Analysis of Safety Performance in Nigerian Construction Industry

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Abstract
The quest for the provision of adequate housing for all has translated to the increase in activities of Building construction industry in Nigeria. This growth is accompanied however with cases of poor safety performance which at times leads to structural failure. This study investigates and analyses safety performance in Nigerian construction industry. Investigatory survey research method (work study) was adopted to appraise the aim and objectives of the study through field and questionnaire approach. Questionnaire survey consisting of a five point Likert scale was conducted to solicit information from the respondents, and a total of 120 questionnaires were issued to construction professionals and workers on the sites visited. 92 questionnaires representing 76.67% response rate were retrieved and analysed using Statistical Package for Social Sciences (SPSS) version 21. Communalities test, Principal Component Analysis along with ANOVA were utilised for data analysis. A total of thirty-two (32) factors influencing safety performance were identified from literature, subsequently principal component analysis was utilised to reduce the list to nine (9) significant principal factors. The top nine principal factors influencing safety performance determined from the research are: Relationship between Supervisors and Employees on site, Geographical Location (Environmental Factors: Natural and Working Environment), Working Procedure, Ear defenders not worn (while working under noisy equipment),Talk by Management on Safety, Tidy Site, Safety Communication, Operatives job experience and Ladders used without being tied secured. These factors were further incorporated into a regression model. The adjusted coefficient of determination of the model was 0.98; this shows that the model has the capability of explaining 98% of variability in the data under consideration. This implies that the model is adequate in evaluating safety performance. It is therefore recommended that key industry professionals and stakeholders should channel available resources to the determined nine (9) principal safety performance factors.

Keywords: ANOVA, Construction, Nigeria, Safety performance**.**

Introduction

The construction industry is vital for economic and social development of every nation, it connects with other sectors of the economy to boost development. This sector is a major employer of labour especially in developing nations like Nigeria. Despite this significance, the industry is plagued with several challenges like unskilled man power, inadequate safety provisions and financial challenges. The quest for the provision of adequate housing for all has translated in the increase in activities of Building construction industry in Nigeria, this growth is accompanied however with cases of poor safety performance.

Various work place behaviours can collectively be termed as safety performance (DeArmond *et al.,* 2011). Researchers over the years dealing with the topic of safety performance have focused mainly on the issues of complying with safety regulations on construction sites. Griffin and Neal (2000) however viewed the topic of safety performance in a multi-dimensional approach, they sub divided safety performance into safety compliance and safety participation. Gou *et al.* (2015) however viewed safety compliance as adhering to the rules and regulations, carrying out work in a safe manner while performing a task whereas safety participation refers to behaviours which help develop an environment to support safety (promoting safety programmes on site, helping co workers and putting effort geared towards improving safety on site).

Construction activities in virtually all developing countries like Nigeria is a labour intensive venture unlike in the developed countries around the globe, it involves 2.5 – 10 workers per activity (Farooqui *et al.,* 2008). Majority of these workers are migratory in nature, they tend to move round the country in most cases without their families in search of work. Injury occurrence on these construction sites are rarely reported by the workers, this is because they mostly have the perception that nothing will be done to address the problems even when reported. Construction contractors in Abuja, Nigeria rarely take care of injured workers, in cases where they do, the workers themselves see it as a form of generosity from the contractors (Kolo, 2015).

Impact of Poor Safety Performance

According to the International labour organization (ILO) an estimated 2.78 million workers die on a yearly basis accompanied with an estimated loss of gross domestic product (GDP) of 2.99 trillion dollars yearly as a result of work related illnesses and injuries worldwide. From these figures, 2.4 million of the deaths are as a result of work related diseases alone (The Nation, 2017). The alarming statistics tend to further support existing body of evidence demonstrating the global cost of failing to adequately address existing and emerging occupational safety and health (OSH) concerns and the importance attached to OSH for sustainable development. Okeola (2009) opined that in Canada, company practices had an impact on safety performance, projects where a safety officer was employed had better safety performance records. A report by the Corruption prevention department of the Independent Commission against Corruption Hong Kong (ICAC, 2013) revealed that corruption within the construction industry has led to substandard works which affect quality of buildings and also threatens public safety. Ideal construction quality control involves inspecting and testing of materials, ICAC reveals the process is corruption prone; the cost of purchasing construction materials and paying for workmanship is very high hence there are always attempts by unscrupulous contractors to cover up the use of substandard materials and works by offering bribes to the inspectors. A number of malpractices as enumerated by the ICAC include: manipulation in sampling of materials for testing, substitution of test samples, falsification of test reports and false or selective reporting of results obtained from field test.

According to Ezenwa (2001) the number of fatal injuries reported to the Federal Ministry of Labour and Productivity (Inspectorate Division) revealed that of about 3, 183 reported injuries, 71 were fatal. The period from 1990 to 1994 recorded about 22% fatality rate. Idoro (2011) further opined that in the year 2006, the best safety record was 5 injuries per worker and 2 accidents per 100 workers. These statistics are arguably high. Unfortunately, though prequalification is widely practiced in Nigeria in the process of awarding construction contracts, safety considerations are not given priority in these processes (Olatunji and Aje, 2005).

