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Fatalities in the Nigerian Construction Industry: A Case of Poor Safety Culture

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Authors' contribution

Authors MOA and HEO designed, carried out the research, performed the statistical analysis, wrote, read and approved the final manuscript with the assistance of SDI reviewers' and editor's guides.

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ABSTRACT

The paper discussed fatalities in the Nigerian construction industry- a case of poor safety culture. It views safety culture as the set of beliefs, norms, attitudes, roles, social and technical practices that are concerned with minimizing the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious. It assumes that incorporation of positive safety culture into investment in machines and technology (socio-technical investments) by Nigerian construction companies will result in better safety performance of employees (reduced rate of unsafe acts) and the company (reduced rate of fatalities). The research question addressed the extent of the relationship between poor safety culture and increased rate of unsafe acts/fatalities in the Nigerian construction industry. The place of study comprises of twelve construction companies, two from each of the six geopolitical zones in Nigeria while the duration of study is between August 2012 and July 2013. A descriptive research design was used in executing the study using 600 (judgmentally determined) randomly selected respondents from twelve construction companies in the six geopolitical zones of Nigeria for questionnaire administration. Data collected were analyzed using descriptive and inferential statistics. Results from the data analysis indicated that significant relationship exists between poor safety culture and increased rate of unsafe acts/fatalities in the Nigerian construction industry and recommends among others: regular site safety audits

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to identify/eliminate potential workplace hazards, regular staff training to improve their hazard identification skills, involvement of management and workers in addressing safety matters, formation of safety committees to identify and eliminate potential workplace hazards and making hazard identification/reporting everyone's responsibility.

Keywords: Safety culture; fatalities; unsafe acts; construction industry; workplace hazards.

1. INTRODUCTION

The construction industry is the hub of social and economic development in all countries of the world. Though, the construction industry contributed only about 1.98% of the total Gross Domestic Product (GDP) to the Nigerian economy in 2009, its importance and roles in the development of the economy of any nation can never be disputed [1]. However, when compared with other labour intensive industries, construction industry has historically experienced a disproportionately high rate of disability injuries and fatalities for its size [2]. The industry alone produces 30% of all fatal industrial accidents across the European Union (EU), yet it employs only 10% of the working population [3]. In The United States of America (USA), the construction industry accounts for 22% of all fatal accidents [4]. In other countries such as Japan United Kingdom (UK) and Ireland, the situation is even not better. Bomel [5] notes that in Japan, construction accidents account for 30%-40% of the overall industrial accidents, with the total being 50% in Ireland and 25% in the United Kingdom (UK). This situation is worse in the developing countries, particularly Nigeria where there are no reliable sources of data for such accident records.

Globally, construction workers are three times more likely to be killed and twice as likely to be injured as workers in other occupations. Hong Kong recorded a total of 3,001 convictions for health and safety offences with a total fine of \$17million in 1993. Out of this figure, 1,382 convictions with a total fine of \$1million were related to construction site alone [6]. In Italy, the fatal accidents in the field of construction represent 25% of the total accidents occurring in the industry [7]. In New South Wales, Australia, the inherent hazards and associated risks of the construction industry are reflected in its high incidents and frequency injury rates demonstrated by the fact that in 1998/1999, construction had the third highest number of incidents, based on compensated injuries [8]. The U.S.A. National safety Council (NSC), found that construction injuries accounted for nearly 11% of all work related injuries and more that 30% of all fatalities in 1991[9].

In Nigeria though there is no reliable data on accident cases in construction, because contractors do not report accidents at appropriate ministry nor keep proper records on accidents. In 2005, a four-storey building under construction in Port Harcourt collapsed and not less than twenty workers died in the incident barely 24 hours after a similar incident in Lagos [10]. Many people have met their ultimate death in construction sites in Nigeria while others have become permanently crippled from construction related injuries. Fatalities are by their nature unplanned and uncontrolled events. Laufer and Ledbetter [11] described fatalities as chance-caused events that are normally not given to direct observation but rather most methods are based on post-factum measurement. Fatalities can result in direct and indirect cost. Direct costs of construction fatalities are: medical bills, premiums for compensation benefits, liability and property loss while the indirect costs are: time lost in attending burial ceremonies, time lost in fatality in investigation, down time of damaged equipment and losses arising from site closure. These ugly incidents have necessitated the

need for a positive safety culture in the Nigerian construction industry, since the associated costs of fatalities are immense to the individual, the employer and the society.

