

# Occupational Safety and Health Administration Factorial Study

**Cordelia Ochuole Omoyi\***

Department of Production Engineering, University of Benin, Benin City  
Nigeria

\* [cordelia.omoyi@eng.uniben.edu](mailto:cordelia.omoyi@eng.uniben.edu)

**Kazeem Aderemi Bello**

Mechanical and Mechatronics Engineering  
Department, College of Engineering, Afe Babalola  
University, Ado Ekiti, Ekiti State, Nigeria  
[itanooluwaponmile@yahoo.com](mailto:itanooluwaponmile@yahoo.com)

**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 ( $\chi^2$ ) 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.

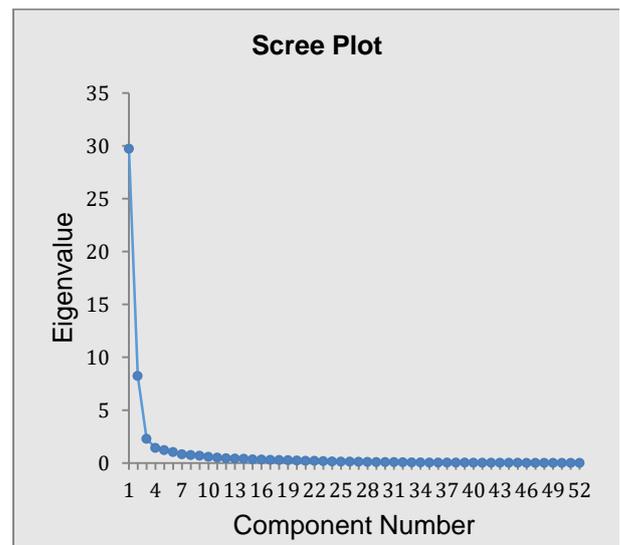


Fig.1: Scree Plot

D. Factor interpretation

Table 2: Factor 1 (F<sub>1</sub>) "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 (F<sub>2</sub>) “**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(F<sub>3</sub>) “**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(F<sub>4</sub>) “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 (F<sub>5</sub>)

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

Table 7: Factor 6 (F<sub>6</sub>)

| S/N | Variable Description | Factor Loading |
|-----|----------------------|----------------|
| 32  | Outsized Workforce   | <b>-0.746</b>  |

Table 8: Factor 7 (F<sub>7</sub>)

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

Table 9: Factor 8 (F<sub>8</sub>)

| 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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