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Evaluation of Workplace Safety Culture Implementation and Practice Using Agglomerative Hierarchy Clustering

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Authors' contributions

This work was carried out in collaboration between all authors. Author GIA designed the study, performed the literature search, wrote the protocol and the first draft of the manuscript. Author ILN served as his major PhD supervisor and assisted in study design and managed the analyses of the study. Author EU served as assistant supervisor and assisted in statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

This study assessed safety culture and practices in selected companies from the oil and gas, construction, transportation and logistics companies operating in the Niger Delta region of Nigeria. The questionnaire design utilized 15 safety cultural parameters and practices peculiar to 11 companies formed the basis of questionnaire distributed to 663 respondents in the study area. Purposive sampling was employed in the choice of companies sampled while random sampling technique was applied with respect to questionnaires distribution within the selected companies. XLSTAT 2016 statistical computer package was applied as aid for data analysis which includes Shapiro-wilks test of normality as an aid for the choice of analysis of variance option, the Friedman's test to determine the variance among the various sampled groups which also includes a post-hoc test (Nemenyi's Procedure) and Agglomerative Hierarchy Clustering (AHC) for clustering of workplace safety culture practices within the sampled groups. The output from the analysis of variance showed that there is a significant difference between the safety cultural

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practices of the three sampled industrial sectors with the alpha = 0.5 being lower than computed p-value (< 0.0001). Further analysis by AHC resulted in 4, 3 and 3 clusters of workplace safety cultural practices for oil and gas, construction and transportation and logistics sectors, respectively. The cultural practice were supervisors are authorized to stop unsafe work was identified as common between the construction and oil and gas sector while the practice of periodic hazards hunts and inspections by staff and management was identified as common among the construction and transportation and logistics industrial sector.

Keywords: Safety culture practice; illnesses; injuries; oil and gas; construction; transportation and logistics; companies; agglomerative hierarchy clustering.

1. INTRODUCTION

Industries must strive towards the promotion of standard operational practices that reduce both workplace and environmental incidents. Hence, there is need to understand the causes of workplace incidents which when neglected, will affect the health and well-being of the workforce. Similarly, lack of and poor implementation of operational practices will affect the integrity of plants and machinery, protection of the environment and reputation of the organizations involved. The reason adduced for the prevalence of industrial or workplace body altering incidents, are as follows: i) poor risk assessment of proposed projects prior to execution; ii) poor hazards identification; iii) failure to use safe work procedures to execute assigned tasks; iv) lack of reporting of hazards; v) neglected significant near misses/incidents investigation; and vi) poor safety cultural practices. The presence of blame culture, poor management commitment and accountability to the practice and implementation of safety programs, all contribute in one way or another to the occurrence of injuries, illnesses and fatalities in the workplace.

Harvey et al. [1] conducted a study on "analysis of safety culture attitudes in a highly regulated environment''; this study was aimed at the occurrence of a disaster initiates processes. The researchers opined that disaster is often linked to fraudulent processes and lack of accountability; thus, someone is blamed for the fatal occurrence. This led to the conclusion that disasters are as a result of malpractices that have corrupted a greater part of the mechanisms of the social system [2]. But on the contrary, Reason [3] is of the view that organizational "latent failures" will in most instances lie beneath individuals "active errors". However, Rousseau [4] reported that investigations carried out by other scholars, revealed that an organization's entire culture can be responsible for accidents.

However, Akalonu [5], opined that the main contributing factors to accidents in the workplace, are lack of organizational health, safety and environmental policy framework, structure, work involvement and management systems. He went further to posit, that poor safety culture, lack of motivation or incentive based compensation system, trust, effective communication, management commitment and leadership, inadequate tools, poor work environment, deficient personnel competencies and goal settings, poor safety record keeping and non-enforcement of government policies and legislation, equally contribute to occupational accidents. In most instances, a combination of two or more of these factors are responsible for accidents and injuries in the workplace.

Furthermore, organizational safety culture may be taken as the pivot on which most causes of industrial accidents revolve. Culture describes the values, the norms, the beliefs, the ways a group of people carry out their activities. The Safety culture of an organization, therefore can be said to mean the safety value systems, beliefs and norms of the workforce as obtainable in a particular organization whereas safety climate deals with attitudes and perceptions of an individual or a group on organizational safety practices. Both concepts are key components of studies leading to the prevention of injuries, illnesses and fatalities in any organization.

The work aspects which are informal in nature as compared to the formal ones, are known as safety culture [6]. It is the organization's safety culture in place that determines employee's perception of which actions are right or wrong based on acceptable practices in the organization they work for. Guldenmund [7] summed the whole definition of safety culture as "the way we do things here". It should be noted, that the size of an organization, determines the impact of safety culture on its operations. Large organizations safety culture, have more

domineering effect on its workforce and operations as compared to small institutions. Organizations may have more than one safety culture existing in it, as different cultures can exist in one organization from department to department and from unit to unit depending on the size of its workforce, its operations, roles and responsibilities of its key personnel and reporting structure. As organizations evolve day by day, so also is their safety culture. Safety culture, therefore is not static. Safety culture drives safety best practices, initiatives and improvements in an organization.