To develop a positive safety culture in the Nigerian construction industry, visible top management commitment is required. This means leading by example. If top management fails to challenge unsafe behaviors, they unwittingly reinforce the notion that this behavior is acceptable to the organization. Senior management decisions and actions must match their words- this creates a shared vision of the importance of safety to the industry. When upper-level management is committed to safety; it provides adequate resources and consistently supports the development and implementation of safety activities. It is against this background that it becomes pertinent to examine fatalities in the Nigerian construction industry from the perspective of poor safety culture.

1.1 Statement of the Problem

Globally, the construction industry has a poor safety record. It remains one of the most dangerous industries in which to work. Statistics from the Health and Safety Executive (HSE) show that U.K. construction workers are approximately five times more likely to be killed and two times more likely to be seriously injured compared to the average for all industries [12]. (U.S. construction workers are over three times more likely to be killed than the all-industry average and one in six construction workers can expect to be injured every year [13]. In 1998 the U.K. average annual fatal accident rate per 100,000 employees was 5.6, while the E.U. average was 13.3 [14]. Though there is no reliable construction accident/incident data in Nigeria, a study of 40 contractors in 2006 revealed that accident and injury rates were high in the Nigerian construction industry - the best safety ratios were 2 accidents per 100 workers and 5 injuries per 100 workers [15].

The occurrence of fatalities in construction sites usually leads to site closure for accident investigation, loss of man/machine hours, loss of output, high labour turnover, loss of corporate reputation, payment of burial expenses/compensation/insurance claims for the dead. Economic development activities are usually hampered in a country with high rate of construction fatalities; since productivity/national output will be low, inflation and rate of unemployment will be high while there will be an increase in social vices. Since fatalities originate from unsafe acts of people, they can be prevented through the inculcation of a positive safety culture in the Nigerian construction industry.

1.2 Research Objectives

The objectives of the research are as follows:

1. To determine the extent of the relationship between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry.
2. To determine the extent of the relationship between poor safety culture and increased rate of fatalities in the Nigerian construction industry.

1.3 Research Questions

The inability of the prevailing weak legislative framework in addressing fatalities in the Nigerian construction industry necessitated the need for a positive safety culture in carrying

out routine/non-routine construction activities thus prompting the following research questions:

1. Does any significant relationship exist between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry?
2. Does any significant relationship exist between poor safety culture and increased rate of fatalities in the Nigerian construction industry?

1.4 Research Hypotheses

In view of the above research questions, the following null hypotheses were formulated:

- 1H₀: There is no significant relationship between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry.
- 2H₀: There is no significant relationship between poor safety culture and increased rate of fatalities in the Nigerian construction industry.

1.5 Literature Review

The construction industry is one of the most injury-prone industries and an increasing number of scholars are paying great attention to safety culture in this industry. It is generally accepted wisdom that an organization that develops and maintains a strong safety culture is more effective at preventing individual and large scale accidents [16]. Research studies discovered that accident and injury rates in many developing countries such as Nigeria [17, 18], Thailand [19] and Tanzania [15] are considerably higher than in European countries. Mbuya and Lema [20] opined that in most developing countries, safety consideration in construction project delivery is not given a priority and the employment of safety measures during construction is considered a burden. Enhassi et al. [21] reported that in many developing countries, the legislation governing Occupational Health and Safety is significantly limited when compared with UK. They further reported that there are rarely any special provisions for construction workers' safety and the general conditions of work are often not addressed. Lee and Halpin [22] reported that in many of the countries where safety legislation exists, the regulatory authority is weak and non-existent and employers 'pay lip service' to regulations.

