seen from the data collection which involves primary and secondary data. For the secondary data, relevant materials of the safety report were subjected to statistical evaluations. At the end of the work, The work revealed that there was synergy in its operation as

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the safety performance and compliance was 91%, health, and safety policy was seen to be 95%, planning was 93%, the work showed that implementation and operation have 98% while audit rate was seen to be 98%; however, management review was tagged 93%. The state of compliance ratio earned 95%. Further classifications revealed that 100 respondents were involved and classified as 64 males and 36 females, and given the total of the responses, the technical personnel and nontechnical personnel were 68 and 32, respectively. After critical evaluation, it was seen that the feedback review was 4,113, and this was based on the result of the staff awareness of the state of safety satisfaction; 4,182 agreed on the state of training level and competence, 4,212 revealed the safety reporting guidelines and investigation, with 3,989 okay the work pressure, on management attitude to commitment it was rated 4.098; safety communication has it as 4.171; with 4,126 being the emergency level of response and state planning. Using the test mechanism (t-test) to measure the performance, it showed that no tangible attribute was on a significant level as it affected the males as well as the females. It further revealed the perception of skilled and non-skilled staff with $p > 0.05$. The R & C possibility table was used to unveil the synergy of safety performance and safety compliance level. The classification states it showed a clear result of a significant difference between the safety compliance level and the level of the safety performance index. Therefore, a safety management system will continuously improve safety performance. Their work is a clear guide to the author's safety precaution model as proposed because it would aid employers in knowing that the effectiveness of a safety management system is key to the sustainable state of any organization (Chen *et al.*, 2022; Chen *et al.*, 2017)

In a work by Adebiyi (2020), the combinatorial model for determining the best safety strategy was proposed. They employed a strategy for combination theory, having a cost advantage in creating monetary saving/loss preventions with an embedded cost prevention ratio strategically classified. In gathering relevant data, tools such as documentation, interviews, and structured questionnaires were used to collect information before-and-after safety program records from a tobacco company between the periods of 1993-2001(for pre-safety) and 2002-2008 (safety period) for the model application. They further classified their finding through three key structures of combinatorial alternatives A, B, and C and translated them to 4, 6, and 4 guidelines as they involve Personal Protective Equipment (PPE). On A training procedures, 724 accidents were carefully articulated and recorded, and this covered 9 9-year duration period of the pre-safety program, and a direct accident of 163 in 7 years was articulated as well during the safety program. Six alternative B prevention activities were evaluated as the best proactive results. Nevertheless, except for the year 2004, the study provides professional experience for planning a successful safety guideline (Duryan *et al.*, 2020; Fargnoli *et al.*, 2020; Fung *et al.*, 2012).

The construction industries have been mired with a series of injuries that would have been managed. Oil and Gas is a vast industry that comprises different engineering departments. The units cut across several departments such as water engineering, marine engineering, fabrication engineering, construction engineering, etc., of review, is the safety level of management in the ever-steady state of construction, and it isn't very easy because construction activities are predominantly complex. A study unveiled by Winge *et al.* (2019) identified safety management factors ranging from risk management itemization and onsite management to contextual factors such as organizational value-chain complexity and combinations of factors of the safety performance index. They critically selected twelve defined construction project works in other to know the safety management state and safety level of performance strategy. Based on the definition, an analytical framework was used as qualitative comparative tool analysis (QCA), the idea was to do a comparative study to identify connections strength in between safety performance and factors. The material analyzed cut across planning documents, the construction, OHS-inspections reports, safety guide indicators, project leaders interviewers and experts from OHS. (Gong *et al.*, 2021; Gunduz and Khader 2020; Harden *et al.*, 2021). The findings indicated that:

(a) the higher safety level performance outweighs the project with an average score of 12 when put in close comparison with low-level safety performance

(b) high safety performance level has a direct impact complexity collaboration synergy of construction with the complexity level of organizational

(c) it is revealed that arriving at a high-level performance index can be a function of relatively not to efficient performance safety management factors

(d) for performance rating, safety management factors were summed to be eight roles for high safety level performance, which include:

1. defined parts and tasks,
2. plan,
3. OHS team synergy,
4. level of safety climate,
5. learning strategy,
6. site functionality management,
7. staff orientation management,
8. risk classification management.

On reasons for comparative strategy, site functionality management, risk classification management, and staff orientation management are key factors that determine the safety performance level. It is believed that high safety performance synergy is required and needed for safety management level factors such as contextual factors level and a combination factor index (Kang *et al.*, 2021; Keurentjes *et al.*, 2021).

Dele *et al.* (2020) asserted that Safety management program activities (SMPs) are key programs developed to bring about risk reduction among workforce injuries and hitherto bring about smooth working conditions amongst staff. In the work, evaluations were made to understand the relationship that exists between contractors' SMPs, workers' level of perceived safety climate attributes, and safety patterns or behaviors within small and medium-sized subcontractors. A program written to code the Subcontractor SMP scores of 18 organizations and project-level safety items were reviewed through interviews. The state of the subcontractor safety was carried out to know the perception of climate and the safety behaviors of staff members. The associations between SMP scores, safety climate, and behavior were examined using a synergetic Spearman correlation and hierarchical linear regression models (HLM) guidelines. In the end, 78 subcontractors working on large commercial construction projects revealed that the differences in the SMP scores for small, medium, and large subcontractors ($p < 0.001$) are directly related to a number of safety management level practices. Hence, the attestation of weak relationships between SMP scales and safety climate score levels acclaimed by 746 workers ($\beta = 0.09$, $p = 0.04$ by HLM). In the work, it was shown that the safety climate and safety behaviors have little or no significant difference on the contractor size as SMP predicted safety climate scales of subcontractors weakly, thereby revealing a large difference in the quality and content of SMPs (Machida 2012; Mkungunugwa *et al.*, 2022).