Construction industry exposes humans who are its major drivers to various safety hazards (Ranganathan, 2016). These hazards if not adequately managed can lead to poor workmanship which hinders design quality and the desired life span of construction. The existing traditional approaches of measuring safety performance primarily utilises the lag indicators: accident rates, total recordable injury rates (TRIR), fatality rates, experience modification rating (EMR) and days away, restricted work or transfer (DART). These measures have been critisised for being reactive in nature with the shortcomings of the inability to give early warning against accident occurrence (Gou *et al.,* 2015: Hinze *et al*., 2012). These shortcomings have led to an advocacy for adoption of lead indicators, leading indicators are measures (not necessarily historical) which can be used as predictors of future level of safety performance.

The effects of inadequate Health and Safety performance in the Nigerian construction industry is evident in the high number of fatalities and injuries recorded across the country (Ayedun *et al.,* 2012). Table 1 shows a breakdown of casualties of building collapse in some selected states in Nigeria.

Table 1: Casualties of building collapse in some selected states in Nigeria

Year	State/Town	Casualty(Death)
2003	Ebute-Meta, Lagos	3
2003	Agege, Lagos	2
2003	Ebute-Meta, Lagos	5
2006	Lagos	20
2008	Ebonyi	7
2009	Abuja, FCT	1
2009	Ebute-Meta, Lagos	12
2009	Mushin, Lagos	6
2009	Abuja, FCT	1
2010	Oshodi, Lagos	4
2014	Ibadan	1
2015	Ebute-Meta, Lagos	4
2016	Lekki, Lagos	34
2016	9 Ali Close, Lagos	1

Sources: Anosike, 2011; Omenihu *et al.*, 2016.

Methodology

This research was conducted in Abuja, Nigeria's Federal Capital Territory; a well-structured questionnaire was used in soliciting data from the respondents. Data was generated from Building construction sites whose personnel were registered with the available regulatory agencies in Nigeria. Investigatory survey research method (work study) was adopted to appraise the aim and objectives of the study through field and questionnaire approach. A five-point Likert scale system from "1=strongly disagree to 5=strongly agree" was used in designing the questionnaire. A total of 120 questionnaires were issued to construction professionals and workers on the sites visited. 92 questionnaires representing 76.67% response rate were retrieved and analysed, the response rate is deemed adequate according to Ahmadu (2014) who opined that a response rate of 30 was adequate for construction industry studies. Communalities test, Principal Component Analysis and ANOVA test were conducted using Statistical Package for Social Sciences (SPSS) version 21.The thirty two identified safety performance factors from literature were further categorized into six groups under the following headings for ease of analysis, namely: Historical Factors, Environmental Factors (Natural and Working Environment), Psychological Factors, Organizational Factors, Working at height Factors and Self Protection Factors.

Results and Discussion

The demographic data and communalities results for safety performance factors are presented in Tables 2 and 3.

Table 2: Respondents Demographic data

Position	Percentage (%)
Project Manager	11.10
Site Engineer	5.60
Architect	11.10
Worker	50.00
Others	22.20
Total	**100**

In order to determine the adequacy of the data for principal component analysis (PCA), communalities test was conducted. Table 3 shows the communalities for the safety performance factors. Communality explains the total amount a variable shares with other variables included in the analysis. PCA works on the assumption that all variance is common hence all communalities are 1 before extraction. The communalities in the column labeled extraction reflect the common variance in the data structure for Operatives age, 87.5% of the variance associated with operatives age is common or shared variance. After the extraction some of the factors are discarded and some lost. The average communality value obtained was above 0.6, this means the sample size is adequate for PCA (Ahadzie, 2007).

Table 3: Communalities (Safety Performance)

Safety Performance factors	Initial	Extraction
Operatives Age	1.000	0.875
Operatives Trade	1.000	0.846
Operatives job experience (Duration in construction)	1.000	0.927
Tidy Site	1.000	0.920
Tools and Equipment	1.000	0.936
Working Procedure	1.000	0.958
Geographical Location	1.000	0.919
Weather condition(Poor visibility/Night work)	1.000	0.834
Tools or small Machinery not stored/Placed properly	1.000	0.872
Interrelationship between employees on site	1.000	0.931
Relationship between Supervisors and Employees on site	1.000	0.926
Excessive overtime work for employees	1.000	0.916
Relationship between management and employees on site	1.000	0.928
Incentives	1.000	0.976
Inspection, Record and Audit	1.000	0.714
Management Commitment	1.000	0.899
Safety Communication	1.000	0.945
Safety Training	1.000	0.885
Employees involvement	1.000	0.870
Talk by Management on Safety	1.000	0.868
Conducting safety meeting before each activity	1.000	0.760
Attendance of Safety meetings by Management	1.000	0.963
Conducting regular Tool box meetings	1.000	0.936
Ladders too short for a tax	1.000	0.900
Ladders used without being tied secured	1.000	0.906
Ladders used with defective / broken rungs	1.000	0.871
Mobile tower scaffolds used unsafely	1.000	0.849
Face masks not worn (under dusty condition)	1.000	0.941
Ear defenders not worn (while working under noisy equipment)	1.000	0.944
Protective footwear not worn	1.000	0.929
Safety helmets not worm	1.000	0.938
Goggles/other eye protection	1.000	0.949

Extraction Method: Principal Component Analysis.