Koehn et al. [23] further reported that in developing countries, injuries are often not reported and the employer only provides some form of cash compensation for employee's injuries. It is important to note that construction companies in Nigeria frequently push safety to the bottom rung of priorities when carrying out their activities. When fatality occurs, the human life involved is irreplaceable, while loss of man-hours and material progress are equally irreparable. Generally, in developing countries laws to protect workers may not be strictly enforced and contractors and their employees tend to ignore basic safety rules and regulations [24]. Certainly in every organization, safety should be considered number one priority, hence the need for integrating safety culture into the organizational system.

The term safety culture was first proposed by the International Atomic Energy Agency (IAEA) on the Post-Accident Review meeting of the Chernobyl Accident in 1986. Safety culture is viewed as the set of beliefs, norms, attitudes, roles, social and technical practices that are concerned with minimizing the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious. Diaz-Cabrera et al. [25]

considered safety culture as a manifestation of shared values and meanings, and in a particular organizational structure and processes, safety policies, strategies, goals, practices and leadership styles related to safety management system. Lots of international scholars agree that safety culture is a pivotal factor for the safety of an organization [26]. Recognizing the pivotal impact of safety culture on safety outcomes such as injuries, fatalities and other incidents, scholars have shown increasing interests in the research of safety culture in the construction industry [27].

Reason [28] argued that a safe culture is one in which the line between acceptable and unacceptable behaviour is clearly drawn and understood. A successful safety program must focus on preventing fatalities by assuring proper engineering of critical crane lifts, preventing falls from heights, trench collapse, etc.,. Pigeon and O'Leary [29] stated that a 'good' safety culture might both reflect and be promoted by at least four factors. These four factors include: senior management commitment to safety; shared care and concern for hazards and solicitude for their impacts on people; realistic and flexible norms and rules about hazards and continual reflection upon practice through monitoring, analysis and feedback systems (organizational learning). It has also been argued that fundamentally leadership is the key to affecting a safety culture [30]. The safety maturity model of Hudson [31] divided reigning safety cultures into five different categories, based on only two criteria: being informed and trust. The safety culture in these five categories varies from "pathological" to "generative". Anastacio et al. [32] proposed a safety culture maturity model, used in measuring the stage of maturity of safety culture of an organization. But the model does not identify the influence of national culture on safety culture. If the safety culture maturity model is applied in one multinational organization in different countries with different culture, it could identify the same stages of maturity in this organization in different countries.

In a strong safety culture, everyone feels responsible for safety and pursues it on a daily basis; employees go beyond "the call of duty" to identify unsafe conditions and behaviours and intervene to correct them [33]. Ali [34] opined that wherever reliable records are available, construction is found to be one of the most dangerous on safety criteria, particularly in developing countries. He further stated that though much improvement in construction safety has been achieved, the industry still continues to lag behind most other industries with regard to safety. In developing countries, safety rules usually do not exist; if any exist, the regulatory authority is usually very weak in implementing such rules effectively. It is important to remember that an organization's safety culture develops as a result of history, work environment, the workforce, safety practices, and management leadership [28].

1.6 Conceptual Framework

The term safety culture was introduced by the International Atomic Energy Agency (IAEA) as a result of their first analysis into the nuclear reactor accident at Chernobyl [35]. The Advisory Committee for Safety in Nuclear Installations defined it as '... the product of individual and group values, attitudes, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's Health & Safety programs. This definition reveals an implicit/explicit recognition of the interactive relationship between psychological, behavioural and organizational factors in the construction industry. The individual/group values and attitudes refers to employees perceptions/attitudes towards safety goals; patterns of behaviour refers to employees day to day goal-directed safety behaviour while the style/proficiency of an organizations safety programs indirectly refers to the presence/quality of organizational safety systems to support goal-directed safety behaviour.

People are neither deterministically controlled by their environments nor entirely self-determining. Instead they exist in a state of reciprocal determinism with their environments whereby they and their environments influence one another in a perpetual dynamic interplay [36]. Both the Social Learning Theory and Social Cognitive Theory [37,38] explain this psychosocial functioning in terms of a triadic reciprocal causation, whereby individuals internal psychological factors, the environment they are in and their behaviour, all operate as interacting determinants that influence each other bi-directionally as shown in Fig. 1.