Antonsen [8], opined that the geographic location of an organization, the type of activities it is engaged in, and the skill set of its employees have an overwhelming effect on the safety culture of the organization. For safety culture to be sustained, there has to be strong management leadership commitment and accountability to the implementation of safety policies and practices. Therefore, organizations need to reassess their safety cultural practices which negatively affect optimization of their productive capacity. The aim of this study is to evaluate the workplace safety cultural practices in selected companies in the Niger Delta. This involves questionnaire design on safety culture and practices; and to confirm any significant differences and ideological safety cultural practices among the sampled companies.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in eleven (11) major cities of the nine (9) Niger Delta states of Nigeria. In Akwa Ibom state, Eket and Uyo cities were selected; Rivers State was represented by Bonny and Port-Harcourt cities; Bayelsa state by Yenegoa city; Cross-River State by Calabar city; while Delta, Edo and Imo States Warri, Benin and Owerri cities, respectively. Also, Abia and Ondo States were represented by Aba, Umuahia and Akure cities, respectively.

The nine (9), Niger Delta states are located on coordinates 05º19' 34" N and 06º 28' 15" E with a total population of well over 41 million people and land mass of about 70,000 Km^2 (27,000 mi^2) (Fig. 1). The Niger delta region of Nigeria has great agricultural potential capable of transforming the economy of the country. This region is also well known for its petroleum deposits; the country is one of the leading exporters of petroleum in Africa.

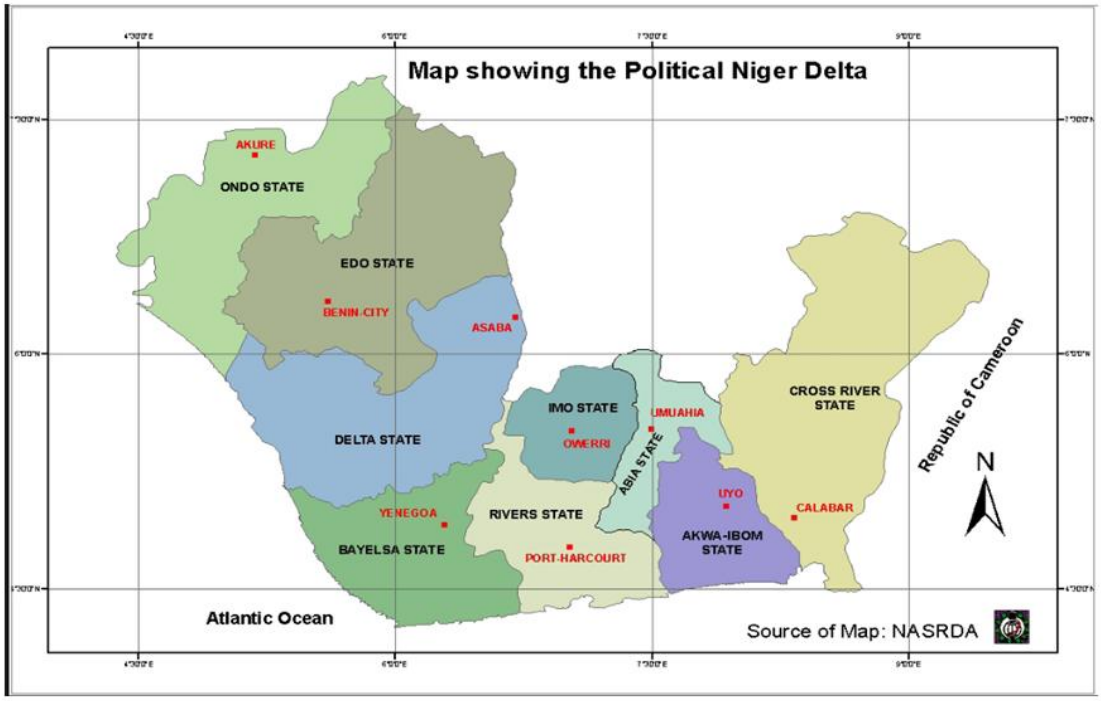

Fig. 1. Map of the Niger Delta States [9]

This study identified 11 companies with major operations in the Niger Delta region. Out of these eleven (11) companies, three (3) were major international oil and gas companies, four (4) were a mixture of multinational and indigenous construction companies while the last four (4) companies were indigenous transportation and logistics companies. Two (2) of the transportation and logistics companies were owned by two State governments while the remaining two of the transportation and logistics companies are privately owned by entrepreneurs in Nigeria.

2.2 Data Collection

Purposive sampling technique was applied in choosing the eleven companies within the three industrial sectors (oil and gas; construction and transportation and logistics companies) of study, while simple random sampling was applied in questionnaire distributions to the staff of the companies within the three sectors.

The letters E, F and G, were used to represent the three (3) International oil and gas companies under discuss. The letters M, N, O and P were used for the construction companies while the letters Q, R, S and T were used to represent the transportation and logistics companies.

With respect to the three (3) industrial sectors studied, the population sizes of respondents sampled whose ages ranged from 5 to 20 years of industrial work experience within the oil and gas firms were, 48, 39 and 67 respondents (E,F and G); the construction companies respondents were 38, 52, 41 and 28 (M, N,O and P) while 73, 53, 68 and 66 (Q, R, S and T) respondents actively participated from the transportation and logistics companies, respectively.

2.3 Sample Size Estimation

For sample size determination, the prevalence formula was adopted (see Equation1):

$$N = \frac{Z^2 P(1-P)}{T^2} \quad (1)$$

Where N represents the sample size, T = tolerance error (0.05); P = prevalence of previous study [10] and Z = 1.96, which is the level of significance and corresponds to 95% confidence level. Evaluating Equation (1) for the three industrial sectors, we have the following population sizes:

a) For Oil and Gas Sector, using prevalence value of 13.5% yields:

$$N = \frac{1.96^2 \, X \, 0.13(1-0.135)}{0.05^2} = 179.44 \approx 179$$

The sample size was calculated as 179, adopting 4.5% as attrition rate, yields a total of 187 staff.

b) For Construction Sector, using prevalence value of 13.5% yields:

$$N = \frac{1.96^2 \, X \, 0.13(1-0.13)}{0.05^2} = 174.79 \approx 174$$

The sample size was calculated as 174, adopting 5.5% as attrition rate, yields a total of 184 staff.

c) For Transportation and Logistics Sector, using prevalence value of 24% yields:

$$N = \frac{1.96^2 \, X \, 0.24(1-0.24)}{0.05^2} = 280.28 \approx 280$$

The sample size was calculated as 280, adopting 4.4% as attrition rate, yields a total of 292 staff.