Developed countries have seen a declined in the hazardous state of the workforce, and this is owed to the need by different industries and regulating bodies in entrenching relevant rules that have constantly aided the review of the health care and safety systems of the workforce. It is understood that safety precaution is something that requires routine review in order to further improve OHS management systems. A similar work by Duryan *et al.* (2020) unveiled factors that facilitate the principle of occupational health systems of knowledge transfer between organizations. An interpretative procedure was employed for implicit knowledge transfer and application. At the end of the study, inconsistency was seen in the OHS practice as it affects organizations. They further stressed the need for a positive safety culture that teaches and encourages the transfer of lessons learned through active participation (Jaafar *et al.*, 2020).

MATERIAL AND METHOD

The model as proposed has some constraints, and to reduce the developmental constraint, a strategic method was employed to build each component of the proposed model. A structural procedure approach was outlined as a plan for the developmental control method. The work as proposed has several interwoven modules where a phase must be actualized to full functionality before the activation of the next phase. The design model is encapsulated with several variables that must be considered as a standalone entity before incorporation. The author considers the waterfall model as one aspect of the linear model of full completion of a phase. The waterfall is seen as a perfect model for the safety precaution execution and evaluation model for oil and gas industries

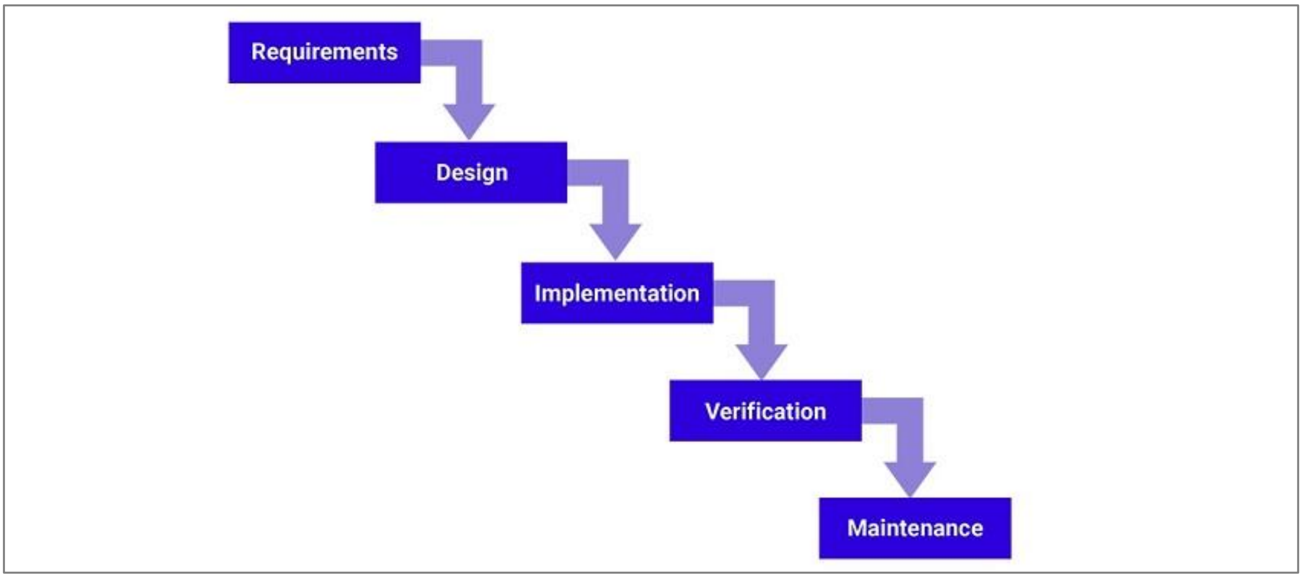

Figure 1: Waterfall model (Osagie and Imoudu 2023)

As a structured linear model, making development through it creates easy-to-go steps for defining variables and requirements constrains.

Data Source

The method employed was a combination of a survey through the instrument of a questionnaire to collect data from the staff of four (4) oil companies operating in Nigeria to answer the research questions. Two (2) of the four (4) oil companies are indigenous oil companies, and the other two (2) are foreign oil companies operating on the shores of Nigeria. The criteria used in the selection of the companies were based on the track record of NPDC, IDSL, BGP and SHELL in Oil and Gas related business. The method focused on a random selection of staff from various departments of the companies; the author did not limit the respondent's safety department alone. Assurance was one aspect given during the survey. It was assured that their identity would be kept from the public domain as the findings output were the main reasons for the research work. The questionnaire consists of a set of restricted questions for respondents to make choices. The questions include the company's safety: whether safety-related training is provided for those working in a hazardous environment, provision of safety equipment (personal protective equipment), whether managers discuss safety issues with workers on the sight of operation, and as well as whether workers in the critically safer environment actually comply with safety regulations. The questionnaires consist of a five-point (Likert scale) in which the different options are assigned numerical values from 5 to 1. With the help of the questionnaires, relevant information(s) concerning the safety of the workforce in the oil and gas industries was updated.

