The Impact of Safety on Engineering Practice: A Case Study of Technical Sector in Nigeria

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Abstract— In the course of practicing technical responsibilities a lot of accidents have occurred in Nigeria in the past resulting to injuries, deaths, permanent disabilities, equipment damage and pollution to the environments. This research paper was developed to identify the level of risk and hazard awareness/ management in Nigeria technical sector with a view to finding solutions to causes of safety problems in order to minimize unintended occurrence to as low as reasonably practicable in Nigerian industries.The materials were used for this research include; Calculator, field note, pen, Laptop and Microsoft excel software. Two research hypotheses (null and alternative hypothesis) were developed and tested. The data used for this research were collected using 50 copies of structured questionnaires that were distributed to elicit responses from respondents. Data analysis was done using F-distribution on collected responses in order to test research hypotheses to determine their significance or otherwise. The analyzed research data show that; there is significance in the test, test Null hypothesis is rejected, while the alternative which says; there is a significant relationship between lack of safety awareness and increased rate of accidents in Nigerian Engineering practice" is accepted. From the findings of this research the following recommendations were made; (1)that the federal government of Nigeria through its Ministry of Education and National University Commission should develop a curriculum for general safety and incorporate same in general study subjects taken at all levels of Nigerian schools, so as to help galvanize safety and security consciousness of every Nigerian. (2), the establishment of safety department in all establishments operating in Nigeria was recommended, so as to ensure strict enforcement and compliance with safety norms and safe work habits by Nigerians.

Keywords: hypotheses, technical, F-distribution, Null hypothesis, Laptop, Microsoft, permanent disabilities, hazard, respondents, significance.

I. INTRODUCTION

Engineering is the applications of scientific, economic, social, and practical knowledge to design, building, maintain structures, machines, devices, systems, materials and processes which are critical to the existence of mankind, [11]. It involves using scientific and technical insights to conceive, model, scale an appropriate solution to a problem and achieve an objective. The discipline of engineering is broad and consists of more specialized fields of engineering, each with specific emphasis on particular areas of technology & application of scientific knowledge,[4].

While, the practice of engineering profession is defined as performing professional service such as consultation, investigation, evaluation, planning, design, supervision of construction and operation in connection with any utilities, structures, buildings, machines, equipment, processes, works, or projects wherein the safeguarding of life, health and property, when such service or work requires the application of engineering principles and data, [1].

According to Merriam-Webster, the primary definition of safety is "the condition of being totally free from harm or risk of all kind," which is essentially the same as the primary definition of security, as the "state of being completely free from danger." This can be differently put as; security is "measures taken to guard against sabotage, crime, attack or escape," and this is generally the definition we use largely when we refer to industrial security. To this end, industrial safety and industrial security are inter-twined.

Using these definitions, we can better understand the relationship between safety and security. The relationship is such that a weakness in security creates increased risk, which in turn creates a decrease in safety. While this may all seem elementary, understanding the relationship between safety and security is very important to understanding how to integrate the two. Those that own and operate industrial facilities, especially those that many governments have defined as critical infrastructures; certainly understand the meaning and importance of safety and security relative to their operations.

Challenges before Nigerian Engineers in practice

The unintended outcomes of past engineering solutions to problems have adversely affected our natural environment. Environmental sustainability, good health, reducing our vulnerability and adding to the joy of living is essential for humanity to flourish, [10]. To fulfill this quest, forms challenges for every professionals including engineers. The challenges relate to; energy, environment, health, medical sciences, education, safety, information technology, infrastructure and security. Through creativity and commitment, these engineering challenges can be realistically managed. Some of the challenges facing engineering practice include but not limited to;

- ✓ Industrial safety & security
- ✓ To make solar energy affordable
- ✓ Provide energy from nuclear fusion & Prevent nuclear terror
- ✓ Develop carbon sequestration methods.

✓ Manage the nitrogen cycle.
✓ Provide access to clean water.
✓ Restore and improve urban infrastructure.
✓ Advance health informatics.
✓ Reverse-engineering
✓ Secure cyberspace.
✓ Enhance virtual reality.
✓ Advance personalized learning.
✓ Engineer the tools for scientific discovery.