2.4 Data Analyses

XLSTAT version 2016.02 (student's edition) statistical package was employed for data analysis. The test of normality (Shapiro-Wilk test) was to determine the data type whether parametric or non-parametric and thus, aid the choice of analysis of variance option. For variance determination among the sampled eleven (11) companies of oil and gas industry, the construction companies & transportation and logistics sectors, the Friedman test was found to be a very useful tool (see Equation 2).

$$\hat{x}_R^2 = \left[\frac{12}{nk(k+1)} \sum_{i=1}^{k} R_i \right] - 3n(k+1) \quad (2)$$

Where $\hat{x}_R$ =Friedman statistic; α = Group mean difference and k = Sample size.

Note: Rejection of the null hypothesis is to be effective, only when $\hat{x}_R > x^2_{k-1;\alpha}$

After the application of the Friedman's test to determine the variance among the various

sampled groups, a post-hoc test in the form of multiple pairwise comparisons [11] were carried out among the sampled group of respondents utilizing Nemenyi's Procedure or the two –tailed test. Post hoc test was applied to determine which groups of data show significant difference from the mean group rank.

Furtherance to the data analysis, Agglomerative Hierarchy Clustering (AHC) was used for workplace safety culture analysis. Based on its capacity to identify the central safety cultural practices with respect to general safety practices obtainable in the workplace and adopted by the various sampled companies.

3. RESULTS AND DISCUSSION

3.1 Results

XLSTAT software relies on Visual Basics Application for the interface and on C++ for the mathematical and statistical computations [12]. Figs. 2-4 present the probability plot from the output of the normality test on the data sets 1, 2, and 3 (data set 1 = oil and gas companies, data set 2 = construction companies and data set 3 = transportation and logistics companies) (see Appendix A). Table 1, presents the summary of the analysis of variance on the data sets 1, 2 and 3 while Table 2, presents the output from the post-hoc test in the form of multiple pairwise comparisons. Finally, on application of AHC on the data sets 1, 2, and 3, and Tables 3, 4 and 5 present the summary of the output analysis (see Figs. 5-7). Also, Tables 6, 7 and 8 present the central object (or ideology) of the resultant clusters (class) around which the various companies' workplace safety culture is built.

Table 1. Friedman's test

Q (Observed value)	28.1333
Q (Critical value)	5.9915
DF	2
p-value (Two-tailed)	< 0.0001
Alpha	0.05

Interpretation of Test:

H_0: The same population produced the computed samples.
H_a: The same population did not produce the computed samples but are from different populations.

From the results as shown in the Table 1, the significance level (alpha = 0.05) is lower than the computed p-value, therefore the null hypothesis $H_{0,}$ is rejected and the alternative hypothesis H_a, is accepted.

Hence, the consequences of rejecting the null hypothesis H_0 while it is considered to be true is much lower than 0.01%.

Table 2. Using Nemenyi's procedure for multiple pairwise comparisons

Sampled company	Frequency	Sum of ranks	Mean of ranks	Groups		
Construction.	15	15.0000	1.0000	A		
Transportation & Logistics.	15	31.0000	2.0667		B	
Oil & Gas	15	44.0000	2.9333			C

Table 3. Summary of AHC – oil and gas companies

Class	1	2	3	4
Objects	3	3	6	3
Sum of weights	3	3	6	3
Within-class variance	444.6667	230.0000	17.1333	16.0000
Minimum distance to centroid	14.3836	4.7610	1.5456	2.8284
Average distance to centroid	17.1019	11.3344	3.6009	3.2513
Maximum distance to centroid	19.1021	16.8325	5.0056	3.5590
	WSC 1	WSC 3	WSC 5	WSC 8
	WSC 2	WSC 6	WSC 10	WSC 9
	WSC 4	WSC 7	WSC 11	WSC 15
			WSC 12	
			WSC 13	
			WSC 14	

Table 4. Summary of AHC – construction companies

Class	1	2	3
Objects	4	8	3
Sum of weights	4	8	3
Within-class variance	145.5000	836.1250	72.0000
Minimum distance to centroid	8.7963	7.9067	3.0551
Average distance to centroid	10.3200	20.2589	6.4887
Maximum distance to centroid	13.0336	65.9963	8.2462
	WSC 1	WSC 3	WSC 4
	WSC 2	WSC 5	WSC 11
	WSC 7	WSC 6	WSC 13
	WSC 8	WSC 9	
		WSC 10	
		WSC 12	
		WSC 14	
		WSC 15	

Table 5. Summary of AHC – transportation and logistics companies

Class	1	2	3
Objects	3	7	5
Sum of weights	3	7	5
Within-class variance	60.0000	139.7143	89.6000
Minimum distance to centroid	3.4157	2.5833	3.2125
Average distance to centroid	6.0333	9.6788	7.5261
Maximum distance to centroid	7.8528	18.6115	14.0328
	WSC 1	WSC 2	WSC 3
	WSC 5	WSC 4	WSC 9
	WSC 13	WSC 6	WSC 10
		WSC 7	WSC 14
		WSC 8	WSC 15
		WSC 11	
		WSC 12	