System Analysis

To develop this system, one important aspect that required a holistic approach was to understand how the current system works because the analysis of the current system would spring forth the proposed system. The author did a holistic aspect of the work by classifying the study into accident prevention training, safety policies, encouragement on safety precaution on duties, mode of filing hazardous reports, responses to injuries when they occur, any company professional on safety precaution management and hard document that support how safety must be implemented during and after work. These responses to the structured questions were adequately analyzed through the responses from the respondents to ascertain the level of company strategies. At the end of the analysis of the information provided, it was clear that several companies, though they have a safety department, lack the will to protect the workforce by sharing valuable information that can help another establishment to mitigate serious workforce injuries. Beyond the needed provision of personal protection equipment (PPE), many of the surveyed companies have regulatory bodies that barely know anything within these companies because issues of such are usually hidden from them, hence the lack of adequate information to aid the regulatory bodies (He *et al.*, 2012).

Generated Data

The data was generated from a questionnaire given to ten (10) randomly selected staff from each of four (4) oil companies operating in Nigeria and from the respective experimental factors. $x_1, x_2, \ldots, x_4$.

Tables 1 – 4 represent the coded levels and experimental factors for NaPDC, IDSL, BGP, and SHELL actual responses generated from distributed questionnaires.

Table 1: Experimental coded level for RSM data NPDC

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for NPDC
1	0	0	0	0	10
2	0	0	0	0	10
3	-1	1	1	1	10
4	-1	1	-1	1	10
5	-1	1	1	-1	10
6	-1	1	-1	-1	10
7	1	1	-1	1	10
8	1	1	-1	-1	10
9	1	-1	1	1	9
10	1	-1	-1	1	9
11	1	-1	1	-1	11
12	1	1	1	-1	9
13	1	1	1	1	11
14	-1	-1	1	-1	10
15	0	0	0	0	8
16	1	-1	-1	-1	10

To be continued next page

Table 1 Continued

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for NPDC
17	0	0	0	0	10
18	-1	-1	1	1	10
19	-1	-1	-1	-1	10
20	-1	-1	-1	1	10
21	0	0	2	0	10
22	0	-2	0	0	10
23	2	0	0	0	10
24	0	0	-2	0	10
25	0	0	0	-2	10
26	0	2	0	0	10
27	0	0	0	0	10
28	0	0	0	0	10
29	2	0	0	0	10
30	0	0	0	2	10

Table 2: Experimental coded level for RSM data IDSL

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for IDSL
1	0	0	0	0	10
2	0	0	0	0	10
3	-1	1	1	1	11
4	-1	1	-1	1	10
5	-1	1	1	-1	10
6	-1	1	-1	-1	10
7	1	1	-1	1	9
8	1	1	-1	-1	10
9	1	-1	1	1	10
10	1	-1	-1	1	9
11	1	-1	1	-1	10
12	1	1	1	-1	12
13	1	1	1	1	8
14	-1	-1	1	-1	10
15	0	0	0	0	10
16	1	-1	-1	-1	10
17	0	0	0	0	10
18	-1	-1	1	1	11
19	-1	-1	-1	-1	10
20	-1	-1	-1	1	10
21	0	0	2	0	9
22	0	-2	0	0	10
23	2	0	0	0	11
24	0	0	-2	0	10
25	0	0	0	-2	9
26	0	2	0	0	10
27	0	0	0	0	10
28	0	0	0	0	10
29	-2	0	0	0	10
30	0	0	0	2	10

Table 3: Experimental coded level for RSM data BGP

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for BGP
1	0	0	0	0	10
2	0	0	0	0	9
3	-1	1	1	1	11
4	-1	1	-1	1	10
5	-1	1	1	-1	10
6	-1	1	-1	-1	10
7	1	1	-1	1	10

To be continued next page

Table 3 Continued

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for BGP
8	1	1	-1	-1	10
9	1	-1	1	1	10
10	1	-1	-1	1	9
11	1	-1	1	-1	10
12	1	1	1	-1	11
13	1	1	1	1	10
14	-1	-1	1	-1	9
15	0	0	0	0	11
16	1	-1	-1	-1	10
17	0	0	0	0	9
18	-1	-1	1	1	10
19	-1	-1	-1	-1	10
20	-1	-1	-1	1	10
21	0	0	2	0	10
22	0	-2	0	0	10
23	2	0	0	0	10
24	0	0	-2	0	`10
25	0	0	0	-2	11
26	0	2	0	0	9
27	0	0	0	0	9
28	0	0	0	0	10
29	-2	0	0	0	10
30	0	0	0	2	10

Table 4: Experimental coded level for RSM data SHELL

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for SHELL
1	0	0	0	0	9
2	0	0	0	0	11
3	-1	1	1	1	10
4	-1	1	-1	1	10
5	-1	1	1	-1	10
6	-1	1	-1	-1	10
7	1	1	-1	1	10
8	1	1	-1	-1	11
9	1	-1	1	1	9
10	1	-1	-1	1	10
11	1	-1	1	-1	10
12	1	1	1	-1	10
13	1	1	1	1	10
14	1	1	1	-1	10
15	0	0	0	0	10
16	1	-1	-1	-1	10
17	0	0	0	0	10
18	-1	-1	1	1	10
19	-1	-1	-1	-1	9
20	-1	-1	-1	1	10
21	0	0	2	0	9
22	0	-2	0	0	10
23	2	0	0	0	10
24	0	0	-2	0	10
25	0	0	0	-2	10
26	0	2	0	0	10
27	0	0	0	0	10
28	0	0	0	0	10
29	-2	0	0	0	10
30	0	0	0	0	10

