

Occupational Safety and Health Administration Factorial Study

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Abstract—Occupational Safety and Health Administration (OSHA) consideration in Nigeria appears to be at its infancy level and far from world best practices. Several factors are associated with OSHA, incidentally the major problem is that the individual role and collective interplay among these factors are not completely implied. This study therefore seeks to use Kendall's Coefficient of Concordance (KCC) to rank 52 identified variables and successively apply Principal Component Analysis (PCA) to ascertain the degree of interaction among these variables. The essence of this study is to use the individual and collective role of these factors for a re-contextualization of OSHA portable concept and subsequently forge a framework for developing a normative safety culture in Nigeria. KCC was used to rank 52 identified variables in descending order of importance. Afterwards, the PCA was used to analyse a set of questionnaires crafted with the 52 variables and administered to knowledgeable respondents in the industry. Statistical software adopted gave several outputs which include: screeplot, eigenvalues, descriptive statistic, eigenvector, unrotated factor loading, case-wise factor scores, correlation matrix, varimax rotated factor loadings, explained variance, factor plot, inter alia. Finally, factor interpretation was rendered. Our result established five important factors which were creatively labelled "Principal Factor", "Accident Management", "Systematization", "Safety Ground Rules" and "Miscellany." These five factors form a framework for establishing a normative safety work culture for any organization. Taken together, the models employed have provided enlightenment on the appearance of current situation of the work world.

Keywords—Accident Management; Normative safety culture; Principal Factor; Safety Ground Rules Systematization

I. INTRODUCTION

OSHA provides a structural way of managing health, safety, accidents and incidents in a workplace. It provides basic for measuring the level of compliance with OHS regulatory requirements, provides information on the value an organization places on

human capital, and provides a systematic way of assessing workplace safety systems and practices. The US labour law governing the federal law of occupational health and safety in the private sector and federal government is the Occupational Safety and Health Act of 1970 enacted by Congress and signed by President Richard Nixon on December 29, 1970. With this act, Occupational Safety and Health Administration (OSHA) was created because of public outcry against rising injury and death rates on the job. The motivation of this agency is to network its resources where they can have the greatest influence in reducing, illnesses, injuries and deaths in the workplace as well as guaranteeing safe and healthful working conditions for industrial employees by setting and enforcing standards and by providing assistance, outreach, education and training. It is expected that OSHA standards and enforcement actions, compliance and programs should be stroked in the industrial sector in Nigeria

The recommendations conventions and of the International Labor Organization was adopted by Nigeria who is a member of the United Nations. Furthermore, Nigeria has a labour law as spelt out in the laws of the Federation of Nigeria (2004). [1] In the Labor Act Cap of Nigeria laws, the Minister of Labour is empowered to make regulations for health, safety and welfare of the worker in the workplace. The Factories' act of 2004, the Workmen's compensation act of 1987 and the labor safety, health and welfare bill of 2012 are significant documents designed for the purpose of protecting the health and safety of the Nigerian worker in the work world. [2] Also, the Nigerian Institute of Safety Professionals the Federal Ministry of Labor and Productivity both have lapse purposes [3] laws concerning occupational health and safety in Nigeria exist, but the level of compliance to those rules is terribly poor in some quarters. Nigeria is used here as a reference in this study, the reflections and deductions drawn are general and valid to typical developing countries. Nigeria as well as many developing countries are determined to achieve an arrangement which structures a supplementary centralized, all-embracing and authorized by OSHA regulatory and enforcement agency. The Nigeria Labour, Safety, Health and Welfare Bill. (LSHW) (2012) was to annul and re-enact the Factory Act, Cap F1 Laws of the Federation, 2004.

Currently, large enough and coherent Occupational Safety and Health (OSH) databases are herculean to come by in Nigeria. A study by [4], though challenged with data limitation, infer that work-related fatalities are on the upsurge in Nigeria between 2003 and 2012. This inference is predicated on actual field data reported to the Inspectorate Division of Ministry of Labour and Productivity ID – FMLP [5]. The ID – FMLP is supplemented by some of groups loosely coordinated Civil Society Groups, Professional Bodies, Government Agencies, Employers' Associations, non- governmental bodies and individual Experts/Consultants undertaking different aspects of OSHA at various levels [5]. International Labour Organization (ILO) has made global estimates of occupational injuries and work-related diseases for the past 20 years. Some Member States submitted their injury data to ILO. However, data on work-related diseases was not available from the ILO regular survey. [6] The missing injury data was estimated from a group of "proxy" countries for each region of the World Health Organisation (WHO). Fatal work-related diseases have been estimated using the latest WHO mortality data by WHO regions and major disease groups. However, distinct from what is obtained in Nigeria, workplaces in the US have become safer over the years. For instance, while UK had 0.8 work-related annual fatal accident rate (per 100,000 full-time work equivalent) in 2003, the rate dropped to about 0.74 by 2011; U.S had 5.0 in 2003 and 3.5 by 2011 [7], [8]. Undoubtedly, Nigeria as well as other developing nations can gain from the enormous experiences of those states that have tremendously invested and established OSHA management systems over numerous decades of hard work. This will not only save the developing nations huge financial resources; it will also fast-track the OSHA development progression round about the developing countries.