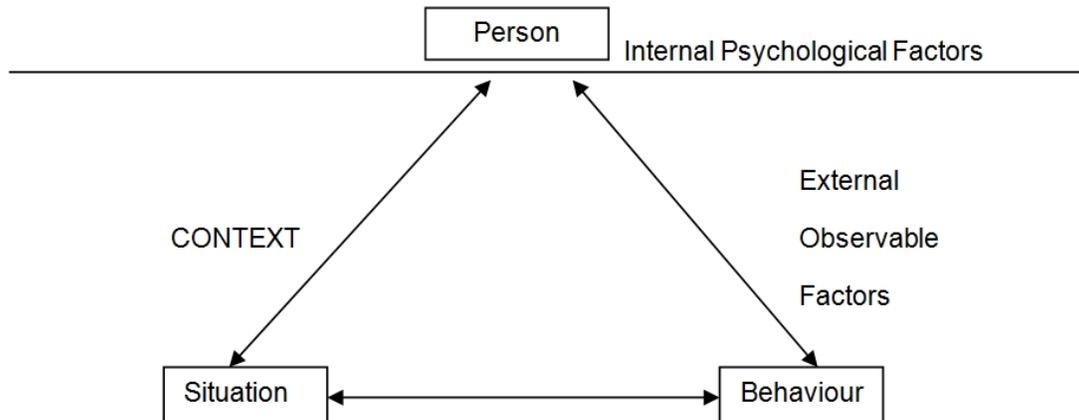


Fig. 1. Bandura's model of reciprocal determinism
 Source: Adapted from Cooper MD. *Towards a model of safety culture.*
Safety Sci., 36(2): 111-136;2000.

Bandura states that reciprocity does not mean that the different sources of influence are of equal strength, neither do the reciprocal influences occur simultaneously. Rather it takes time for a causal factor to exert its influence and to activate reciprocal influences. This bi-directionality of influence means that people are both products and producers of their environment. In other words, situations are as much the function of the person as the person's behaviour is a function of the situation [40] indicating that people self-regulate their own behaviour, in so far as they rely on cognitive supports and manage relevant environmental cues and consequences [41] Bandura's reciprocal model appears to offer the perfect framework with which to analyze safety culture for a number of reasons: First, the psychological, behavioural and situational elements of the model precisely mirror the accident causation relationships found by a number of researchers. Second, its dynamic nature suits the human and organizational systems that operate in dynamic environments [42]. Third, it provides a 'triangulation' methodology with which to encourage multi-level analyses [43]. Fourth, it explicitly incorporates the goal-setting paradigm via task-strategies and self-efficacy mechanisms.

1.7 Theoretical Framework

This research is based on Mossink and De Greef [44], economic effects theory which states that incorporation of positive safety culture into investment in machines and technology (socio-technical investments) will result in better safety performance of employees (reduced rate of unsafe acts) and the company (reduced rate of fatalities). Fig. 2 states that if a company incorporates positive safety culture into its investment in machines and technology (socio-technical investments) through an efficient safety supervision system and

management/employees commitment, this situation will lead to management/employees obedience to safety rules and regulations. The obedience to safety rules and regulations will create room for few unsafe acts and safety risks as well as better fit for work processes, more highly motivated personnel and improvement in working conditions culminating in better safety performance of management/employees and the company. Better safety performance of management/employees will lead to few fatalities, damages, liabilities, legal costs, loss of personnel, burial expenses. Better safety performance of the company will bring about better productivity, efficiency, quality, corporate image and innovative capacity hence there will be less disruption of work process and less liabilities.