Table 6. Class centroids and central object with respect to oil and gas respondents on general workplace safety culture

Class (Object)	E	F	G
1 (WSC 2)	88.0000	101.0000	159.0000
2 (WSC 6)	127.0000	92.0000	157.0000
3 (WSC 11)	133.0000	101.0000	158.0000
4 (WSC 15)	132.0000	102.0000	168.0000

Table 7. Class centroids and central object with respect to construction respondents on general workplace safety culture

Class (object)	M	N	O	P
1 (WSC 2)	77.0000	135.0000	102.0000	72.0000
2 (WSC 9)	101.0000	134.0000	102.0000	72.0000
3 (WSC 13)	80.0000	134.0000	111.0000	72.0000

Table 8. Class centroids and central object with respect to transportation and logistics respondents on general workplace safety culture

Class (object)	Q	R	S	T
1 (WSC 13)	130.0000	97.0000	120.0000	104.0000
2 (WSC 12)	132.0000	92.0000	115.0000	116.0000
3 (WSC 14)	146.0000	90.0000	121.0000	109.0000

3.2 Discussion

3.2.1 Normality, Friedman and post-hoc tests

The safety culture of an organization, plays a significant role in the causes and prevention of injuries, illnesses and fatalities in the workplace. It has been observed, that the elements of workplace safety culture as seen in values, beliefs, standards, perceptions, incentives and practices obtainable in a particular establishment or company, to a great extent affect the overall safety performance of that organization [13].

On application of the test for normality [14] Figs. 2 - 4 present points of the data sets 1, 2, 3, which do not follow the dotted straight line representing the line of normality. It implies that the data sets are not normally distributed hence non-parametric in nature. As a result of the non-parametric nature of the data sets, and in order to check for variance between the data sets, the Friedman test of variance which is a non-parametric test was applied. As presented in Table 1, the $Q_{critical}$ being smaller than the $Q_{observed}$ and with the computed p-value lesser than the critical p-value (i.e alpha) of 0.05 it implies that there is actually a significant difference between the three data sets (Oil and gas, Construction, Transportation and Logistics companies). The result from the post-hoc analysis confirmed that indeed there is a significant difference between the sampled data sets (see Table 2).

3.2.2 Workforce and safety culture attributes in oil and gas sector

The parameters studied, affecting safety cultural practices in sampled companies, which were supported with dendograms (Figs. 5-7), point out that certain safety cultural practices have overwhelming influence on the workforce and their safety as compared to others. Out of the fifteen (15) questionnaire parameters analysed, four classes were identified to be cardinal in the operations of the oil and gas industries, three safety cultural practice classes were discovered to influence activities in the construction, transportation and logistics companies (see Tables 3-5). Though some best practices overlap, for instance, in the oil and gas sector, strong parameters that were discovered from the respondents that influenced the safety culture of the organizations, were noted as: Supervisors and workforce empowerment to stop any unsafe act, risk control measures development, implementation and monitoring of the design and application of safety tools and programs, conduct of safety meetings for the workforce and lastly management commitment, leadership and support to safety programs and initiatives were found to have an over whelming influence on the safety cultural practices of the workforce studied (see Table 9).