National Industrial Safety Council of Nigeria

The National Industrial Safety Council of Nigeria was established in May, 1964 by a cabinet decision under the sponsorship of the Federal Ministry of Labor and Employment to function and be managed based on tripartite structure of Government, Labor and Employers,[9]. The objectives of the Council shall be the prevention of industrial accidents and hazards and the promotion of occupational health, safety and welfare in industrial establishments operating in Nigeria. The Council upholds tripartite composition involving Government, Labor & Employers and invites the participation of critical stakeholders including the private sectors and safety professionals.

The functions of the Council are:

1) To act in an advisory capacity on all matters relating to its objectives
2) To co-operate with all branches of government services, employers and workers organizations and any other organizations or individuals in Nigeria or elsewhere in furtherance of its objectives.

The National Policy on Occupational Safety and Health, which is a guide to Occupational Safety and Health in Nigeria is the government's approach for achieving a National development philosophy of building a united, self-reliant and egalitarian economy through minimizing so far as is reasonably practicable, the causes and effects of hazards inherent in the working environment in response to her ratification of Convention 155 on Occupational Safety, Health and Working Environment. The Policy came into force in November, 2006.

In simple words, safety means freedom from the unplanned/unwanted occurrence or risk of injury or loss of all kind,[3]. As regards, industrial safety, it means the protection of employees/workers from the danger or risk of industrial accidents and exposure in work environment. In other words, industrial safety refers to protection against accidents occurring in the industrial establishments.

Safety performance is measured by the number of accidents recorded by a firm or organization in a year,[2]. Safety Practice is measured by the frequency of visitation to work sites by Safety Inspectors and the frequency of Safety Meetings held to discuss, train and enforce safety within an organization. Both can be held fortnightly, monthly, bimonthly or quarterly. Other parameters are safety management which measure the personality of the safety manager who can be a Safety Manager, Site Manager/Builder/Engineer, Foreman or safety officer; Safety equipment a company possesses from a selected number of equipment; the safety incentive rating of a company which is a measure of the number of incentives provided to workers from selected incentives namely safety bonus, promotion, increase in wages, award of certificate and gift presentation which is intended to reduce incidents rate and encourage safe work culture of employees by the employer/management or supervisor.

An industrial accident is a sudden and unexpected occurrence in the industry which interrupts the orderly progress of work. According to the Factories Act, 1948: "It is an occurrence in an industrial establishment causing bodily injury to a person which makes him unfit to resume his duties in the next 48 hours". In other words, accident is an unexpected event in the course of employment which is neither anticipated nor designed to occur,[5].Thus, an accident is an unplanned and uncontrolled event in which an action or reaction of an object, a substance, a person, or a radiation results in personal injury. It is important to note that self-inflicted injuries cannot be regarded as accidents. An industrial injury is defined as "a personal injury to an employee which has been caused by an accident or an occupational disease and which arises in the course of employment task and which could entitle such employee to compensation under Workers' Compensation Act, 1923".

Industrial accidents are becoming more common globally. Nnedinma, et al(2104) in [7] Revealed that between 2002 and 2012, forty (40) major industrial accidents were reported to the Federal Ministry of Labor and Productivity Inspectorate Division (FMLPID), Nigeria, which led to ninety-three (93) injuries and forty-six (46) deaths. Understanding the causes, fatalities, injuries, and damage involved in an industrial accident is key to preventing future occurrence. There is therefore a felt need to forestall the occurrence of accident in our industry if the lives of its employees and nearby dwellers would be safe. This is especially important because often times, industries are located in densely populated places.

An Industry refers to the commercial production and sale of goods. Industrial companies make tangible items to sell to the public, government or other entities. They create products where no product existed through manufacturing processes. They build factories to create these products by hiring engineers and scientists to design new ones,[8]. Ministry of Health, Labor and Welfare (2008) in [6], categorized industry under the following broad sectors:

i. Primary Industries: these are industries that are involved with mining and extraction of raw material and minerals from their natural sources. Example include; coal mine, quarry and iron ore extraction.

ii. Manufacturing Industry: A secondary industry is concerned with production of finished goods from raw materials.