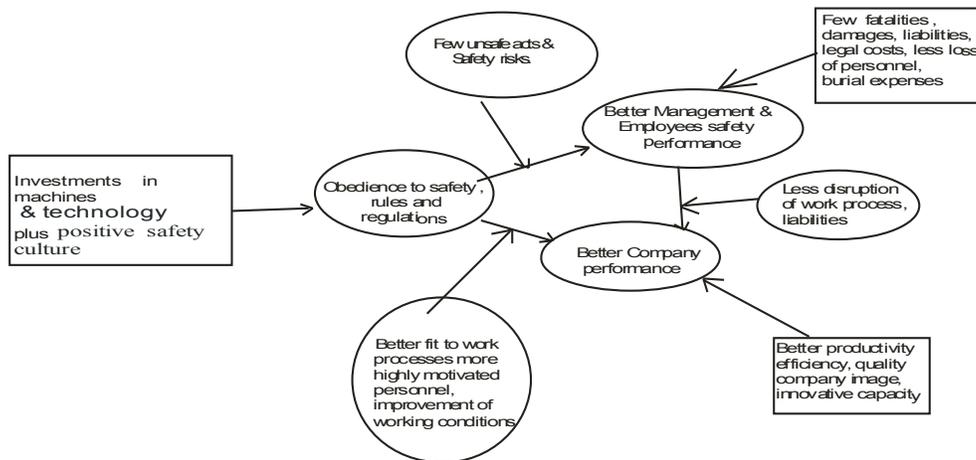


Fig. 2. Economic effects of positive safety culture at company level

Source: Adapted from Mossink J. and De Greef M. *Inventory of Socio-Economic Costs of Work Accidents Report*. European Agency for Safety and Health at Work. Luxembourg: Office for Official Publication of the European Communities; 2002.

1.8 Legal Framework

Nigeria lacks requisite statutory regulations on construction safety. The promulgated ones, notably the Factory Act, are skeletal in nature, non-functional and alien to the Nigerian construction environment. The Factory Act [45] establishes the statutory basis for inspection/enforcement of safety procedures in factories and ensures that systems/structures for reporting accidents and injuries (where necessary) are put in place. It also stipulates the nature of punishments for non-compliance. In spite of these provisions, contractors in Nigeria's construction industry are left to use their discretion in managing construction safety matters in their activities. For instance, the Act does not provide for the mandatory use of personal protective equipment within the construction industry as provided for in the UK Personal Protective Equipment (PPE) Regulations of 2002. Although, Articles 47 and 48 of the Act stipulates the provision of PPE for workers but the definition of factory given in Article 87 of the Act technically excludes construction sites and associated activities from the coverage of the Act. The Employee's compensation Act (2010) creates room for adequate compensation for all employees or their dependents for any death, injury, disease or disability arising out of or in the course of employment and rehabilitation for with work-related disabilities. It ensures that an employee is automatically entitled to receive certain benefits when he/she suffers an occupational disease or accidental personal injury arising out of and in the course of employment. Such benefits may include cash or wage-loss

benefits, medical/career rehabilitation benefits and death benefits in the case of accidental death of an employee. It is important to note that the negligence/fault of the employer/employee is usually immaterial.

The above limitation in the provisions of the factories Act creates room for dearth of accurate records on construction safety performance, thus making it almost impossible to have any meaningful improvement in safety standards of construction firms in Nigeria. Quite naturally, the absence of functional and stringent safety regulations could impact negatively on safety performance (increased rate of fatalities) as construction companies are seemingly not duty bound to establish management systems that could improve safety awareness and standards. Though, the federal and state ministries of works are statutorily responsible for monitoring construction companies' compliance with the provisions of the factories Act, the manner at which this function is executed is far below expectation. This research seeks to fill this gap by advocating the adoption of a positive safety culture in the Nigerian construction industry as a way of reducing the rate of fatalities to the barest minimum.

2. MATERIALS AND METHODS

2.1 Construction Safety Culture Method

The process of inculcating safety culture in the Nigerian construction industry should involve the following twelve steps: start at the top, make safety committees and safety managers part of the job, recognize but hold everyone accountable, plan safety into the project, prequalify subcontractors for safety, train workers for safety, focus on fall management, combat illicit drug use, evaluate each project phase for safety, make safety an everyday topic, review accidents and near misses and work with your insurer and risk management experts[46].

Step 1: Start at the top

Safety on the job site starts in the executive suite. To have a real impact on workers, safety has to become a core value of the organization. Chief executives should instill the idea in every level of management that the responsibility for safety lies with them. Senior executives need to lead by example taking an active and visible role in the implementation and execution of the safety culture.

