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ORIGINAL RESEARCH ARTICLE

MODELLING THE SAFETY LEVEL OF THE CONSTRUCTION INDUSTRY IN SOUTHWESTERN NIGERIA

W. A. Raheem[1]*, O. O. Akinyemi[2], H. O. Adeyemi[2], O. A. Adeaga[3] and O. G. Olasunkanmi[4]

[1]Department of Systems Engineering, University of Lagos, Lagos, Nigeria
[2]Department of Mechanical Engineering, Olabisi Onabanjo University, Ago-Iwoye, Nigeria
[3]Department of Mechanical Engineering, First Technical University, Ibadan, Nigeria
[4]Department of Electrical/Electronic Engineering, Olabisi Onabanjo University, Ago-Iwoye, Nigeria.
**Corresponding author's email address: raheemwasiuade@gmail.com*

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ABSTRACT

The number of accidents in the construction industry in Nigeria is very high. It is rare to disclose safety performance metrics required to draw government attention to these incidents. This research aims to develop a predictive safety analytical model for the construction industry's safety assessment. The activities of safety standards in the Nigerian construction industry and improvement programs expected to be introduced in the construction industry have been researched to recognize the risks of construction accidents. The building injury risks found were modelled as predictor variables while the response variable was the level of safety using multiple regression analysis. Spearman's Correlation Analysis identified predictor variables that correlate significantly at $p>0.05$ to the safety level, while predictor variables with low correlations have been excluded. The safety level was calculated on a linguistic scale of 5 points. The predictive ability of the model was verified at a 5 percent significance range by the coefficient of determination (R2) and the t-test. Under Law and Regulation, Practices, Personal Factors and Encouragement, fifteen task-related construction accident risks were identified and listed. The developed multilinear regression model has an 84.8% R2 rating. A 92.1% correlation between the predicted values and the human-interpreted safety-level values was revealed by the model implementation. The study also shows that personal variables should be given the highest degree of consideration by site engineers. The t-test showed no substantial difference between the values predicted and the values perceived by the level of human protection. Due to the feasibility of the study, the constructed model will serve as a valuable instrument for monitoring the safety level of Nigeria's construction sites. It is recommended that the model be used by site Engineers and Safety personnel from Federal and State Ministries.

1.0 Introduction

Despite the economic contribution of building companies, the construction sector is noted for as a dangerous and highly endangered area. It has been reported in the UK that people face a higher risk of death or harm at work than employees in other sectors of the economy (HSE, 2006a, Asanka and Ranasinghe, 2015; Ahmed *et al.*, 2018) while the building sector is continually responsible for the most extraordinary number of fatal injuries/accidents than any other UK industry (HSE, 2006a). On average, building deaths in the previous five years accounted for around 30 percent of all employee fatalities (HSE, 2006b). Based on these numbers, building was found to have the second-worst file for the health and safety industry after agriculture

Corresponding author's e-mail address: raheemwasiuade@gmail.com

(HSE, 2006c). The building industry is the riskiest industry and is vulnerable to accidents (HSE, 2018).

The response of the construction industry to workplace safety injuries has inevitably changed, and different initiatives aimed at improving the safety culture are now common in large organizations (Adekunle *et al.* (2018). The various programs are not mutually exclusive and, in fact, some say that the most feasible approach is to use a combination of both. In the past, the absence of comprehensive methods to examine and evaluate the various relationships between the different system risk factors associated with construction sites has limited attempts to identify and predict factors that impact safety on construction sites. This has been solved by Predictive analytics. The Ministry of Manpower (MOM) in Singapore tracks site safety through several steps. The rate of incidence, the number of industrial accidents per million hours worked by man, and the severity rate, which is the number of industrial days lost per million hours worked by man, are all included (MOM, 2002).

Accident contributors can be grouped into five considerations from the previous safety studies literature and the Nigeria Code of Practice for Building Worksites Safety Management System (CP79): regulation, process, workers, motivation, and others. Lingard and Rowland (1994) demonstrated that policy legislation forms a mechanism by which health and safety are regulated and controlled. All construction professionals have to correctly follow the laws and regulations and impose fines on anybody who violates them. Lingard and Rowland (1994) found that the implementation of legislation in Hong Kong had an important influence on the protection of construction jobs.