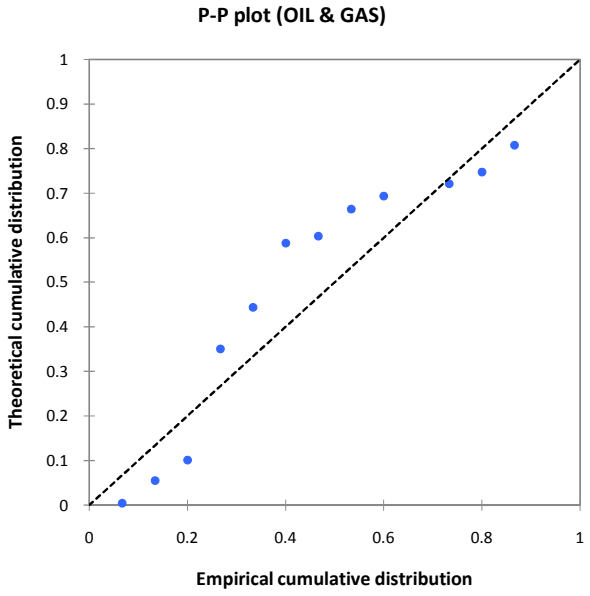

Fig. 2. P-p plot for set 1 data – oil and gas companies

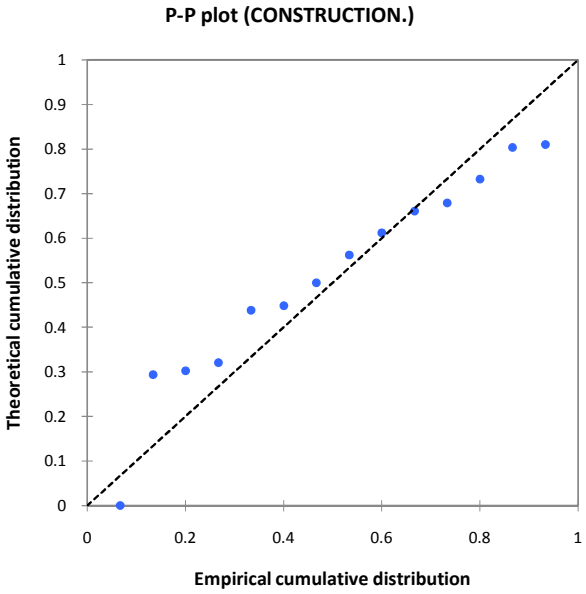

Fig. 3. P-p plot for set 2 data – construction companies

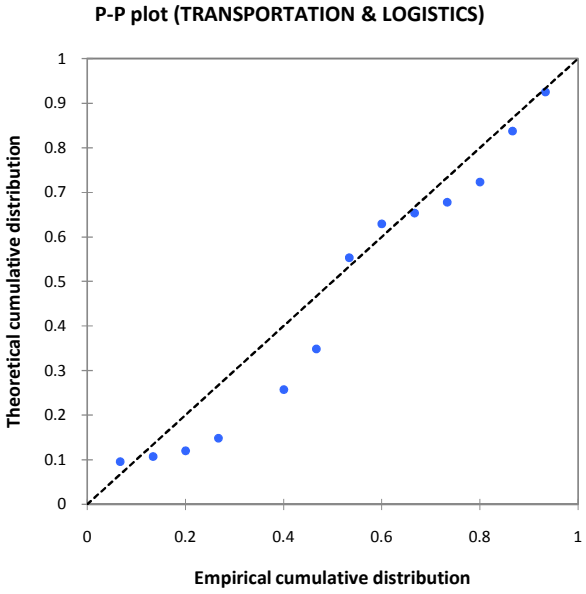

Fig. 4. P-p plot for set 3 data – Transportation and logistics companies

The parameters listed above, are the basis for the success recorded by the oil and gas companies in their approach to integrating safety cultural practices to behaviour models in injuries, illness and fatalities prevention. In almost all leading oil and gas companies operating in the Niger Delta region of Nigeria and elsewhere in the world, supervisors, employees and contractors personnel, have been empowered to stop any work activity considered to be unsafe. In doing this, safety objectives and values for human life are placed above production priorities. This is the winning safety cultural practice that have endeared many of the employees to the management of their company. The term “zero harm”, “target zero”, “nobody gets hurt” and so on, are all acronyms used to show trusting relationships, commitment, ownership and

accountability to intervene and enforce "stop work" authority which helps to encourage safe behaviours at all times in the workplace, by all employees and contractors personnel and it is a safety cultural term known and accepted in these establishments.

Again, the importance of conducting safety meetings, cannot be over emphasized. Safety meetings serve as platforms for communication. It is a fora where vital pieces of information regarding employees' safety and welfare are discussed. It also serves as a basis for sharing lessons learned from past incidents so that employees are well informed of consequences of deviation and or non-compliance to acceptable standards, norms and practices. The sole aim of sharing lessons learned from incidents and discussing safety topics, is to prevent a reoccurrence of such incidents and to keep employees and contractor personnel informed of hazards associated in previous incidents.

Table 9. Summary of the cardinal safety culture parameters that influence the general workplace injuries, illnesses and fatalities prevention of the various sampled companies

Companies	Class (object)	Central workplace safety culture influencing parameters
Oil & Gas	1 (WSC 2)	Are Supervisors and all the workforce empowered to stop any unsafe work?
	2 (WSC 6)	Are risk control measures developed, implemented and monitored the way they are designed to be used?
	3 (WSC 11)	Does your organization conduct safety meetings for its workforce?
	4 (WSC 15)	Does the management of your workplace committed to safety and supports safety programs and initiatives?
Construction	1 (WSC 2)	Are Supervisors and all the workforce empowered to stop any unsafe work?
	2 (WSC 9)	Are there adequate time and arrangements for passing information at shift handovers?
	3 (WSC 13)	Are periodic facilities walkthrough inspections and hazards hunt carried out in your workplace by staff and upper management?
Transportation / Logistics	1 (WSC 13)	Are periodic facilities walkthrough inspections and hazards hunt carried out in your workplace by staff and upper management?
	2 (WSC 12)	Are the safety meetings conducted in a clear and understandable language?
	3 (WSC 14)	Are lessons learned from incidents within and outside your workplace shared during safety meetings?

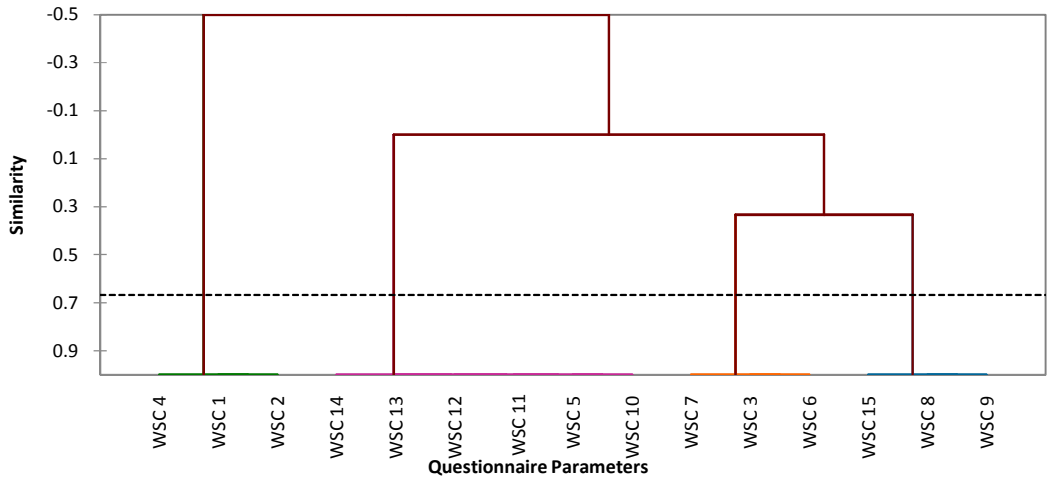

Fig. 5. Dendrogram for similarity of classes w.r.t to oil and gas companies workplace safety Culture