Step 2: Make safety committees and safety managers a part of the job

Safety committees consisting of upper management, risk managers, safety directors and operational staff should be established to continually discuss and review safety performance. Safety efforts should not end with the safety manager. The safety manager should be viewed as a resource to help continually review and enhance the efforts made by everyone on site. Every person on a project site is responsible for safety.

Step 3: Recognize success, but hold everyone accountable

Accountability must be a core component of the safety culture. From individual workers to foremen, project supervisors and executives, everyone needs to be held accountable for safety. Without accountability, employees may be tempted to cut corners in an effort to save time and money. When safety programs, procedures and safe workplace habits are enforced

from the top, field employees take safety seriously. Aggressive safety goals that are reasonable and attainable should be established yearly. Management performance reviews should include those results. Discipline must be part of the process. Construction companies should also recognize success such as reaching a certain number of hours worked without an accident or achieving a full year incident rate that meets or exceeds the goal. Recognition shows workers that management values safety and the contribution it makes to the success of a project and the company.

Step 4: Plan safety into the project

Before work starts, a project specific safety plan should be developed to provide an overview of the scope of the work and the names, roles and responsibilities of key personnel. It should include a list of local emergency responders and medical facilities; emergency procedures and evacuation plans; fall management and retrieval procedures; substance abuse testing and new employee orientation. A project specific safety manual that outlines safety expectations and criteria should be given to each subcontractor. In addition, subcontractors should be required to submit their own project specific safety plan to identify the scope of their work, how the hazards will be mitigated and what measures they will take to provide a safe work environment.

Step 5: Prequalify subcontractors for safety

To evaluate subcontractor safety performance, construction companies should review their experience modification rates, their recordable and lost time incident rates, citation record and their overall safety culture and procedures. The pre-qualification of subcontractors should not stop with safety history and performance. It should include a review of the subcontractor's own safety culture and how the company incorporates safety into its day-to-day operation.

Step 6: Train workers for safety

Workers need to be trained to properly use a variety of safety equipment, such as fall arrest systems and they need to know the appropriate regulations. Orientation should not be limited to new employees. The company should provide orientation specific to each project. The orientation should include an overview of the project, an in-depth review of the safety requirements and expectations, evacuation plans and procedures, disciplinary actions, substance abuse testing policy and fall management procedures/requirements.

Step 7: Focus on fall management

A detailed fall management plan should be developed for each operation where the potential of falls from elevations will be encountered. No operation should commence without an approved fall management plan in place. At a minimum, the plan should address each task where a fall exposure exists; the hazard associated with the task; and the controls that will be implemented to mitigate the exposure and the safety training that will be provided to each worker. The plan should also address retrieval procedures necessary to rescue workers should a fall occur.

Step 8: Combat illicit drug use

Construction companies need to actively combat illicit drug use by conducting tests to identify workers with illicit drug abuse problems and steer them into treatment programs. They should focus on preventing impaired personnel from working on construction site.

Step 9: Evaluate each project phase for safety

As a project progresses, a job safety task analysis should be performed to make sure that the appropriate work and safety equipment is on hand so that workers would not be tempted to make do with what may be inadequate equipment or take chances that will endanger their safety. The analysis should include the specific aspects of the work at hand, identification of potential exposures, controls to eliminate the exposures and the necessary safety equipment to perform the work properly.

Step 10: Make safety an everyday topic

When foremen gather workers at the beginning of a shift to talk about the day's work, they should review the hazards involved and the safety controls, and make sure that the workers have the right protective gear and that all safety concerns are addressed. Regular, planned field safety inspections can help solve a host of issues while also improving safety. Regular inspections are probably the most effective management tool for dealing with the basic root causes of accidents, such as worn equipment, misplaced tools or equipment or unsafe actions by workers.

Step 11: Review accidents and near misses

Construction companies should start with the mindset that accidents are not inevitable. In the event that there is an accident, the facts and circumstances should be reviewed to identify root causes so that corrective action can be taken and future incidents can be prevented. The same attention should be paid to near misses that had the potential to become serious accidents.

Step 12: Work with your insurer and risk management experts

Construction companies should look to their insurers as a resource with substantive expertise in risk management, engineering protocols and procedures to help make their own safety efforts even more robust. Risk engineers may bring a new set of eyes to a project and can help identify issues that may be overlooked.