In Nigeria Currently, OSHA management is largely based on the Factories Act (1958, 1987 & CAP.126 L.F.N.1990, CAP. F1 L.F.N.2004 and 2012) which seems grossly inadequate in terms of coverage, currency, empowerment, independence, education and training [5]. The very few harmonizing OSHA related regulations are distributed across various authorized documents and [6] In principle, the (ID - FMLP) is vested with the responsibility of OSHA management, which so far has been ineffective [16] A large literature on over-all management of industrial safety exists. See, for example, [17] [18] [19]. Others are [20], [21], [22],[23], [24], [25], [26],[27] and [28]. The commonality among these studies is that similar concerns have been raised within the contents of accident models and that accident causality is attributed to either work errors or work conditions. OSHA management frameworks drivers considered in this paper include government involvement, OSHA budget attention, communication among agencies, staff training, employee's complaint's investigation, penalty of defaulters, outsized workforce, safety violation citations etc. Therefore, it is important to

analyse the numerous variables associated with OSHA considerations and the inter play among these variables, hence the use of KCC to rank the fifty-two (52) identified variables and subsequently apply PCA an explorative tool to obtain the normative as the current practice is conterminous.

A wide literature review was conducted from which fifty-two scale items were obtained and used to design a set of questionnaires which were administered to knowledgeable respondents who ranked them in a merit order of sequence. The essence is to pool the ranking in order to know the relative importance of the variables. It is obvious from the aforementioned reviews that although many studies have researched industrial accident occurrence and its impact on organisations and victims, studies that show panoramic, systemic or holistic view of factorial analysis of OSHA variables are rare. This study therefore seeks to provide the best safety normative, by using the variables to contextualize it in Nigeria since the current practice is conterminous. It is the belief of the author that such knowledge would guide the articulation of policy variables that would surely whittle down the rate of occurrence of occupational accidents.

II. METHODOLOGY

The fifty-two (52) identified scale items, through a wide literature survey, were used to craft set of questionnaires that were administered to knowledgeable respondents in the oil and gas industry in the Niger Delta flank in Nigeria. The scale items were distributed to fifteen judges who ranked the first set of questionnaires in descending order of importance. The respondents' scores were collated into data matrix having a dimension of 15 by 52. The measure of agreement among the judges who ranked the scale items was computed. The uniformity in ranking is represented by Kendall's coefficient of concordance. Chi square (χ^2) was used to appraise how consistent the judges were in ranking the scale items. The Chi-square test, moored on a null hypothesis (H_0) which proposes that the ranking by the 15 judges are discordant; while the alternate hypothesis (H_1) proposes that the 15 judges were consistent. The null hypothesis would be rejected at p-value of 0.05 if the experimental data cannot provide sufficient evidence.

Kendall coefficient of concordance is given by

$$W = \frac{S}{\frac{1}{12} K^2 (N^3 - N)} \quad (1)$$

where,

$$S = \sum \left(R_j - \frac{\sum R_j}{N} \right)^2$$

The ranking by the judges were pooled to obtain a sequence of well-ordered scale items.

Furthermore, the second set of questionnaires that also contains 52 critical variables was administered to other set of (100) respondents (Judges) for their expert evaluations. Respondent's scores were collated as data matrix and fed into StatistiXL software, the output factor matrix interpretation was rendered and results discussed.