Examples include cement industry, sugar industry and oil refinery.

iii. Construction Industry: It is the category of industry that deals with road and housing construction using products or by-products from primary industries.

iv. Land Transportation Industry (Logistic Industry): This is also referred to as road transportation industry, as it is concerned with the movement of people and goods by rail, air, waterway and road.

v. Forestry Industry: This is also known as wood industry. It is concerned with the harvest, transport and processing of large trees.

vi. Tertiary Industry: This industry renders services to people. Examples include banks and accountancy firms etc.

Types of Industrial Accidents

Accidents may be of different types depending upon the severity, duration and degree of the injury involved. An accident causing death or permanent or prolonged disability to the injured employee is called 'major accident. An accident resulting to cut that does not render the employee disabled is termed as 'minor' accident. When an employee gets injury with external signs, it is termed an external injury. Injury without showing external signs such as a fractured bone is called an internal one. When an injury renders an injured employee disabled for a short period, say, a day or a week, it is a temporary disability. On the contrary, making injured employee disabled forever is called permanent disability. Disability caused by accident may be partial or total, fatal or non-fatal. It has been noticed that an accident does not have a single cause but a multiplicity of causes, which are often closely related. The types of industrial accidents are represented graphically in fig.1
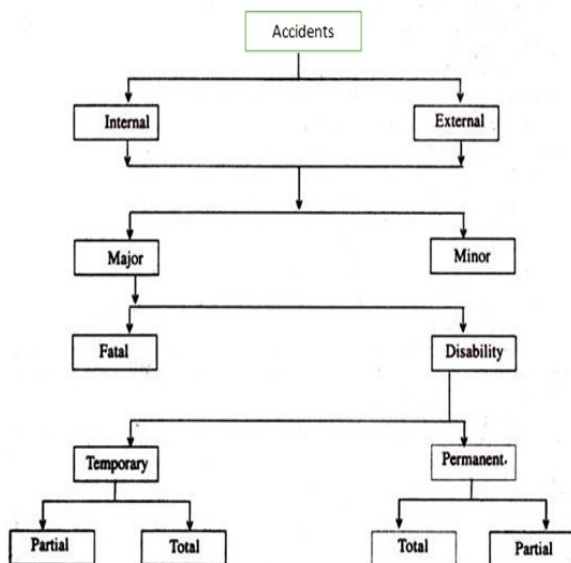

Fig. 1 types of accidents

II. OBJECTIVES OF THE STUDY

i. To create a general framework for the improvement of working conditions and the working environment for employees in Nigerian engineering Industries.
ii. To reduce occurrence of accidents and departures from occupational health problems arising out of or in the course of work.
iii. To ensure the provision of occupational safety and health services to workers in industrial sectors of economy.
iv. To raise awareness on adherence to safe work culture by Nigerian employees and employers.
v. To generate Nigerian industrial accident & incident related data and make same available to repository of knowledge.

III. RESEARCH METHODOLOGY

The following materials were used for this research;

- ✓ Calculator
- ✓ Field note and pen
- ✓ Laptop
- ✓ Microsoft excel software
- ✓ 50 copies of well-structured questionnaires

This research work was carried out using a four steps methodology as follows;

- ✓ Intensive literature search was carried out to identify and completely define areas of needs that necessitate this research.
- ✓ Data collection: Questionnaires and field visits were explored to gather data required for this research.
- ✓ Data classification and analysis of collected information using Microsoft excel and SPSS software.
- ✓ Finally, the writing of research and publication of paper

3.1 Research hypothesis

Ho: There is no significant relationship between lack of safety awareness and increased rate of accidents Nigerian Engineering practice.

H1: There is significant relationship between lack of awareness culture and increased rate of accidents in Nigerian Engineering practice.