Safety legislation needs to be taken seriously when organizing job activities and drawing up company policies. Process variables relate to the work performed by building workers that can potentially be detrimental to their well-being and safety. Enwerem *et al.* (2017), MOM (2002) and Ofori (1997) stressed that construction site accidents are typically caused by a hazardous working environment. There may also be accidents caused by such heights, stepping on, hitting or tripping objects, poor lighting conditions, burying by earth collapse during excavation, fire hazards, inadequate education and training, insufficient equipment and machinery interference.

Personnel variables apply to topics relating to the human aspect of building activities, such as the behavior of supervisors and workers within an organization with regard to safety and attitudes. According to Clarke (1999), safety culture is a subset of organizational culture where beliefs and values specifically apply to matters of health and safety. Therefore, the safety culture of a company relies on the level of commitment of its management and workers to promoting and advocating for safety. Many different human, technical, environmental, and organizational factors affect the safety performance of any construction operation. While a single catalyst is generally credited as the obvious cause of any construction accident, accidents occur from numerous latent triggers and sub-factor that together lead to an accident, most often either due to human error or technical failure. Several models of the incidence of occupational accidents are made up of several variables in the building industry.

Statistical approaches, on the other hand, may be used to infer cause-and-effect relationships between these variables. Due to the large number of factors involved and the uncertainty of the relationships between each other, it is difficult for managers to identify potential risks in

Corresponding author's e-mail address: raheemwasiuade@gmail.com

construction projects and develop effective safety procedures (Cheng *et al*., 2010, Cheng and Wu, 2013).

Historical trends indicate that more studies and data on cause and mitigation methods are needed in the more recent past so that safety experts can educate on how to further reduce these injuries and fatalities (Manuele, 2008). While research attempts have been made to identify factors affecting the safety of construction sites, there is a lack of analytical methods to analyze and evaluate the complex relationships of the system's various risk factors. In addition to the important identification of risk factors, there has been a constant need to develop sophisticated risk assessments to improve system prediction and complex causality assessment and test various combinations of risk mitigation strategies (Luxhøj, 2003). Although major research efforts have been made to identify different factors that cause construction accidents, the literature review shows that very little has been done to assess the likelihood of building safety risk based on current site conditions.

Predictive analytics is a form of advanced analytics that uses recent and historical data to forecast future behavior, behaviour and patterns. Methods of statistical analysis, empirical queries, and automated machine learning algorithms are applied to data sets that create predictive models that place a numerical value or ranking on the likelihood of a given event. Applications have been reported in a number of fields, including financial services, banking, telecommunications, etc. The predictive analytics method has not gained prominence in the engineering industry because it is not inherently linear, and where data scientists do not look, correlations also occur. Recent engineering work has, however, been performed using predictive analytics. The aim of this research is to carry out predictive analysis of safety problems for SMEs in the construction industry. In order to accomplish this goal, the research aims to recognize possible construction work hazards at selected construction sites in southwestern Nigeria and develop a model to predict the safety level of the construction site. The scope of this study is restricted to certain tasks specifically related to the construction of a building and other civil engineering works.

1.1 Dynamic Nature of the Construction Industry

In certain respects, construction workplaces are very different from fixed industries. Not only are they different, but they also tend to grow and shift from day to day. When a project is completed, staff and managers move on to new projects and start all over again. This community reflects the diverse character of the industry. Many aspects of health and safety have been affected by the complex existence of the industry. The building industry, therefore, has the most injuries than the fixed market (Ajayeoba *et al*., 2019). Ratay (1997) reported that every year in the United States, nearly 1,000 construction workers lose their lives, and many others are injured. HSE (2017) reported that 80,000 construction workers in Great Britain suffered from a disease caused by the existence of such work between 2014/15 and 2016/17. This event is not limited to the United States and Great Britain alone, but in all other countries it is more prevalent. As an example, the occurrence of a construction accident in Nigeria tends to increase each year, as shown in the following Table 1.

Corresponding author's e-mail address: raheemwasiuade@gmail.com

Table 1: Construction accident cases in Lagos Southwest Nigeria from 2001 to 2015 (Adekunle *et al*., 2018)

	Number of wounded people	Number of live lost	Number of amputees	Number of near misses	Number of reported accidents
2001	1	-	-	-	1
2002	-	-	-	-	1
2003	5	1	-	-	2
2004	8	2	1	1	3
2005	12	3	1	1	5
2006	17	10	-	-	4
2007	21	12	1	2	4
2008	26	15	-	-	5
2009	32	22	2	1	6
2010	38	18	2	1	6
2011	40	25	-	4	7
2012	45	20	2	3	8
2013	48	15	5	2	9
2014	59	22	13	2	15
2015	65	40	15	4	20
Total	417	205	43	21	96

The best ways to avoid accidents are ultimate procedure, realistic inspection, and rigorous implementation of high standards of treatment, useful predictive safety analytics and appropriate building practices. The engineer, contractor, regulator, and the authority, however, should comply with all the same rules that have the power to enforce them. The purpose and design, codes and standards are served by the building to some extent. Although all failures and incidents are not prevented by codes and regulations, compliance with them improves site safety.