Central Composite Design (CCD) transformation to RSM

The nonparametric evaluation of regression techniques in RSM had the explanatory variables coded as 0 and 1. Hence, the mathematical relation of the Central Composite Design (CCD) transformed as follows:

$$x_{new} = \frac{Min(x_{old}) - x_0}{(Min(x_{old}) - Max(x_{old}))} \qquad (1)$$

the transformed data value isx_{new}, x_0 is the exact value for the transformation vector coded as old value, with representation as x_{old}, Min (x_{old}) and $Max(x_{old})$ being minimum and maximum coded values in vector x_{old} . The exact coded variables in Tables 3- 5 are transformed to explanatory variables in Tables 6 - 9 using equation (1). Target points for the coded variables are transformed for location 4 as seen below:

Target points $x_0: -1, 1, -1, 1; Min(x_{old}): -2, -2, -2, -2;\ Max(x_{old}): 2, 2, 2, 2$

$$x_{new} = \frac{Min(x_{old}) - x_0}{\left(Min(x_{old}) - Max(x_{old})\right)}$$

$$Explanatory\ variable\ x_1\ :\ x_{41} = \frac{-2 - (-1)}{((-2) - (2))} = 0.2500$$

$$Explanatory\ variable x_2\ :\ x_{42} = \frac{-2 - (1)}{((-2) - (2))} = 0.7500$$

$$Explanatory\ variable x_3\ :\ x_{43} = \frac{-2 - (-1)}{((-2) - (2))} = 0.2500$$

$$Explanatory\ variable x_4\ :\ x_{44} = \frac{-2 - (1)}{((-2) - (2))} = 0.7500$$

The exact point transformation for the new location 23 on the coded variables is seen as:

Target points $x_0: 2, 0, 0, 0, 0; Min(x_{old}): -2, -2, -2, -2;\ Max(x_{old}): 2, 2, 2, 2$

$$x_{new} = \frac{Min(x_{old}) - x_0}{\left(Min(x_{old}) - Max(x_{old})\right)}$$

$$Explanatory\ variable\ x_1\ :\ x_{23,1} = \frac{-2 - (2)}{((-2) - (2))} = 1.0000$$

$$Explanatory\ variable x_2\ :\ x_{23,2} = \frac{-2 - (0)}{((-2) - (2))} = 0.5000$$

$$Explanatory\ variable x_3\ :\ x_{23,3} = \frac{-2 - (0)}{((-2) - (2))} = 0.5000$$

$$Explanatory\ variable x_4\ :\ x_{23,4} = \frac{-2 - (0)}{((-2) - (2))} = 0.5000$$

On an iterative steps of multiple process says 30 gives the exact entries of the explanatory variables asx_1,x_2,x_3 and x_4 respectively in Tables 5 – 8 (NPDC, IDSL, BGP and SHELL) representing transformed RSM data between zero and one.

Transformation RSM

Table 5, 6, 7 and 8 are Transformation RSM for NPDC, IDSL, BGP and Shell respectively

Table 5: Transformed experimental coded level for RSM data NPDC

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for NPDC
1	0.5000	0.5000	0.5000	0.5000	10
2	0.5000	0.5000	0.5000	0.5000	10
3	0.2500	0.7500	0.7500	0.7500	10
4	0.2500	0.7500	0.2500	0.7500	10
5	0.2500	0.7500	0,7500	0.2500	10
6	0.2500	0.7500	0.2500	0.2500	10
7	0.7500	0.7500	0.2500	0.7500	10
8	0.7500	0.7500	0.2500	0.2500	10
9	0.7500	0.2500	0.7500	0.7500	9
10	0.7500	0.2500	0.2500	0.7500	9
11	0.7500	0.2500	0.7500	0.2500	11
12	0.7500	0.7500	0.7500	0.2500	9
13	0.7500	0.7500	0.7500	0.7500	11
14	0.2500	0.2500	0.7500	0.2500	10
15	0.5000	0.5000	0.5000	0.5000	8

To be continued next page

Table 5 Continued

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for NPDC
16	0.7500	0.2500	0.2500	0.2500	10
17	0.5000	0.5000	0.5000	0.5000	10
18	0.2500	0.2500	0.7500	0.7500	10
19	0.2500	0.2500	0.2500	0.2500	10
20	0.2500	0.2500	0.2500	0.7500	10
21	0.5000	0.5000	1.0000	0.5000	10
22	0.5000	0.0000	0.5000	0.5000	10
23	1.0000	0.5000	0.5000	0.5000	10
24	0.5000	0.5000	0.0000	0.5000	10
25	0.5000	0.5000	0.5000	0.0000	10
26	0.5000	0.5000	0.5000	0.5000	10
27	0.5000	0.5000	0.5000	0.5000	10