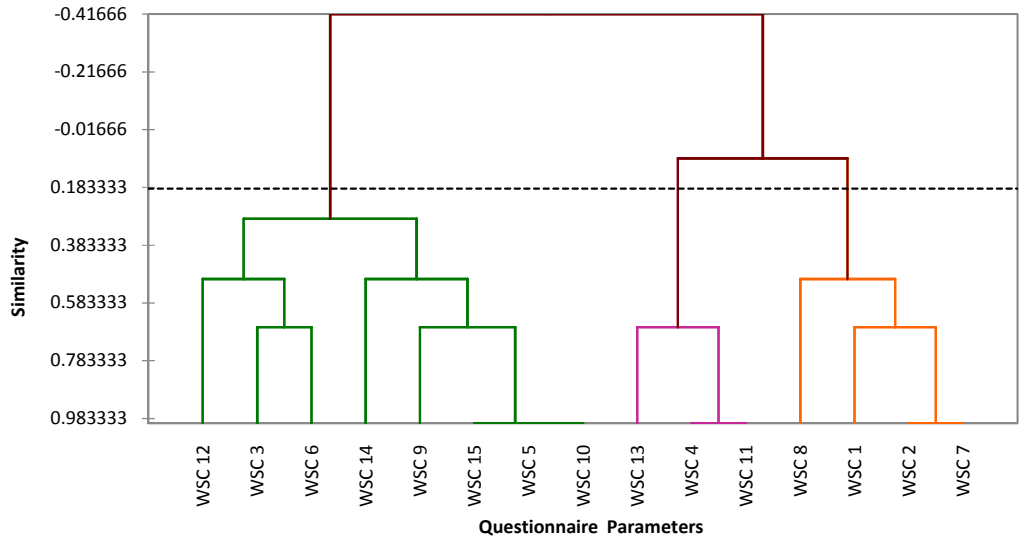

Fig. 6. Dendrogram for similarity of classes w.r.t to construction companies workplace safety Culture

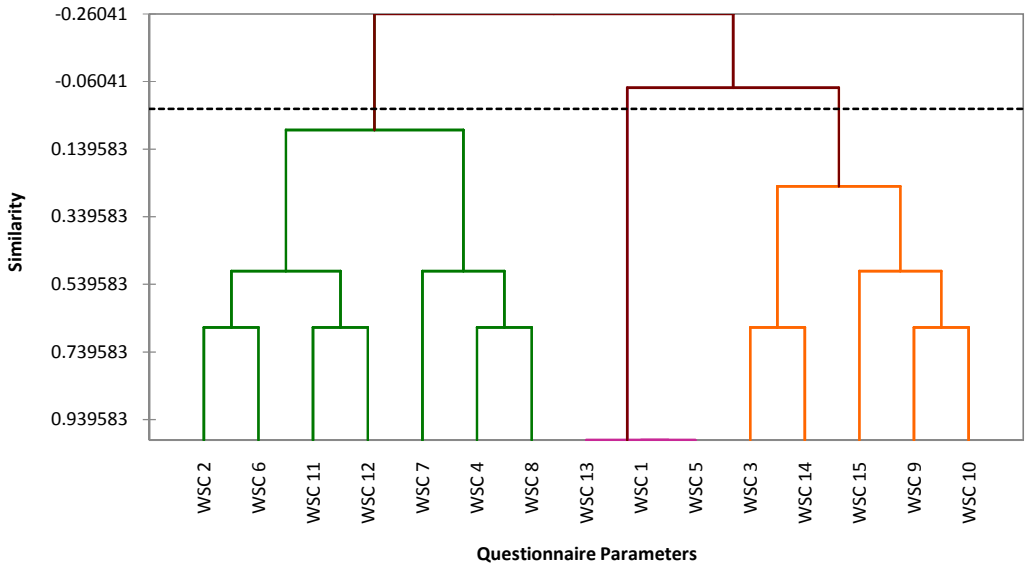

Fig. 7. Dendrogram for similarity of classes w.r.t to transportation and logistics companies workplace safety Culture

On management commitment, leadership and support to safety programs and initiatives, this shows a top down approach to safety programs, initiatives, implementation and ownership. A culture where there is management support and accountability to safety programs and initiatives is a healthy culture. Here, the financial resources for safety programs execution is not the issue, as there is management support at all times [15]. Also, management support drives incentives, resource availability, hazards hunts, safety policy implementation, audits and other key safety beliefs and value systems.

3.2.3 Safety culture attributes of construction companies

Similarly, the construction industry in Nigeria has contributed a lot to Nigeria's Gross Domestic Product [9]. However, the analysis of the

construction companies carried out in this study, showed that three safety cultural parameters were identified to be very effective at influencing injuries, illnesses and fatalities in this sector. They include supervisors and workforce empowerment to stop any unsafe act, adequate time and arrangements for passing information at shift handovers, periodic facilities walkthrough inspections and hazards hunt carried out by staff and upper management.

Like in the oil and gas companies, supervisors and workforce empowerment to stop any unsafe act was highlighted in the construction companies as well. The need to stop any unsafe work practices by any person identifying them, is a major boost in injuries prevention in the construction industries.

Furthermore, the safety of employees, equipment and the environment can be placed in jeopardy when the incoming shift is not kept abreast of the activities of the outgoing shift. There is need therefore, to ensure that adequate information is passed between shifts on job completion status. This helps to ensure continuity, reduces cases of inadvertent operation of machines and other equipment that have been tagged “out of service” which have the potential to cause harm.