2. Materials and Methods

2.1 Data Collection

A questionnaire was prepared and administered to determine the more important variables affecting the protection site. Information on the safety aspects of one of their most recent completed projects were demanded by the respondents. On a five-point linguistic scale, respondents were asked to rate the degree to which each of the variables affected the construction project's site safety level, where '1' was not relevant at all, and '5' reflected 'very important'. The target population is contractors registered with the Council of Registered Builders of Nigeria (CORBON). Based on their operational and financial capacities, CORBON classifies each registered contractor into one of seven categories. The lowest category of contractors can bid no more than NGN500,000 in value for construction projects, while the highest category of contractors may bid for construction projects of any size. Two hundred and fifty general building contractors were selected for the study sampling initiative. Of these, questionnaires in all seven categories were sent to 200 randomly chosen contractors. This is predicated on the fact that the sample size selected is based on desired accuracy with confidence level of 99% (Taherdoost, 2017). The survey package contained a cover letter, a questionnaire and an envelope that was self-addressed and pre-stamped.

2.2 Survey Results and Data Analysis

The designation of the respondents covers a wide range. 20%, 48% and 17% of respondents were upper management, middle management and safety personnel, respectively. Junior staffs were just 7 percent of the respondents. Managing directors, directors, general managers and senior project managers were among the upper management respondents. Project managers and assistant general managers were middle management respondents. Safety personnel report to the officer/manager for environmental health and safety, the safety officer, the safety supervisor and the auditor for safety. Site managers, site coordinators and clerk-of-works are referred to by junior workers. In the construction industry, the average number of years that respondents employed was ten years. The minimum and maximum numbers of years of experience, respectively, are 1 and 34. Also, 60% of the respondents have more than five years of working experience. The mean response for each attribute was calculated, as shown in Table 2.

2.3 Development of the Model

In this study, the model was developed using multiple regression analysis to assess the statistical relationship between the level of site safety (response variable) and the explanatory variables (accident-causing construction site task-related activities, see Table 3). The model was developed using multiple regression techniques with Statistical Package for Social Science Software (SPSS16.0).

The attributes related to the regulation and policy, work practices, workers and motivation aspects of the project listed in Table 3 are the independent/predictor variables. Techniques for modelling make it possible to simulate the actual situation more accurately. It allows the effect to be predicted of changes to a given system. The number of predictor variables compiled was reduced before embarking on regression modelling. In Step 1, predictor variables that correlate significantly ($p \leq 0.05$) to the safety level are identified via Spearman's correlation analysis. The other independent variables showing weak correlations with the output parameter ($p > 0.05$) were excluded, and the number of predictor variables was also reduced. The predictor variables that were significantly correlated with the dependent variable were then used to construct a linear regression model. The SPSS program implemented site safety and related construction project features and created 15 potential models. The model's predictive power is measured by the determination coefficient (R^2), which is a measure of the consistency of fit for the model. When more than two variables are being analysed, R^2 is used to calculate the intensity of the correlation; R^2 provides the proportion of Y's variance (dependent variable), which is explained by the independent variables, illustrating the model's feasibility. However, R^2 increases automatically as more independent variables are added into the model. R^2 modifies a better estimate of the goodness of fit of the model.