Table 6: Transformed experimental coded level for RSM data IDSL

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for IDSL
1	0.5000	0.5000	0.5000	0.5000	10
2	0.5000	0.5000	0.5000	0.5000	10
3	0.2500	0.7500	0.7500	0.7500	11
4	0.2500	0.7500	0.2500	0.7500	10
5	0.2500	0.7500	0.7500	0.2500	10
6	0.2500	0.7500	0.2500	0.2500	10
7	0.7500	0.7500	0.2500	0.7500	9
8	0.7500	0.7500	0.2500	0.2500	10
9	0.7500	0.2500	0.7500	0.7500	10
10	0.7500	0.2500	0.2500	0.7500	9
11	0.7500	0.2500	0.7500	0.2500	10
12	0.7500	0.7500	0.7500	0.2500	12
13	0.7500	0.7500	0.7500	0.7500	8
14	0.2500	0.2500	0.7500	0.2500	10
15	0.5000	0.5000	0.5000	0.5000	10
16	0.7500	0.2500	0.2500	0.2500	10
17	0.5000	0.5000	0.5000	0.5000	10
18	0.2500	0.2500	0.7500	0.7500	11
19	0.2500	0.2500	0.2500	0.2500	10
20	0.2500	0.2500	0.2500	0.7500	10
21	0.5000	0.5000	1.0000	0.5000	9
22	0.5000	0.0000	0.5000	0.5000	10
23	1.0000	0.5000	0.5000	0.5000	11
24	0.5000	0.5000	0.0000	0.5000	10
25	0.5000	0.5000	0.5000	0.0000	9
26	0.5000	1.0000	0.5000	0.5000	10
27	0.5000	0.5000	0.5000	0.5000	10
28	0.5000	0.5000	0.5000	0.5000	10
29	0.0000	0.5000	0.5000	0.5000	10
30	0.5000	0.5000	0.5000	1.0000	10

Table 7: Transformed experimental coded level for RSM data BGP

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for BGP
1	0.5000	0.5000	0.5000	0.5000	10
2	0.5000	0.5000	0.5000	0.5000	9
3	0.2500	0.7500	0.7500	0.7500	11
4	0.2500	0.7500	0.2500	0.7500	10
5	0.2500	0.7500	0.7500	0.2500	10
6	0.2500	0.7500	0.2500	0.2500	10
7	0.7500	0.7500	0.2500	0.7500	10
8	0.7500	0.7500	0.2500	0.2500	10
9	0.7500	0.2500	0.7500	0.7500	10

To be continued next page

Table 7 Continued

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for BGP
10	0.7500	0.2500	0.2500	0.7500	9
11	0.7500	0.2500	0.7500	0.2500	10
12	0.7500	0.7500	0.7500	0.2500	11
13	0.7500	0.7500	0.7500	0.7500	10
14	0.2500	0.2500	0.7500	0.2500	9
15	0.5000	0.5000	0.5000	0.5000	11
16	0.7500	0.2500	0.2500	0.2500	10
17	0.5000	0.5000	0.5000	0.5000	9
18	0.2500	0.2500	0.7500	0.7500	10
19	0.2500	0.2500	0.2500	0.2500	9
20	0.2500	0.2500	0.2500	0.7500	10
21	0.5000	0.5000	1.0000	0.5000	10
22	0.5000	0.0000	0.5000	0.5000	10
23	1.0000	0.5000	0.5000	0.5000	10
24	0.5000	0.5000	0.0000	0.5000	10
25	0.5000	0.5000	0.5000	0.0000	11
26	0.5000	1.0000	0.5000	0.5000	9
27	0.5000	0.5000	0.5000	0.5000	9
28	0.5000	0.5000	0.5000	0.5000	10
29	0.0000	0.5000	0.5000	0.5000	10
30	0.5000	0.5000	0.5000	1.0000	10

Table 8: Transformed experimental coded level for RSM data SHELL

Exptal. Run	X_1	X_2	X_3	X_4	Actual Response for SHELL
1	0.5000	0.5000	0.5000	0.5000	9
2	0.5000	0.5000	0.5000	0.5000	11
3	0.2500	0.7500	0.7500	0.7500	10
4	0.2500	0.7500	0.2500	0.7500	10
5	0.2500	0.7500	0.7500	0.2500	10
6	0.2500	0.7500	0.2500	0.2500	10
7	0.7500	0.7500	0.2500	0.7500	10
8	0.7500	0.7500	0.2500	0.2500	11
9	0.7500	0.2500	0.7500	0.7500	9
10	0.7500	0.2500	0.2500	0.7500	10
11	0.7500	0.2500	0.7500	0.2500	10
12	0.7500	0.7500	0.7500	0.2500	10
13	0.7500	0.7500	0.7500	0.7500	10
14	0.2500	0.2500	0.7500	0.2500	10
15	0.5000	0.5000	0.5000	0.5000	10
16	0.7500	0.2500	0.2500	0.2500	10
17	0.5000	0.5000	0.5000	0.5000	10
18	0.2500	0.2500	0.7500	0.7500	10
19	0.2500	0.2500	0.2500	0.2500	9
20	0.2500	0.2500	0.2500	0.7500	10
21	0.5000	0.5000	1.0000	0.5000	9
22	0.5000	0.0000	0.5000	0.5000	10
23	1.0000	0.5000	0.5000	0.5000	10
24	0.5000	0.5000	0.0000	0.5000	10
25	0.5000	0.5000	0.5000	0.0000	10
26	0.5000	1.0000	0.5000	0.5000	10
27	0.5000	0.5000	0.5000	0.5000	10
28	0.5000	0.5000	0.5000	0.5000	10
29	0.0000	0.5000	0.5000	0.5000	10
30	0.5000	0.5000	0.5000	1.0000	10