Periodic facilities walkthrough inspection and hazards hunt carried out by staff and upper management is a veritable safety cultural tool that is effective in hazards mitigation and risk control measures. Once this is enshrined in the safety deliverables of any organization, the workforce take this practice as an established norm, and key-in to take ownership in order to ensure its success. These identified three key elements, are cardinal in safety cultural attributes of the construction companies sampled (see Tables 7 and 9).

3.2.4 Safety culture attributes for transportation & logistic companies

Just like the studies carried out by Sumaila [16] and corroborated by Ogunsanya [17], in this study, the transportation and logistics sector have a lot to do with safety culture ownership and implementation in their peculiar work environment. This is premised on the fact that majority of the respondents sampled, are people whose local norms and values much especially as obtainable in the workplace, will have a lot of influence on safety activities, bearing in mind that majority of the composition of respondents, hardly attended post-secondary schools.

In this sector, identified safety cultural parameters which have a strong influence on general causes of injuries, illnesses and fatalities in the transportation and logistics sectors, are periodic facilities, walkthrough inspections and hazards hunt carried out by staff and upper management, journey management, tool box talks conducted before embarking on a journey with periodic safety meetings conducted in a clear and understandable language, lessons learned from incidents within and outside the workplace being shared during safety meetings (see Tables 8 and 9).

Moreover, it should be noted that periodic upper management facilities walkthrough inspections coupled with the ability to carry out planned hazards hunt activities by all the workforce is a safety cultural attribute that is proactive in injuries, illnesses and fatalities prevention and have the potential to change the overall incident architecture of an entire organization for either productive gain or enhanced corporate reputation.

In this instance, established management and employee norm, is the ability to ensure that a safety walkthrough is carried out with enhanced hazards hunt ability. This practice helps to identify unsafe conditions and unsafe acts that have the capacity to cause harm on systems and processes, buildings, vehicles, cargo haulage enclosures and so on. Organizations need to act differently to reshape and refocus their safety cultural practices in order to prevent incidents in the workplace [18].

In journey management and tool box talk discussions, the journey is planned, the condition of the vehicle is evaluated to ensure it is fit to embark on the proposed journey, the driver’s state of health and ability to drive is equally evaluated. The road condition, intermittent rest stations and so on are factored in, to ensure a safe and incident free journey. Just before the journey commences, a toolbox talk is held between the driver and his assistants to ensure that they duly understand the expectations required from them for the journey. At this stage, abnormalities and hazards discovered during the cause of this planning, is rectified and discussed before embarking on the journey. This is a safety cultural attribute that if sustained, in all transportation and logistics companies, will help

to reduce incidences of road traffic crashes, injuries and fatalities.

Always, safety meetings should be conducted in a language that is understandable by all concerned in the transportation and logistics chain. A safety meeting done in a non-communicable, high level or difficult language will be meaningless to the audience. Subjects discussed, will not be understood by the intended recipients leading to zero inputs in the journey to prevent injuries, illnesses and fatalities in the workplace. Therefore, the stage should be set to ensure that at all times, communication in safety meetings are done in a clear and understandable language and should be taken as a positive safety cultural practice in all organizations and if it is needed a total value chain re-orientation to enshrine this positive and effective communication strategy should be endorsed by the companies upper management.

However, lessons learned from previous incidents, within and outside the organization, when shared during safety meetings are good safety cultural practices as it helps to properly keep the employees abreast of happenings, industry wide. It equally helps in communicating safety barriers that failed which led to the incidents and what can be done differently, to prevent a reoccurrence.

4. CONCLUSION

The conclusions drawn from this study are as presented below:

i.) A significant difference exists between the safety cultural practices as obtained in the oil and gas, construction companies and the transportation and logistics companies;
ii.) The safety cultural practices in the transportation and logistics industries as analysed using agglomerative hierarchy clustering (AHC), showed very low knowledge, practice and acceptance as compared to what is obtainable in the construction industries and that of the oil and gas industries; and
iii.) There is a downward trend in safety culture acceptance and practice in the three sectors studied. The safety cultural practices and adherence which help to reduce occupational incident cases, are more practiced, appreciated and pronounced in the oil and gas companies as compared to the construction and transportation companies. Similarly, safety cultural practice is more pronounced, practiced and appreciated in the construction firms as compared to the transportation and logistics companies. These findings can also explain the high level of incidents and road traffic crashes as recorded in the transportation and logistics companies in Nigeria when compared to the construction industries and the oil and gas firms which have a considerable low incident as a result of enhanced implementation and acceptance of well-established positive safety cultural norms and value systems.

5. RECOMMENDATION

Based on the outcome of this study, the following recommendations are made:

i.) Safety policies and programs must be tailored to embrace the safety cultural practices as obtainable in specific organizations and not borrowed from other organizations as culture cannot be borrowed but embraced.
ii.) Safety policies and programs should not be designed to be punitive in nature thereby introducing elements of fear and blame culture in the organization.
iii.) Safety should be driven to show the need for an inclusive duty of care, commitment and ownership from management, employees and contractor personnel rather than that of compliance.
iv.) There should be open communication and enablement to freely report accidents, near misses, unsafe acts and unsafe conditions. Action items resulting from Near Miss reports, Incident investigations, Hazards identification from walkthrough inspections should be reviewed and appropriately closed-out. Safety meetings and sharing of lessons learned from incidents should be encouraged at all times by management.
v.) The workforce should be empowered to stop any work activity considered to be unsafe. Every employee should be made to know that he has the responsibility for his own safety and that of others working around him and that all the workforce are expected to work safely at all times using approved company safe work procedures.