Table 2: The mean response to the questionnaire for each attribute

Rank	Ref	Attributes Influencing Site Safety	Mean
		Regulations and Policy (RP)	
1	RP1	National environment standards and regulation enforcement agency (NESREA) act of 2007	3.4789
2	RP2	National environmental (construction sector) regulations, 2010. S. I. NO. 19.	3.5775
3	RP3	Environmental impact assessment act	2.8169
4	RP4	The Nigerian urban and regional planning ACT CAP N138, LFN 2004	3.6197
5	RP5	State physical planning and development control laws and regulations	2.6620
6	RP6	Factories act (1958, 1987 & CAP.126 L.F.N.1990, CAP. F1 L.F.N.2004);	2.8310
7	RP7	Labour act (1974 & 1990)	3.9014
8	RP8	Workmen's compensation act (NO.17, 1987, CAP. W6 LFN, 2004, 2010)	2.9155

Corresponding author's e-mail address: raheemwasiuade@gmail.com

9	RP9	All risk insurance policy	4.0282
		Work Practices (WP)	
1	WP1	Identification of unsafe practices on site	3.3803
2	WP2	Proper implementation of safe practices and procedures on site	3.8169
3	WP3	Clean site keeping	2.9437
4	WP4	Proper handling of tools, equipment and plants	4.1268
5	WP5	Good maintenance of tools, equipment and plants	2.0845
6	WP6	Safety communication and adequate dissemination of information	4.0141
7	WP7	Reasonable control of hazardous material and activities	2.8451
8	WP8	Technical competency of specialist sub-contractors	2.8732
9	WP9	Proper control and management of sub-contractors	1.9014
		Personal (P)	
1	P1	Quality of safety knowledge among workers and managers	2.8732
2	P2	Safe work practices of workers and managers	3.9296
3	P3	Management commitment to advancing safety and health among workers	3.8028
4	P4	Quality of safety and health training among workers and managers	3.9155
5	P5	Effectiveness of the safety committee	1.8028
6	P6	Regular site inspection by the safety committee	2.8732
7	P7	Safety promotion and posters	2.8028
8	P8	Safety program and talks	2.8310
9	P9	Work experience of workers and managers	3.9296
10	P10	Safety communications among workers& managers	4.0986
		Motivations (M)	
1	M1	Quality of incentives (monetary)	3.3380
2	M2	Quality of incentives (promotion)	2.5915
3	M3	Quality of penalties and punishments (Monetary)	3.4930
4	M4	Quality of penalties and punishments (termination of service)	2.6620
5	M5	Quality of penalties and punishments (delayed promotion)	2.6197
6	M6	Safety committee /managements' accident investigation and analysis plans	1.8028
7	M7	Safety committee accident investigations and analysis plans	2.9296

3. Results and Discussion

3.1 Results

In order to determine how predictive safety analytics can predict task-related hazards in the construction industry, a multiple linear regression model (MLRM) was developed. For the predictor variables, the coefficients are as presented in Table 4. After the 20th iterative process, the predictor variables selected were Nigerian urban and regional planning ACT CAP N138, LFN 2004 (RP5), and Labour Act (1974 & 1990) (RP8). All-risk insurance policies (RP9), identification of hazardous on-site activities (WP-1). Also, Proper implementation of safe practices, procedures on-site (WP2), Proper handling of tools, equipment and plants (WP4), Safety communication and adequate dissemination of information (WP6), Good control of hazardous material and activities (WP7). Others are Safe work practices of workers and managers (P2), Management commitment to advancing safety and health among workers (P4), Quality of safety and health training among workers and managers (P9), Work experience of workers and managers (P10), quality of incentives (monetary) (M1), Quality of penalties and punishments (Monetary) (M3). And lastly,Amongst the predictor variables, (RP9) followed by (M3) were the strongest. The regression model's description, the analysis of variance (ANOVA) of the regression model, and the regression model's residual statistics are shown in Tables 5, 6 and 7. Figure 1 shows the histogram of the residuals that are close to being normally distributed because violation of normal distribution compromises the estimation of the coefficients.

Table 3: Summary of Results obtained (Coefficients of predictor variables)

Model	Unstandardised Coefficient B	Unstandardised Coefficient Std. Error	Standardised Coefficient Beta	t	Sig.
(constant)	-1.447	.372		-3.885	.000
The Nigerian urban and regional planning ACT CAP N138, LFN 2004	.030	.113	.032	.267	.791
Labour act (1974 & 1990)	.044	.059	.045	.738	.464
All risk insurance policy	.229	.071	.248	3.208	.002
Identification of unsafe practices on site	.076	.093	.082	.813	.420
Proper implementation of safe practices and procedures on site	.081	.109	.072	.746	.459
Proper handling of tools, equipment and plants	.030	.100	.028	.304	.762
Safety communication and good dissemination of information	.102	.070	.109	1.446	.148
Good control of hazardous material and activities	.194	.101	.205	1.915	.061
Safe work practices of workers and managers	.055	.086	.059	.639	.526
Management commitment to advancing safety and health among workers	.147	.103	.145	1.431	.158
Management commitment to advancing safety and health among workers	.055	.086	.047	.638	.526
Work experience workers and managers of	.011	.087	.011	.127	.899
Safety communications among workers& managers	.010	.066	.011	.155	.878
Quality of incentives (monetary)	.045	.052	.063	.863	.392
Quality of penalties and punishments (Monetary)	.224	.073	.222	3.057	.003