From the data matrix the correlation matrix was obtained using Equation (2);

$$r_{ij} = \frac{\sum xy}{\sqrt{(\sum x^2)(\sum y^2)}} \quad (2)$$

where,

$$x = X_{ij} - \bar{X}_{.j}$$

$$y = Y_{ij} - \bar{Y}_{.j}$$

$$\bar{X}_{.j} = \frac{\sum_{i=1}^N X_{ij}}{N}$$

$$\bar{Y}_{.j} = \frac{\sum_{i=1}^N Y_{ij}}{N}$$

$$N = n_j = I = i_{\max}$$

$$J = j_{\max}$$

III. RESULT AND DISCUSSION

Kendall's coefficient of concordance (W), was calculated using Equation (1)

$$W = \frac{S}{\frac{1}{12} K^2 (N^3 - N)}$$

$$S = \sum \left(R_j - \frac{\sum R_j}{N} \right)^2$$

From Factor Ranking Matrix

$$\sum R_j = 20,640$$

$$\frac{\sum R_j}{N} = \frac{20,640}{52} = 396.9231$$

$$S = \sum \left(R_j - \frac{\sum R_j}{N} \right)^2 = 253,653,8$$

Therefore

$$W = \frac{253,653,8}{\frac{1}{12} \times 15^2 (52^3 - 52)} = \frac{253,653,8}{263,542,5} = 0.962477$$

$$\text{Also, } \chi^2_{cal} = K (N - 1) W \quad (3)$$

Where, $K = 15, N = 52, W = 0.962477$

$$\therefore \chi^2 = 15(52 - 1)0.9624 = 736.236$$

A. Test of Hypothesis

H_0 : the ranking of the fifteen (15) judges are not coherent.

H_1 : the ranking of the fifteen (15) judges are in agreement.

Since $\chi^2_{cal} = 736.236 > \chi^2_{tab} = 68.66$, we reject the null hypothesis (H_0) and therefore conclude that the judges ranking of the 52 scale items were consistent.

Our results show that since $\chi^2_{cal} = 736.236 > \chi^2_{tab} = 68.66$, our experimental data do not provide sufficient proof for us to accept a null hypothesis of discordance among the judges who did the ranking. Thus, the null hypothesis, H_0 was rejected at a p-value of 0.05, implying that the judges ranking was in concordance, $W = 0.962477$ (which is meritorious).

B. Result of Kendall Coefficient of concordance

The R_j totals were arranged in increasing order of sequence. $R_1, R_2, R_3, \dots, R_n$, and this helped to determine the order of importance of the variable as ranked by the fifteen Judges. The result of the ranking is depicted in Table 1.

Table 1: Ranking of Variables

S / N	Ranking	Variable description	S/ N	Ranking	Variable description
1	19	Proper Record Keeping	27	400	Illness and Injuries
2	32	Staff Training	28	420	Safety Bureaucratic Processes
3	80	Pre-planning Operation	29	436	Productivity
4	83	National Economy influence	30	460	Thorough Inspection
5	100	Health, Safety and Environment	31	460	Outsized Workforce
6	116	Identification of hazard	32	479	Adequate OSHA Manpower

7	117	Communication Among Agencies	33	490	Comprehensive OSHA Programme
8	146	Prediction of Hazard	34	514	Safety Violation Citations
9	160	Political Factors	35	520	Regional OSHA Offices
10	160	Prevention of Hazards	36	535	Accidents Reporting
11	175	Company Policy	37	538	Dedicated Safety Personnel
12	195	International Labour Organisation	38	539	Injuries and Illness Control
13	208	OSHA Regulatory Update	39	550	Charting of Accidents
14	210	Regular Visit Schedule	40	579	Regional Supervision
15	225	Government Involvement	41	585	Employee's Safety
16	240	Penalty of Defaulters	42	625	Industrial Safety Programme
17	255	Industries Safety Culture	43	640	Cost of Training Programme
18	270	Logistics Issues	44	645	OSHA Budget Attention
19	285	Available Safety On-the-ground Inspectors	45	666	Inspectorate Resources
20	300	Adequate Safety Gadgets	46	674	Incidents Reductions
21	315	Means of Communication	47	697	Safety, Agencies Structures
22	332	Adequacy of Compensation	48	705	OSHA Indicators
23	363	Prompt Response	49	710	OSHA Data Collection
24	371	Workplace Safety Inspectors	50	740	Healthy Working Conditions

25	390	Employees Complaints Investigations	51	744	International Networking Practices
26	395	Documentation of Violations	52	747	Illness and Injuries

C. Result of Principal Component Analysis

The fifty-two variables were developed into questionnaire and presented to 150 respondents where only 100 respondents were retrieved. The responds scores obtained from the questionnaire were arranged in matrix form based on the 5-point Resis-Likert scale. The scree plot showing the elbow at (8,1) is depicted in Figure 1 below. It is obvious from the scree plot that at eigenvalue of 1, and component number 7, the curvity tends to flatten out, suggesting that eight factors extracted are adequate. This shows that there is significant thrift in factor reduction from 52 to mere 8.