2.2 Research Method

The scope of this research is limited to the selected employees of twelve construction companies, two from each of the six geopolitical zones in Nigeria. It is assumed that responses obtained from the sample respondents would be representative of the opinions of all construction employees in Nigeria on fatalities in the Nigerian construction industry - a case of poor safety culture. The duration of study is between August 2012 and July 2013. A descriptive research design was used in executing the study using 600 (judgmentally determined) randomly selected respondents, fifty from each of the twelve selected construction companies for questionnaire administration. Data collected were analyzed using

descriptive and inferential statistics. The questionnaire was designed to obtain a fair representation of the opinions of the 600 sample respondents using a four-point Likert type scale. The questionnaire responses of the sample respondents were presented using tables while formulated hypotheses were tested using analysis of variance (ANOVA). A total of 600 copies of the questionnaire were administered, collected and used for the analysis.

3. RESULTS AND DISCUSSION

3.1 Distribution of Sample Respondents

The distribution of sample respondents from the twelve selected construction companies in the six geopolitical zones of Nigeria is as shown in Table 1 below:

Table 1. Distribution of sample respondents from twelve selected construction companies in the six geopolitical zones of Nigeria

S/No.	Geopolitical zone in Nigeria	Number of Companies	Sample project managers	Sample construction supervisors	Sample construction workmen	Total number of sample respondents
1.	North-East Zone	2	10	30	60	100
2.	North-West Zone	2	10	30	60	100
3.	North-Central Zone	2	10	30	60	100
4.	South-East Zone	2	10	30	60	100
5.	South- West Zone	2	10	30	60	100
6.	South- South Zone	2	10	30	60	100
	Total Number of Sample Respondents	12	60	180	360	600

Source: Field survey, 2013.

3.2 Distribution of Responses on Research Questions

3.2.1 Question number 1

Does any significant relationship exist between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry? Table 2 shows that questions: 1, 2, 3, 4, and 5 with varying mean scores of 3.17, 3.15, 3.27, 3.10 and 3.02 were above the weighted average of 2.5. The table further revealed a grand mean score of **3.14** indicating a strong evidence of the existence of a significant relationship between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry. This conclusion is buttressed by Reason [28], assertion that “...a poor safety culture will encourage an atmosphere of non-compliance to safe operating practices. Violations are likely to be most common in organizations where the unspoken attitudes and beliefs mean that production and commercial goals are seen to outweigh those relating to safety.” This assertion is further strengthened by Mbuya and Lema [20] perception that in most developing countries, safety consideration in construction project delivery is not given a priority and the employment of safety measures during construction is considered a burden.

Table 2. Mean responses on the relationship between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry (n=600)

S/No.	Research Questions	SA (4)	A (3)	D (2)	SD(1)	Total responses	Mean score
1	Do you experience poor safety culture in the execution of construction activities in your company?	300 1200	150 450	100 200	50 50	1900	3.17
2	Does the existence of poor safety culture in your company create room for employees to cut corners/commit unsafe acts in the execution of their duties?	330 1320	100 300	100 200	70 70	1890	3.15
3	Does the existence of poor safety culture negatively affect employees' safety training in your company?	350 1400	120 360	70 140	60 60	1960	3.27
4	Does the existence of poor safety culture in your company negatively affect your personal attitude to workplace hazards?	290 1160	150 450	90 180	70 70	1860	3.10
5	Does the existence of poor safety culture in your company negatively affect employees' involvement in safety matters?	280 1120	120 360	130 260	70 70	1810	3.02
	Grand Mean						3.14

Source: Field Survey, 2013.