Table 4: Model summary of the regression model

Model	R	R Square	Adjusted R Square	Std. An error of the Estimate
1	.921	.848	.806	.37278

Table 5: ANOVA of the regression model

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	42.554	15	2.837	20.415	.000
Residual	7.643	55	.139		
Total	50.197	70			

Corresponding author's e-mail address: raheemwasiuade@gmail.com

Table 6: Residual Statistics of the regression model

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.8360	5.0162	3.6479	.77969	71
Stud. Deleted Residual	-2.653	2.457	.000	1.034	71
Mahal. Distance	6.842	25.629	14.789	4.747	71
Cook's Distance	.000	.122	.020	.030	71
Centred Leverage Value	.098	.366	.211	.068	71

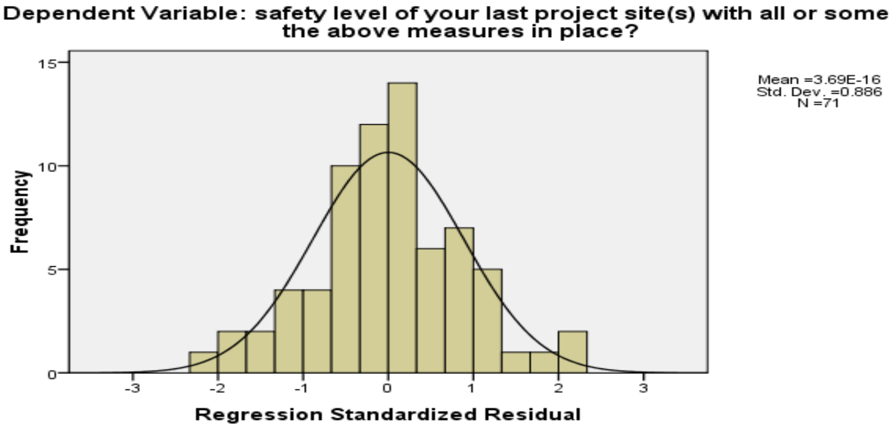

Figure 1: Histogram of residual for the predictive safety level model

Figure 2 revealed some deviations of the dependent variable from the normal distribution line (from (0.18 to 0.42) meanwhile, some residual fall on the normal distribution line (0.38 to 0.65).