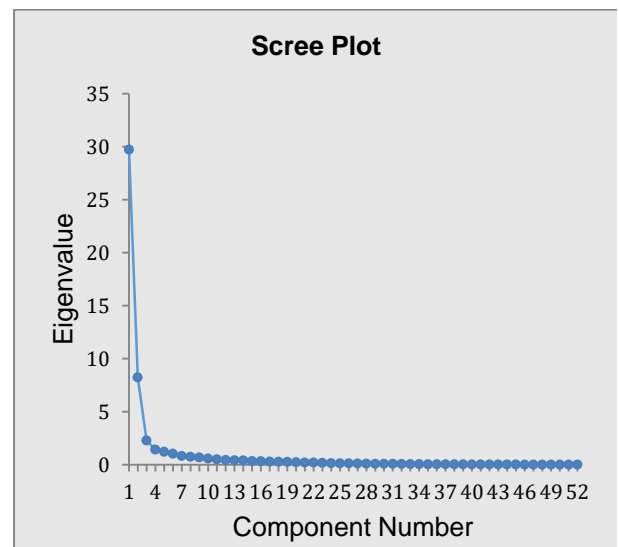


Fig.1: Scree Plot

D. Factor interpretation

Table 2: Factor 1 (F₁) "PRINCIPAL FACTOR"

S/N	Variable description	Factor Loading
1	Proper Record Keeping	0.563
2	Staff Training	0.863
3	Pre-planning Operation	0.450
4	National Economy influence	0.864
5	Health, Safety and Environment	0.681
6	Identification of hazard	0.538
7	Communication Among Agencies	0.875
8	Prediction of Hazard	0.677
9	Political Factors	0.713
10	Prevention of Hazards	0.784
12	International Labour	0.799

	Organisation	
14	Regular Visit Schedule	0.663
15	Government Involvement	0.526
16	Penalty of Defaulters	0.898
17	Industries Safety Culture	0.722
23	Prompt Response	0.478
24	Workplace Safety Inspectors	0.743
27	Fatality Rates	0.471
30	Productivity	0.724
32	Outsized Workforce	0.563
33	Adequate OSHA Manpower	0.863
34	Comprehensive OSHA Programme	0.450
35	Safety Violation Citations	0.864
37	Accidents Reporting	0.417
38	Dedicated Safety Personnel	0.566
39	Injuries and Illness Control	0.715
40	Charting of Accidents	0.579
41	Regional Supervision	0.543
45	OSHA Budget Attention	0.820

This principal factor is stocky and it contains seven (7) key variables with substantial factor loading of the order of **0.8**. Foremost among them is penalty of defaulters it is quite crucial and even critical because the penalty could entail severe punishment such as close down of an organisation or even imprisonment of offenders calculated to serve as deterrence to future offenders. Next in importance is communication among agencies which wield a factor loading of **0.875** it is equally significant as the flow of formal and informal communication within the organisation is vital for all round effectiveness of a system. Safety violation citations and National Economy Influence both wields a factor loading of **0.864** with laws in place, disobedience of safety rules is prevented, the influence of the economy of a nation have a unique existence greater than the individual units within it. Staff Training wield **0.865** this helps to improve the knowledge of the employees or workforce. Adequate OSHA manpower who is always available and fitted for service. OSHA budget attention loaded **0.820** requires that the relevant body should give the needed attention to budget. Similar interpretation is rendered for all other factors.

Table 3: Factor2 (F₂) “**Accident Management**”

S/N	Variable Description	Factor loading
26	Documentation of Violations	0.466
36	Regional OSHA Offices	-0.775
37	Accidents Reporting	-0.691
38	Dedicated Safety Personnel	-0.654
40	Charting of Accidents	-0.673
41	Regional Supervision	-0.725
42	Employee’s Safety	-0.958
43	Industrial Safety Programme	-0.914
44	Cost of Training Programme	-0.890
46	Inspectorate Resources	-0.921
47	Incidents Reductions	-0.939
48	Safety, Agencies Structures	-0.853