The role of the method practiced by the companies under the current system reviewed has inherent challenges, as seen from where the injured staff would have to make complaints of possible injuries through the filing mechanism of the traditional documentation and, after that, awaiting a response from the superior (Osagie and

Enehizena, 2023). Osagie and Imoudu (2023) proposed a new model titled "A Model for Performance Indices in Oil and Gas Industries." as seen in Figure 2, they opined that the entire workforce of the organization is expected to carry out their job functions in line with the company's laid down procedures and policies, having the understanding that "safety is everyone's business". They further explained that the entire staff, visitors and contractors are expected to work safely in the company's premises. It was further revealed in the same study that some procedures and policies guide workers on job specification. They discoursed that a deviation from this means staff is working outside the safety policies of the company. One aspect of the findings, as revealed by their work, is that documentation is the major information-gathering mechanism and a breakout from this could cost the company a fortune. From the work, they produced a clear cut of safety management through adequate documentation expected to be used via this proposed design model to critically evaluate the performance indices adherence.

The System

The system, as demonstrated in Figure 2, was a model proposed by Osagie and Imoudu (2023). The idea is born out of the fact that safety execution and evaluation have gone past onsite performance. To gain an understanding of how the system works, the work employs an integrated platform development strategy that aids the classification of each module into a distinct angle where a single system retrieves the data as shown in the input data against staff compliance. The home page gives a wider scope of what is expected by staff members, with several aspects of safety performance captured by the system designed. For an employee, the system provides an inclusive backend check to the functional policies, training, and reporting a protection synergy through a single entity.

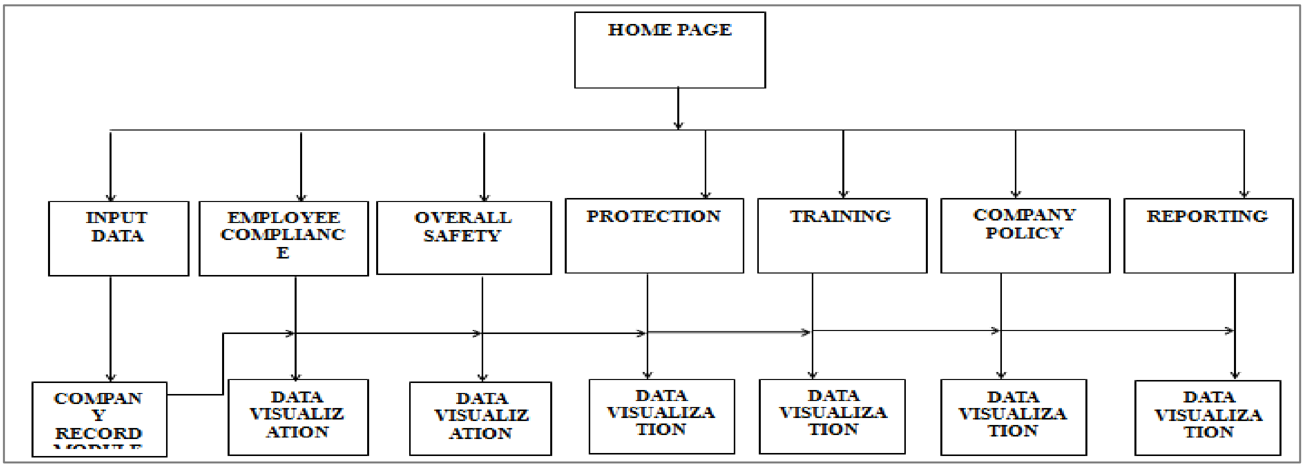

Figure 2: Central Composite Design (CCD) (Osagie and Imoudu., 2023)

The performance parameters are embedded in the computation classification to give a clear state of the safety design application with inherent attributes of a comparative analysis of the company's requirements. The criteria for comparing the state of safety procedure hinge on the overall performance execution and performance in training, provision of personal protective equipment (PPE), workers compliance, company's policy on safety, and personal awareness of the guidelines. This system, being all centered application, helps determine which company can be seen as employing the best safety performance. For better output, the linear regression approach authored by Akhideno and Eguasa (2022) was employed and adopted.

RESULTS/DISCUSSION

Local Linear Regression Predicted Results for NPDC and IDSL

The work, as examined and designed, carried out several evaluations to know the best active sate of the response to safety performance. As received, the data were sorted using a clear scientific approach. Each of the responses, as seen in Table 9, where NPDC and IDSL were comparatively analyzed through the local linear regression (LLR) method, validated the actual response clarity. In Table 9, four explanatory variables of actual response performance by NPDC and IDSL were obtained from the Local Linear Regression (LLR) model with fixed bandwidths. This approach was repeated in Table 10 using the four variable response criteria. A clear examination shows that the variable points x_1, x_2, x_3, and x_4 maintained a steady value at points 1-10, while NPDC y(1) at point 10 exceeds the value of IDSL at y(2) at point 10. At every response, the LLR clearly shows the distinction in the safety performance of both companies. For better clarity, a more detailed comparative approach was carried out with the four companies, as seen in Table 11, where a comparative approach was carried with the four companies on the performance indices.