ETHICAL CLEARANCE

Ethical approval was obtained from the Ethics Committee of the companies sampled. All

information shared during the research were strictly confidential and protected by the law of confidentiality.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX A

Workplace Safety Culture Questionnaire Response Distributions

Table A1. Questionnaire parameters versus reference code

S/N	Questionnaire parameters	Reference code
1	Are there safety programs and processes in your place of work to monitor workers safety performance?	WSC 1
2	Are Supervisors and all the workforce empowered to stop any unsafe work?	WSC 2
3	Does your company punish workers for reporting unsafe acts and conditions?	WSC 3
4	Are contractors working for your organization given in-house safety induction, monitored and supervised?	WSC 4
5	Are workers held accountable for their Safety, Health and Environment actions and inactions?	WSC 5
6	Are risk control measures developed, implemented and monitored the way they are designed to be used?	WSC 6
7	Are adequate resources made available to employees to carry out their duties safely?	WSC 7
8	Are the communication of expectations clearly understood by the workforce carrying out the tasks?	WSC 8
9	Are there provision of appropriate and adequate PPE and the right tools to execute assigned tasks?	WSC 9
10	Is there a way of testing the effectiveness of safety communication in your workplace?	WSC 10
11	Does your organization conduct safety meetings for its workforce?	WSC 11
12	Are the safety meetings conducted in a clear and understandable language?	WSC 12
13	Are periodic facilities walkthrough inspections and hazards hunt carried out in your workplace by staff and upper management?	WSC 13
14	Are lessons learned from incidents within and outside your workplace shared during safety meetings?	WSC 14
15	Does the management of your workplace committed to safety and supports safety programs and initiatives?	WSC 15

Table A2. Questionnaire response distribution for oil and gas companies

Reference code	Response distribution for companies E, F & G								
	Company E			Company F			Company G		
	Yes	No	UND[±]	Yes	No	UND[±]	Yes	No	UND[±]
WSC 1	24	6	18	25	10	4	35	20	12
WSC 2	10	18	20	26	10	3	36	20	11
WSC 3	19	3	26	10	25	4	21	35	11
WSC 4	6	10	32	21	11	7	22	21	24
WSC 5	38	4	6	28	8	3	38	18	11
WSC 6	34	3	11	21	11	7	34	22	11
WSC 7	38	2	8	24	11	4	36	21	10
WSC 8	37	2	9	26	8	5	39	27	1
WSC 9	37	2	9	24	10	5	39	21	7
WSC 10	37	5	6	25	10	4	35	21	11
WSC 11	40	3	5	25	12	2	35	21	11
WSC 12	41	2	5	25	12	2	36	21	10
WSC 13	37	2	9	24	12	3	34	21	12
WSC 14	42	3	3	28	9	2	38	19	10
WSC 15	39	3	6	29	5	5	39	23	5

[±]*UND = Undecided*

Table A3. Questionnaire response distribution for construction companies

Reference code	Response distribution for companies M, N, O & P											
	Company M			Company N			Company O			Company P		
	Yes	No	UND±	Yes	No	UND±	Yes	No	UND±	Yes	No	UND±
WSC 1	6	9	23	42	8	2	22	17	2	21	5	2
WSC 2	10	9	19	40	9	3	29	9	3	22	6	0
WSC 3	9	3	26	14	32	6	9	28	4	3	22	3
WSC 4	6	10	22	36	8	8	29	4	8	19	1	8
WSC 5	29	4	5	37	6	9	30	7	4	21	3	4
WSC 6	25	3	10	30	14	8	22	16	3	18	7	3
WSC 7	18	12	8	38	8	6	30	9	2	21	5	2
WSC 8	19	10	9	37	8	7	20	20	1	21	6	1
WSC 9	27	2	9	37	7	8	29	9	3	21	5	2
WSC 10	25	7	6	36	8	8	30	8	3	21	5	2
WSC 11	22	11	5	35	8	9	35	5	1	24	3	1
WSC 12	30	3	5	38	8	6	33	5	3	25	3	0
WSC 13	16	12	10	37	7	8	34	5	2	21	5	2
WSC 14	33	2	3	42	3	7	31	4	6	26	0	2
WSC 15	29	3	6	39	6	7	33	6	2	23	3	2

±UND = Undecided

Table A4. Questionnaire response distribution for transportation and logistics companies

Reference code	Response distribution for companies Q, R, S & T											
	Company Q			Company R			Company S			Company T		
	Yes	No	UND±	Yes	No	UND±	Yes	No	UND±	Yes	No	UND±
WSC 1	6	20	47	10	24	19	16	37	15	2	31	33
WSC 2	12	27	34	10	22	21	7	36	25	6	29	31
WSC 3	6	13	54	5	29	19	21	32	15	5	32	29
WSC 4	12	23	38	14	28	11	11	27	30	14	25	27
WSC 5	11	22	40	17	19	17	13	30	25	7	30	29
WSC 6	7	12	54	17	18	18	15	31	22	18	23	25
WSC 7	6	20	47	11	23	19	17	31	20	10	27	29
WSC 8	5	28	40	6	29	18	6	23	39	12	26	28
WSC 9	15	11	47	13	21	19	14	31	23	11	27	28
WSC 10	13	13	47	11	19	23	13	30	25	4	29	33
WSC 11	8	29	36	9	22	22	12	32	24	8	29	29
WSC 12	13	27	33	9	23	21	12	33	23	9	25	32
WSC 13	5	21	47	12	21	20	15	31	22	5	33	28
WSC 14	16	16	41	8	24	21	17	32	19	6	29	31
WSC 15	15	16	42	12	21	20	16	30	22	8	28	30

±UND = Undecided

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