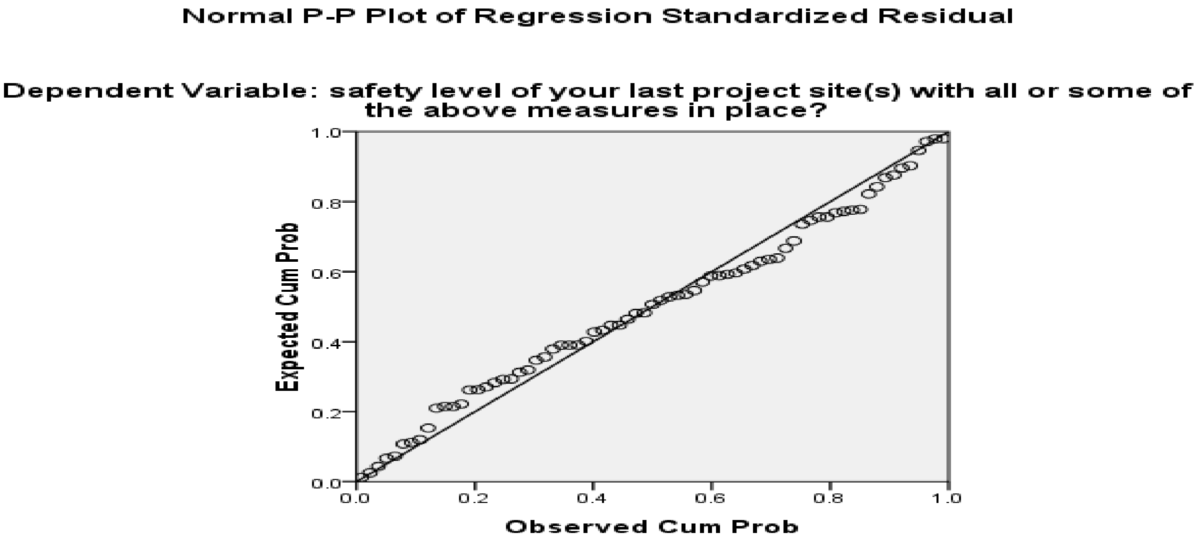

Figure 2: Normal P-P plot of regression standard residual

3.2 Model Estimation and Diagnostics

The safety level was measured on a 5-point scale, where 1 = Shallow risk (VLR), 2 = low risk (LR), 3 = medium risk (MR), 4 = high risk (HR), and 5 = very high risk (VHR). The other variables are as defined in Table 3 and were measured on a 5-point scale, where 1 = not important, and 5 = very important. The predictive safety level model can be represented below:

$$Y = 1.447 + 0.030(RP5) + 0.044(RP8) + 0.229(RP9) + 0.076(WP1) + 0.081(WP2) + 0.030(WP4) + 0.102(WP6) + 0.194(WP7) + 0.055(P2) + 0.147(P3) + 0.055(P4) + 0.011(P9) + 0.010(P10) + 0.045(M1) + 0.224(M3)$$

Where Y = the predicted safety level. Cook's distance value was determined. According to Field (2013), the Cook distance's maximum value should be less than 1.0 to mean that no cases have an unfair effect to find out the maximum value, as shown in Table 7, the Cook distance's maximum value was 0.122, with a standard deviation of 0.030. Since the maximum value is smaller than the 1.0 value, it seems like there are no problematic cases in the regression model.

3.3 Model Implementation

To use the model, contractors enter the appropriate ratings using the 5-point scale for the 15 predictor variables (1 = not significant, 5 = very significant) and then determine the construction site's safety level (Y). Table 7 shows the interpretation of the response variable (safety level) obtained from the model. Three predictor variables were described under regulatory and policy factors: ACT CAP N138, LFN 2004 (i.e. State Physical Planning and Growth Control Laws and Regulations) (RP5) of Nigerian urban and regional planning; Workmen's Compensation Act (NO.17, 1987, CAP.W6 LFN, 2004, 2010) (RP8) and All Liability Insurance Scheme Act (RP8) (RP9). This policy is done with other variables that make up the model. There is no negative beta (β) coefficient for the entire attribute, indicating that the site safety level may increase when there is higher participation or understanding.

Table 7: Interpretation of the safety level of the MLRM

Safety level	Interpretation of safety level
1.00-1.99	Very low safety level (high risk)
2.00-2.99	Low safety level
3.00-3.99	Average safety level
4.00-4.99	High safety level (low risk)
5.00-above	Very high safety level (very low risk)

3.4 Correlation test

A strong correlation was observed after comparing the outcome of the predicted MLRM values with that of HP for the correlation strength using Spearman's rho, r = 0.921, p<.01. The coefficient of correlation R (92.1%) shows that the model indicates a good linear relationship between the predictor variables and the dependent variable. The determination coefficient of the model indicates that 84.8% of the independent variable determines the expected safety level of construction sites.

3.5 Discussion

A company's participation in the protection certification scheme may be accomplished by the Labor Act. To do this, businesses need to follow the Occupational Health and Safety Evaluation Scheme (OHSAS) 18001. While safety certification is intended to encourage and increase awareness of safety, promote healthy work practices and increase the safety standards of the construction industry in Nigeria, the findings show that low levels of this will harm safety standards in Nigeria (Workmen's compensation act (NO.17, 1987, CAP. W6 LFN, 2004, 2010), RP8). A potential reason is that employees might be busier with on-site documentation, paperwork without regards to real aspects of safety. The Workmen's Compensation Policy and the All Risk Liability Policy of the Contractor, as defined in the Labour Act, require insurance

Corresponding author's e-mail address: raheemwasiuade@gmail.com requirements to be met by the contractor before any construction work begins. Table 7 show that a better understanding of insurance policies can contribute to lower safety at the site (RP9). This result is contrary to the study by Lingard and Rowlinson (1994) who reported that contractors who rely more on insurance can prefer to pass the responsibility for compensation to insurance companies and thus neglect the adequate provision of adequate training and supervision for workers in site safety. Five factors directly impact site safety under work practices: identification of unsafe on-site practices (WP1), proper implementation of safe on-site practices and procedures (WP2), proper handling of machinery and plant tools (WP4), safety communication and adequate information distribution (WP6) and reasonable control of hazardous materials and activities (WP7). The positive beta (ß) coefficient shows that as more safety procedures are implemented, safety levels can increase. One potential reason is that workers with many safety processes employed on construction sites may become complacent about safety.