Local Linear Regression Predicted Results for BGP and SHELL

In Table 10, four explanatory variables, actual responses for BGP and SHELL, and their respective predicted responses so obtained from the Local Linear regression (LLR) model with fixed bandwidths.

Local Linear Regression Residual Results for NPDC, IDSL, BGP and SHELL

Table 11 gives the respective residual errors obtained between the actual and the predicted responses for NPDC, IDSL, BGP and SHELL.

Local Linear Regression Goodness-of-Fit Results for NPDC, IDSL, BGP, and Shell

Table 12 shows the resulting fitness the statistics level for NPDC, IDSL, BGP, and SHELL on the LLR_{FB} where the SHELL on LLR_{FB} felt better than NPDC, IDSL, and BGP in terms of the results obtained, and IDSL safety management system has the poorest performance statistics. Obviously, SHELL safety management system is the best among the four oil companies considered in this study.

Table 9: Actual and Predictive Responses for NPDC and IDSL

Exp. Run	X_1	X_2	X_3	X_4	YACT$^{(1)}$ NPDC	YPRE$^{(1)}$ NPDC	YACT$^{(2)}$ IDSL	YPRE$^{(2)}$ IDSL
1	0.2500	0.2500	0.2500	0.2500	10	9.8937	10	9.9992
2	0.7500	0.2500	0.2500	0.2500	10	9.9109	10	9.9981
3	0.2500	0.7500	0.2500	0.2500	10	10.1265	11	10.9974
4	0.7500	0.7500	0.2500	0.2500	10	9.9001	10	10.0018
5	0.2500	0.2500	0.7500	0.2500	10	10.1202	10	9.9969
6	0.7500	0.2500	0.7500	0.2500	10	10.0015	10	9.9996
7	0.2500	0.7500	0.7500	0.2500	10	9.7859	9	9.0010
8	0.7500	0.7500	0.7500	0.2500	10	10.0187	10	9.9995
9	0.2500	0.2500	0.2500	0.7500	9	9.1568	10	10.0003
10	0.7500	0.2500	0.2500	0.7500	9	9.1203	9	9.0023
11	0.2500	0.7500	0.2500	0.7500	11	10.8060	10	10.0017
12	0.7500	0.7500	0.2500	0.7500	9	9.1445	12	11.9974
13	0.2500	0.2500	0.7500	0.7500	11	10.8183	8	8.0039
14	0.7500	0.2500	0.7500	0.7500	10	9.9997	10	10.0008
15	0.2500	0.7500	0.7500	0.7500	8	8.3139	10	9.9994
16	0.7500	0.7500	0.7500	0.7500	10	9.9631	10	10.0010
17	0.0000	0.5000	0.5000	0.5000	10	9.9822	10	9.9998
18	1.0000	0.5000	0.5000	0.5000	10	9.9642	11	10.9997
19	0.5000	0.0000	0.5000	0.5000	10	9.9822	10	9.9997
20	0.5000	1.0000	0.5000	0.5000	10	9.9642	10	10.0002
21	0.5000	0.5000	0.0000	0.5000	10	9.9642	9	9.0005
22	0.5000	0.5000	1.0000	0.5000	10	9.9822	10	9.9997
23	0.5000	0.5000	0.5000	0.5000	10	9.9795	11	9.9999
24	0.5000	0.5000	0.5000	0.5000	10	9.9795	10	9.9999
25	0.5000	0.5000	0.5000	0.0000	10	10.0212	9	9.5007
26	0.5000	0.5000	0.5000	1.0000	10	9.9379	10	10.4991
27	0.5000	0.5000	0.5000	0.5000	10	9.9795	10	9.9999
28	0.5000	0.5000	0.5000	0.5000	10	9.9795	10	9.9999
29	0.5000	0.5000	0.5000	0.5000	10	9.9795	10	9.9999
30	0.5000	0.5000	0.5000	0.5000	10	9.9795	10	9.9999

Table 10: Actual and Predictive Responses for BGP and SHELL

	X^1	X^2	X^3	X^4	YACT BGP	YPRE$^{(3)}$ BGP	YACT SHELL	YPRE$^{(4)}$ SHELL
1	0.2500	0.2500	0.2500	0.2500	10	10.0012	9	9.0020
2	0.7500	0.2500	0.2500	0.2500	9	9.0018	11	10.9659
3	0.2500	0.7500	0.2500	0.2500	11	10.9995	10	9.9961
4	0.7500	0.7500	0.2500	0.2500	10	10.0025	10	9.9995
5	0.2500	0.2500	0.7500	0.2500	10	10.0011	10	9.9961
6	0.7500	0.2500	0.7500	0.2500	10	10.0001	10	9.9995