Principal Factors Affecting Safety Performance in Nigerian Construction sites

Principal component analysis (PCA) was utilised in order to reduce the number of identified safety performance factors to a smaller and manageable size for effectiveness. PCA was utilised in determining which of the safety performance factors could be measuring the same underlying effect and thereafter reduce them to a manageable size. Safety performance factors with Eigenvalues greater than one (1) were factored out, this resulted in a total of nine (9) factors from the initial list of thirty-two (32) identified safety performance factors.

The SPSS-based results (Total variance explained Table and Scree plot chat) indicated that nine (9) principal factors were extracted from the initial list of thirty two (32). The total variance explained by the extracted components is as follows: component 1 (22.354%), component 2 (17.270%), component 3 (13.966%), component 4 (10.503%), component 5 (8.725%), component 6 (5.665%), component 7 (4.395%), component 8 (3.966%) and component 9 (3.249%). Thus the extracted factors accounted for 90.09 % of the total cumulative variance of independent factors.

From Table 4, the regression model achieved an adjusted coefficient of determination (R-Sq) value of 0.984. It implies the model explains 98.4% of the variations in safety performance evaluation leaving 1.6% unexplained. Hence, the model could predict the dependent variable (safety performance) by about 98.4%. Coefficient of determination is a measure of how good a prediction of the overall performance outcome can be made when the predictor variables are known, it however tends to overestimate the success of the model when used in the real world as such an Adjusted coefficient of determination is calculated; it takes into account the number of variables and observations in the developed model (Ahadzie, 2007).

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.993	0.987	0.984	0.08289

Table 5 shows the ANOVA results for the model, the regression sum of squares is larger when compared to residual sum of squares. This implies that the model accounts for more variation in the dependent variable (safety performance) and is statistically significant (F = 379.934 and P< 0.05).

Table 5: Model Analysis of Variance (ANOVA)

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	33.934	13	2.610	379.934	0.000
1	Residual	0.453	66	0.007		
	Total	34.388	79			

$$Y = -23.165 + 0.260 X_1 + 3.064 X_2 + 9.001 X_3 - 0.450 X_4 - 0.513 X_5 + 4.662 X_6 - 0.03 X_7 - 0.098 X_8 - 0.144 X_9 - 0.41 X_1^2 - 0.414 X_2^2 - 1.114 X_3^2 - 0.625 X_6^2 \quad (1)$$

The values of $X_1 \dots X_9$ used were collected through questionnaire survey, the P value for the model returned a significant value of 0.00. This suggests that for effective safety performance delivery on construction sites, adequate attention should be paid to these factors. The top nine important factors influencing safety performance in the Nigerian construction sites are:

X_1: Relationship between Supervisors and Employees on site
X_2: Geographical Location (Environmental Factors: Natural and Working Environment)
X_3: Working Procedure
X_4: Ear defenders not worn (while working under noisy equipment)
X_5: Talk by Management on Safety
X_6: Tidy Site
X_7: Safety Communication
X_8: Operatives job experience (Duration in construction)
X_9: Ladders used without being tied secured

Conclusion

The importance attached to safety of workers on construction sites can never be overemphasized, this is because of the mere reason that occurrence of accidents on sites result in far reaching consequences like delays in project completion time, alter overall cost of executing project, taint the reputation of the construction firm, de-motivate the co-workers and in some cases lead to death of the workers. Activities of the construction industry in Nigeria still remain dangerous with the highest fatality rate of any industry in virtually all countries. The fatalities and injuries are very costly to the economy of Nigeria in terms of lost time and productivity. This of course is in addition to the unimaginable pain and suffering brought to the families and loved ones of employees killed or injured on the work-site. There has been noticeable decrease in the amount of fatalities and injuries over the years, however there is still a significant amount of work to be done. The list of thirty two (32) safety performance factors identified from literature were reduced to nine (9) by the SPSS based PCA. These nine (9) principal factors accounted for 90.09% of the variability in the data, they include: (1) Relationship between Supervisors and Employees on site, (2) Geographical Location (Environmental Factors: Natural and Working Environment), (3) Working Procedure, (4) Ear defenders not worn (while working under noisy equipment), (5) Talk by Management on Safety, (6) Tidy Site, (7) Safety Communication, (8) Operatives job experience (Duration in construction), (9) Ladders used without being tied secured.Therefore in order to improve safety performance on building construction sites, key industry professionals and stakeholders must input and channel available resources into tackling the determined nine (9) principal factors.

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