3.2 Data Collection

The data used for this research were collected using 50 copies of structured questionnaires that were randomly distributed to elicit responses from respondents who are mainly employees in different establishment within Port Harcourt in Rivers state and Yenagoa, Bayelsa State, Both in Nigeria. The questionnaire contain two parts; section 1 "contain information on Bio Data of Respondents", while section 2 contain "the research questions".

3.3 Data Analysis

Data analysis was done using F-distribution analysis on collected and classified data in order to test research hypotheses so as to determine their significance or otherwise.

IV. RESULTS AND DISCUSSION

Analysis of Bio Data of Respondents

Tab. 2.Gender composition of Respondents

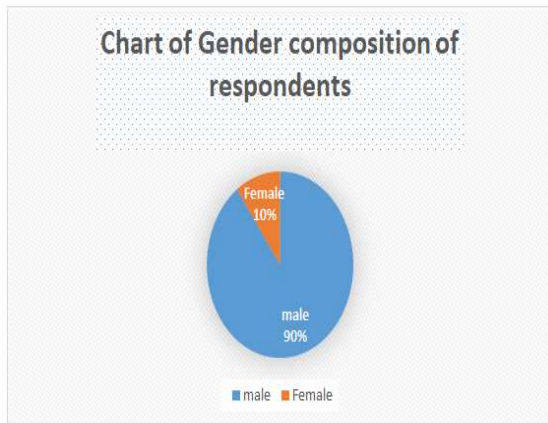| Male	Female
45	5

Fig. 1. Chart of Gender composition of respondents

Tab.2. and Fig.1.show the gender composition of respondents that were sampled. The result indicates 90% of the respondents are male while 10% are female this might be due to the fact that the Nigerian Engineering/technical sector is male dominated owing to drudgery involved in its operation and also the difficult terrain in most operational site.

Tab. 3. Age distribution of Respondents

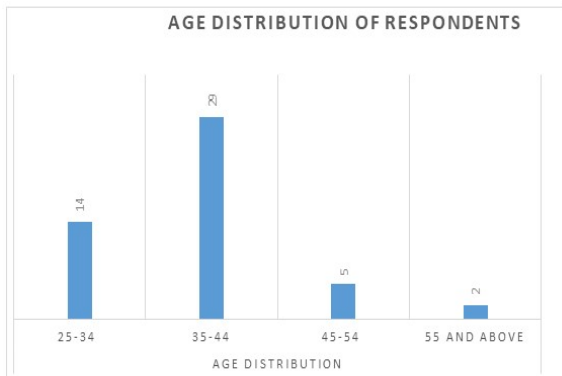| 25-34	35-44	45-54	55 and above
14	29	5	2

Fig.2. Age Distribution of respondents

The Age distribution of respondents is shown in Tab.3. and Fig.2 respectively**.** The result indicates that; 29 respondents out the 50 sampled (58%) had their age ranges between 35-44 years. 14 (28%) respondent were between 25 and 34 years old, 5 (10%) of respondents were between 45 and 54 years while 2 (4%) of those sampled fell in the age range of 55 and above.

Tab.4.Educational Qualification of Respondents

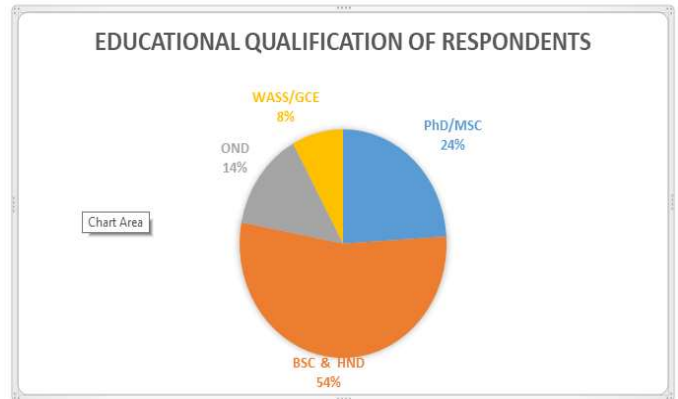| PhD/MSC	BSC/ HND	OND	WASS/GCE
12	27	7	4

Fig.3. Educational Qualification of Respondents

Tab.4. and Fig.3. Show the educational qualifications of respondents. 54% of the respondents had BSC /HND, 24% had PhD/MSC, 14% had OND while 8% of the 50 respondents interviewed had WASCE/GCE and lower academic qualifications.