Dedobbeler and Beland (1991) found that in carrying out mission and jobs, some organizations or individuals had actually unknowingly committed an unsafe act. As a result of their negligence, they are subjecting themselves and others to potential hazards and injuries. But, in this study the personnel component has five variables that impact the protection of the site. Healthy work practices of employees and managers (P2); management contribution to the development of worker safety and health (P3); consistency of worker and manager safety and health training; responsibilities (P4); work experience of employees and managers (P9); and safety communications between employees and managers (P9) (P10). The results show that when there are more safety and health training for employees (P2), site safety will become higher. This act is consistent with work done by Heberle (1998), Lingard (2001) and Ajayeoba, *et al.,* (2019).

In addition, Lingard (2001) revealed that training has a positive protective impact on staff to escape injury while researching the effects of first aid training on Australian construction workers. Likewise, McKenna and Hale (1981) found that workplace injuries were reduced when workers received first aid training. The positive beta (ß) coefficient for workers' language and communication barriers (P10) shows that when barriers are lower, site protection will be lowered. These are similar to the findings of studies by Ajayeoba *et al*., (2015) that strengthened safety practices and enhanced safety policies can be accomplished through better communication and knowledge transfer (Holt, 2001). The type and quality of knowledge transmission varies in different ways (e.g. verbal, written, gestural, etc.). They may have a big effect on the efficacy of such means of transition. The protection of the site will also improve as staff and supervisors (P9) are elevated. Work experience will contribute to better job efficiency, and this will also result in lower breaches of safety. More work experience leads to better job results because work experience enables people to learn skills, strategies, techniques and activities that produce performance capabilities directly (Schmidt *et al*. 1986). This study shows that when management is committed to advancing safety and health among employees, the level of safety on site will actually increase (P3). This outcome is a peculiar outcome because if all the positive actions contribute to reduced outcomes, they appear to have no beneficial use. The dependence on this committee to ensure site safety is one potential explanation; this finding is similar to the result of jayeoba et.al.,(2018) A et al. (2018) instead of keeping the business of everyone protected. The quality of rewards (monetary) (M1) and the quality of fines and punishments (monetary) are two motivational characteristics that affect site safety (M3). Consequently, these motivational features are in line with the studies of Geller (1999) and Adebiyi and Charles-Owaba (2009). The reasons may be that these steps are extreme and can only be taken into account if the violator has committed or is a repeat

Corresponding author's e-mail address: raheemwasiuade@gmail.com

offender of serious safety and health abuse. This result is consistent with Hislop (1999), who argued that punishment should be the last resort when all others has failed to strengthen the implementation of healthy work practices (training, guidance and encouragement).

4. Conclusion

The work reported that significant factors have been established that affect construction safety and the degree of site safety can be expected. The multiple linear regression models built to predict building site safety has shown that 15 variables can be used to predict building safety. Under regulations and policy factors, three predictor variables were established, namely: The Nigerian Urban and Regional Planning ACT CAP N138, LFN 2004; the Labor Act (1974 & 1990); and all risk insurance policies. Five factors directly influence site safety in terms of work practices, *viz* identification of unsafe on-site practices; successful implementation of safe on-site practices and procedures; careful handling of machinery, equipment and plants; coordination of safety and effective dissemination of information; and good management of hazardous materials and activities. In the aspect of personnel, there are five variables that affect site safety. These are the healthy working practices of managers and employees as; management dedication to ensuring the safety and wellbeing of employees, the continuity of health and safety instruction among employees and managers, the job experience of employees and managers and safety communications among employees and managers. Quality of rewards (monetary) and quality of fines and penalties are two motivational characteristics influencing site safety. The model has a strong R^2, and there are large regression coefficients. It is clear that the model built in this study can be used to predict the safety level of the construction site. Therefore, contractors should ensure that their projects have high safety standards and be more focus on the important characteristics that influence the degree of site safety.

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Corresponding author's e-mail address: raheemwasiuade@gmail.com

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Corresponding author's e-mail address: raheemwasiuade@gmail.com