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Table 10 Continued

	X^1	X^2	X^3	X^4	YACT BGP	YPRE(3) BGP	YACT SHELL	YPRE(4) SHELL
7	0.2500	0.7500	0.7500	0.2500	10	10.0024	10	10.0014
8	0.7500	0.7500	0.7500	0.2500	10	10.0013	11	10.9731
9	0.2500	0.2500	0.2500	0.7500	10	9.9985	9	8.9998
10	0.7500	0.2500	0.2500	0.7500	9	8.9992	10	10.0126
11	0.2500	0.7500	0.2500	0.7500	10	9.9998	10	9.9961
12	0.7500	0.7500	0.2500	0.7500	11	10.9971	10	9.9951
13	0.2500	0.2500	0.7500	0.7500	10	9.9985	10	9.9961
14	0.7500	0.2500	0.7500	0.7500	9	9.0003	10	9.9951
15	0.2500	0.7500	0.7500	0.7500	11	10.9969	10	9.9992
16	0.7500	0.7500	0.7500	0.7500	10	9.9998	10	10.0197
17	0.0000	0.5000	0.5000	0.5000	9	9.0006	10	9.9951
18	1.0000	0.5000	0.5000	0.5000	10	9.9999	10	10.0049
19	0.5000	0.0000	0.5000	0.5000	10	9.9998	9	9.0073
20	0.5000	1.0000	0.5000	0.5000	10	10.0003	10	10.0024
21	0.5000	0.5000	0.0000	0.5000	10	10.0000	10	9.0073
22	0.5000	0.5000	1.0000	0.5000	10	10.0000	10	10.0024
23	0.5000	0.5000	0.5000	0.5000	10	9.8752	10	9.9994
24	0.5000	0.5000	0.5000	0.5000	10	9.8752	10	9.9994
25	0.5000	0.5000	0.5000	0.0000	11	10.8738	10	10.0046
26	0.5000	0.5000	0.5000	1.0000	9	8.8765	10	9.9943
27	0.5000	0.5000	0.5000	0.5000	9	9.8752	10	9.9994
28	0.5000	0.5000	0.5000	0.5000	10	9.8752	10	9.9994
29	0.5000	0.5000	0.5000	0.5000	10	9.8752	10	9.9994
30	0.5000	0.5000	0.5000	0.5000	10	10.0012	10	9.9994

Table 11: Residual Responses for NPDC, IDSL, BGP, and SHELL on the LLR_{FB}

Exp. Run	YRES NPDC	YRES IDSL	YRES BGP	YRES SHELL
1	0.1063	0.0008	-0.0012	-0.0020
2	0.0891	0.0019	-0.0018	0.0341
3	-0.1265	0.0026	0.0005	0.0039
4	0.0999	-0.0018	-0.0025	0.0005
5	-0.1202	0.0031	-0.0011	0.0039
6	-0.0015	0.0004	-0.0001	0.0005
7	0.2141	-0.0010	-0.0024	-0.0014
8	-0.0187	0.0005	-0.0013	0.0269
9	-0.1568	-0.0003	0.0015	0.0002
10	-0.1203	-0.0023	0.0008	-0.0126
11	0.1940	-0.0017	0.0002	0.0039
12	-0.1445	0.0026	0.0029	0.0049
13	0.1817	-0.0039	0.0015	0.0039
14	0.0003	-0.0008	-0.0003	0.0049
15	-0.3139	0.0006	0.0031	0.0008
16	0.0369	-0.0010	0.0012	-0.0197
17	0.0178	0.0002	-0.0006	0.0049
18	0.0358	0.0003	0.0001	-0.0049
19	0.0178	0.0003	0.0002	-0.0073
20	0.0358	-0.0002	-0.0003	-0.0024
21	0.0358	-0.0005	-0.0000	-0.0073
22	0.0178	0.0003	-0.0000	-0.0024
23	0.0205	1.0001	0.1248	0.0006
24	0.0205	0.0001	0.1248	0.0006
25	-0.0212	-0.5007	0.1262	-0.0046
26	0.0621	-0.4991	0.1235	0.0057
27	0.0205	0.0001	-0.8752	0.0006
28	0.0205	0.0001	0.1248	0.0006

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Table 11 Continued

Exp. Run	YRES	YRES	YRES	YRES
	NPDC	IDSL	BGP	SHELL
29	0.0205	0.0001	0.1248	0.0006
30	0.0205	0.0001	0.1248	0.0006

Table 12: Model Goodness-of-Fits Statistics NPDC, IDSL, BGP, and SHELL on the LLR_{FB}

Response	Model	DF	$PRESS^{**}$	$PRESS$	SSE	MSE	R^2(%)	R^2_{Adj} (%)
$y\ LLR_{FB}$	$NPDC$	8.9826	0.5167	17.0118	0.3479	0.0387	96.00	87.09
	$IDSL$	6.0306	1.1140	31.2180	1.5001	0.2487	89.98	51.80
	BGP	6.0306	0.8040	22.6146	0.8750	0.1451	91.13	57.35
	$SHELL$	6.5322	0.1672	5.2699	0.0028	0.000425	99.96	99.79

CONCLUSION

In this study, the authors have shown that the data or response generated from the administered questionnaire as given by the respondents to aid the system design was coded in its levels, and facts generated were transformed through the use of CCD factors that needed to show the goodness-of-fits statistic of the local linear regression (LLR) model was introduced for leveling of the exact data, the utilization of the LLR by SHELL with embedded fixed bandwidth got a better result than NPDC, IDSL and BGP oil companies. This achievement is based on the regression results and squared distance target optimization synergy on safety precautions analysis and design system. Obtaining data for comparative analysis of safety in the oil and gas industry is a challenging task. The report obtained will assist the users of such information to persuade company management to continue to improve safety measures in areas where they have not performed well compared to other companies.

RECOMMENDATIONS

Safety is one of the major components of employee rights, and it must not be seen as a gift from employers. It is of utmost importance for organizations to start engaging relevant safety agencies for the actualization of the full safety precaution by way of employment of a system such as this in the precaution execution and evaluation model of safety guidelines within the organization.

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