Tab .5. Income distribution of Respondents

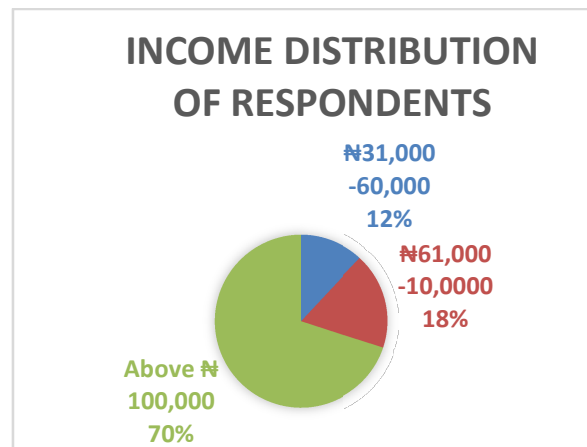| Amount	₦31,000-60,000	₦61,000-10,0000	Above ₦ 100,000
frequency	6	9	35

Fig.4. Income distribution of Respondents

Income distribution of respondents is illustrated in Tab.5 and Fig.4 respectively. 70% of the respondents sampled reveled their monthly income is above ₦100,000.   18% of respondents said their monthly income range is between ₦61,000-10, 0000 while 12% earned ₦31,000-60,000 per month.

Analysis of Research Questions

Tab.5 Mean responses on the relationship between lack of safety awareness and increased rate of accidents in Nigerian industry (n=50)

Research Questions	SA (4)	A (3)	D (2)	SD (1)	Total responses	Mean score
1. Safety is as important as production in engineering practice in Nigeria.	23	15	8	4		
	92	45	16	4	157	3.14
2. Most workplace accidents in Nigeria are caused by actions, in-actions of employees or unsafe work conditions in Nigeria.	32	10	5	3		
	128	30	10	3	171	3.42
3. The safety culture and management commitment to safety matters in an organization can positively or negatively affect personal attitude to workplace hazards management and general safety in engineering practice.	18	22	8	2		
	72	66	16	2	156	3.12
4. In recent time there have been increased rate of accidents and fatalities resulting from poor safety culture in the execution of technical projects in Nigeria.	10	32	2	6		
	40	96	4	6	146	2.92
5. Excess work pressure and unrealistic production target on Nigerian workforce by Employers creates room for poor safety culture that result in several accidents.	12	29	8	1		
	48	87	16	1	152	3.04
Grand Mean						**3.128**

Key: Strongly agree→ SA

Agree   → A

Disagree   →   D

Strongly disagree→ SD

Tab.6 Computation of statistical variables from the hypothesis in Tab.5

S/N	Strongly agree X	X^2	Agree X	X^2	Disagree X	X^2	Strongly disagree X	X^2
1.	23	529	15	225	8	64	4	16
2.	32	1024	10	100	5	25	3	9
3.	18	324	22	484	8	64	2	4
4.	10	100	32	1024	2	4	6	36
5.	12	144	29	841	8	64	1	1
Totals	**95**	**2121**	**108**	**2674**	**31**	**221**	**16**	**66**

$$SS_T = \sum y - \frac{(\sum X)^2}{N}$$

Where SS_T= Total sum of Squares

$(\sum X)^2$ = sum of squares X

$\sum y$ = sum of y

 N   = no of Research Question x group of response = 5 x 4 =20

$\sum y$= 2121 +2674+ 221 + 66 = 5082

$$\frac{(\sum X)^2}{N} = \frac{(95+108+31+16)^2}{20} = \left(\frac{250}{20}\right)^2 =$$