49	OSHA Indicators	-0.900
50	OSHA Data Collection	-0.885
51	Healthy Working Conditions	-0.946

All the variables on table 3 except the first, are negatively loaded thereby making the factor slender. It should be noted that the slenderness’ is interpreted with respect to the issue of accident management. The implication of this is that the practice of safety in the nation appears to be a complete departure from the normative. It lacks continuous commitment to protecting workers from deadly safety hazards at work, fails in ensuring that vulnerable workers in high-risk jobs such as obtainable in the Niger delta flank of Nigeria have access to critical information and education about job hazards Employees safety wields a meritorious factor loading of **-0.958** the implication is that our perception of industrial safety practice is basal or at infantry level, the nation is far from OSHA best practice. The standard of OSHA in Nigeria is there adjudged to be weak. This is the equivalent incident at Alpha Piper [[Piper oilfield](#)] an oil production platform in the North Sea approximately 120 miles north-east of Aberdeen, Scotland, that was operated by Occidental Petroleum Limited. Where **167** lives were lost in 1988 with property damaged worth £1.7 billion. The Nation concerned is at its threshold of infancy. These events as depicted on the table 3 above with substantial negative factor loadings will often cause huge damages to the environment, facilities and even in some cases, fatalities and disabilities for people.

Table 4: Factor 3(F₃) “**Systemization**”

S/N	Variable Description	Factor Loading
3	Pre-planning Operation	0.650
13	OSHA Regulatory Update	0.594
18	Logistics Issues	0.825
22	Adequacy of Compensation	0.592
23	Prompt Response	0.555
27	Fatality Rates	0.481
28	Illness and Injuries	0.840
29	Safety Bureaucratic Processes	0.415
31	Thorough Inspection	0.737
34	Comprehensive OSHA Programme	0.650

Systemization. Here, the most substantive factor which wields a meritorious factor loading of 0.840 is illness and injuries, this is a vital factor in safety, it is necessary for a system to ensure the safety of both lives and properties always. As a matter of necessity, a process of automaton of safety is top most priority of a viable system, next is logistic issues with factor loading of 0.825 this also implies the need to systematize our approaches to solving safety problems. Occupying the third position is thorough inspection with factor loading of 0.737, for accurate prediction of fatality in any work world, thorough inspection must be in place. Other factors in order of

descending factor loading are pre –planning, comprehensive OSHA programme, adequacy of compensation among others requires proper systematization. OSHA is generally known for the centralization and systematization of records keeping and reporting of the OSHA Act to employer.

Table 5: Factor 4(F₄) “Safety Ground Rules”

S/N	Variable Description	Factor Loading
11	Company Policy	-0.843
17	Industries Safety Culture	-0.445
19	Available Safety On-the-ground Inspectors	-0.832
20	Adequate Safety Gadgets	-0.819
21	Means of Communication	-0.769
29	Safety Bureaucratic Processes	-0.600

Safety Ground Rules refers to basic principles on which future action will be based. It is the formula for operating a system, in this case the factor loadings are negative which implies slenderness in this factor indicates gross departure from OSHA best practices, deficiency in providing assistance and cooperative programs to save thousands of lives and prevent countless injuries and illnesses. with company policy topping the list with factor loading of **-0.843** indicating that practices in industries are at variance with the norm. There is no availability of safety on the ground inspectors as shown in the next factor with factor loading of **- 0.832**. Adequate safety gadgets wield **-0.819** and means of communication wields **-0. 769**. Portraying paucity OSHA situation.

Table 6: Factor 5 (F₅)

S/N	Variable Description	Factor Loading
25	Employees Complaint’s Investigation	-0.872

Table 7: Factor 6 (F₆)

S/N	Variable Description	Factor Loading
32	Outsized Workforce	-0.746

Table 8: Factor 7 (F₇)

S/N	Variable Description	Factor Loading
26	Documentation of Violations	0.594

Table 9: Factor 8 (F₈)

S/N	Variable Description	Factor Loading
15	Government Involvement	0.635

Factors 5, 6, 7 and 8 are collectively labelled Miscellany. This can be said that it is a mixed bag or

cock tail with a conglomeration of sensitive factors with employee’s complaint’s investigation having a negative factor loading of **-0.872** showing the careless attitude of the system towards employees. Next is Outsized Workforce with factor loading of **-0.746** indicating lack of adequate hands managing the safety administration. Government Involvement is next with factor loading of **0.635**; here the level of involvement does not indicate meritory as it ought because it concerns safety. The business of safety in any system can be effective when violations are recorded, from the result shown above Documentation of Violations with factor loading of **0.594** indicate a meddling effect. Looking to the future employers with vigorous compliance to promote best practices that can save lives will need a review of the current practices to give hope and confidence to the lives of employees.

IV. CONCLUSION

Accident management in Nigeria from the studies appear to be at the threshold of its kindergarten. Therefore, a basic principle on which future action will be based is a re-contextualisation of OSHA portable concept – the best formula needed for operating a normative safety system have been discussed. This would guide the articulation of policy variables that would surely whittle down the rate of occurrence of occupational accidents.

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