$\frac{62500}{20}$ =3125

SS_T = 5082 − 3125 = 1957

Calculation of between group sum of squares (SSB)

$$\mathbf{SSB} = \frac{(\ \Sigma X\ )^2}{n} - \frac{(\ \Sigma X\ )^2}{N}$$

$$\left(\frac{\Sigma X}{n}\right)^2 = \left(\frac{95}{5}\right)^2 + \left(\frac{108}{5}\right)^2 + \left(\frac{31}{5}\right)^2 + \left(\frac{16}{5}\right)^2$$

Hence; $\left(\dfrac{\Sigma X}{n}\right)^2 = 1{,}805 + 2{,}332.8 + 192.2 + 51.2 = 4{,}381$

Similarly; $\left(\dfrac{\Sigma X}{N}\right)^2 = \dfrac{(\ 95+108+31+16\ )^2}{20} =$

$\left(\dfrac{250}{20}\right)^2 = \dfrac{62500}{20} = 3125$

$\mathbf{SS_B} = 4{,}381 - 3125 = 1{,}256$

Calculation of within group sum of squares (SSw)

$SS_W = SST - SSB$

$SST - SSB = 1957 - 1256 = 701$

$SS_W = 701$

Calculation of Degrees of Freedom

df for the whole group = total number of observation minus one

$df = 20 - 1 = 19$

$SS_B df$ = number of group minus 1 = 4-1 = 3

SSW df = number of group taken away from number of subjects = 20-4 = 16

Calculation of Variances:

Between group variance (SB^2) =

$$\frac{Between group sum of squares (SSB)}{Between group degree of freedom}$$

Where C-1 → 4 – 1 = 3

$\mathbf{SB^2} = \dfrac{1{,}256.2}{3} = 418.73$

Within group variance (SW^2)

$$\frac{Within group sum of squares (SSW)}{Within group degree of freedom}$$

Where; n = 20

C = 4

That is; 20 - 4 = 16

$$SW^2 = \frac{701}{20 - 4} = \frac{701}{16}$$

$\mathbf{SW^2} = 43.8$

$$F_{\text{Calculated value}} = \frac{Between group variance}{Within group variance} = \frac{SB^2}{SW^2}$$

degree of freedom is 16 under 3 → 3/16

$$F_{\text{Calculated value}} = \frac{418.73}{43.8} = 9.56$$

F Distribution: Critical Values of F @ 0.01 level of significance (1% significance level)

$F_{\text{Calculated value}} = 5.29$

The statistical analysis of experimental data above gave a calculated F-Value of **9.56**. While the critical F-Value of 5.29 is gotten from F-distribution table; row 16 under column 3 degree of freedom at 0.01 level of significance. This calculated F-Value is greater than the F-tabulated value hence there is significance in the test. To this end the null hypothesis which states that; "there is no significant relationship between poor safety culture and increased rate of accidents in Nigeria Engineering practice" is rejected while the alternative hypothesis which states that "there is a significant relationship between poor safety culture and increased rate of accidents in Nigerian Engineering practice" is accepted.

V. CONCLUSIONS

The analyzed research data above show that; there is significance in the test. To this end the null hypothesis which states that; "there is no significant relationship between lack of safety awareness and increased rate of accidents in Nigerian Engineering practice" is rejected while the alternative hypothesis which states that "there is a significant relationship between lack of safety awareness and increased rate of accidents in Nigerian Engineering practice" is accepted.

VI. RECOMMENDATION

From the findings of this research I wish to make the following recommendations;

i. That the federal government of Nigeria through its Ministry of Education and National University Commission should develop a curriculum for general safety and incorporate same into general study subjects/courses taken at all levels in Nigerian

schools, so as to help galvanize safety and security consciousness of every Nigerian.

ii. The establishment of safety compliance unit in all establishments including, companies, Universities, Polytechnics and other educational Institutions operating in Nigeria. This will ensure strict enforcement and compliance with safety norms and safe work habits by Nigerians which has the possibility of managing hazards, reducing incidence & accidents to make our homes & work place safer.

iii. That the federal government of Nigeria through its Ministry of Trade and Industry should ensure that every employer of labor in Nigeria provides; adequate personal protective equipment, clean drinking water & toilets at work place, work tools/materials, free occupational health & safety services as well as conducive work environment for their employees.

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