3.2.2 Question number 2

Does any significant relationship exist between poor safety culture and increased rate of fatalities in the Nigerian construction industry? Table 3 shows that questions: 6, 7, 8, 9, and 10 with mean scores of 3.09, 2.93, 3.12, 3.32 and 3.08 were above the weighted average of 2.5. The grand mean of **3.11** shows that there is a strong evidence of a significant relationship between poor safety culture and increased rate of fatalities in the Nigerian construction industry. This conclusion is buttressed by the report of the International Atomic Energy Agency [47] on the Chernobyl disaster, in which 'poor safety culture' at the plant and in the Soviet society at large was identified as the root cause of the accident. Also, several accident investigations post-Chernobyl have pointed to poor safety culture as a key causal factor in the occurrence of accidents e.g. Piper Alpha, Ladbroke Grove, Kings cross, Challenger and Columbia. This is further strengthened by the observation of Sawacha et al. [48], in which unsafe acts resulting from poor safety culture were identified as the main cause of construction accidents. Choudhry et al. [27], also observed that poor safety culture

is one of the main attributes causing many injuries and fatalities in the construction industry all over the world.

Table 3. Mean responses on the relationship between poor safety culture and increased rate of fatalities in the Nigerian construction industry (n=600)

S/No.	Research Questions	SA (4)	A (3)	D(2)	SD(1)	Total responses	Mean score
6.	Does your company experience increased rate of fatalities in the execution of its construction projects?	290	120	145	45		
		1160	360	290	45	1855	3.09
7.	Does the existence of poor safety culture contribute to the increased rate of fatalities in your company?	260	110	160	70		
		1040	330	320	70	1760	2.93
8.	Does the existence of poor safety culture create room for unsafe acts that result in fatalities in your company?	300	140	90	70		
		1200	420	180	70	1870	3.12
9	Does lack of management commitment to safety matters create room for poor safety culture that result in fatalities in your company?	370	100	80	50		
		1480	300	160	50	1990	3.32
10	Does work pressure create room for poor safety culture that result in fatalities in your company?	285	135	125	55		
		1140	405	250	55	1850	3.08
	Grand Mean						3.11

Source: Field Survey, 2013.

3.3 Test Hypotheses

3.3.1 Test of the first hypothesis

H₀: There is no significant relationship between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry.

H₁: There is a significant relationship between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry.

Table 4. Computation of statistical variables on the first hypothesis from table 2

S/No.	Strongly agree		Agree		Disagree		Strongly disagree	
	X	X ²	X	X ²	X	X ²	X	X ²
1	300	90000	150	22500	100	10000	50	2500
2	330	108900	100	10000	100	10000	70	4900
3	350	122500	120	14400	70	4900	60	3600
4	290	84100	150	22500	90	8100	70	4900
5	280	78400	120	14400	130	16900	70	4900
Totals	1550	483900	640	83800	490	49900	320	20800

Source: Survey Data, 2013.

Calculation of total sum of square (SS_T)

$$SS_T = \sum_{i=1}^c \sum_{j=1}^{n_i} (X_{ij} - \bar{X}_i)^2$$

$$\sum X^2 = 483900 + 83800 + 49900 + 20800 = 638400$$

$$\frac{(\sum X)^2}{N} = \frac{(1550 + 640 + 490 + 320)^2}{20} = \frac{(3000)^2}{20} = 450000$$

SS_T = 638400 – 450000 = 188400

SS_T = 188400

Calculation of between group sum of squares (SS_B)

$$SS_B = \sum_{i=1}^c n_i (\bar{X}_i - \bar{X})^2$$

$$\frac{(\sum X)^2}{n} = \frac{(1550)^2}{5} + \frac{(640)^2}{5} + \frac{(490)^2}{5} + \frac{(320)^2}{5}$$

$$= 480500 + 81920 + 48020 + 20480 = 630920$$

$$\frac{(\sum X)^2}{N} = \frac{(1550 + 640 + 490 + 320)^2}{20} = \frac{(3000)^2}{20} = 450000$$

SS_B = 630920 – 450000 = 180920

SS_B = 180920

Calculation of within group sum of squares (SS_w)

$$SS_w = \sum_{i=1}^c \sum_{j=1}^{n_i} (X_{ij} - \bar{X})^2 \text{ or } SS_w = SS_T - SS_B$$

SS_T - SS_B = 188400 – 180920 = 7480

SS_w = 7480

Calculation of Degrees of Freedom

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

df = 20-1 = **19**

SS_Bdf = number of group minus 1= 4-1 = **3**

SS_Wdf = number of group taken away from number of subjects = 20-4 = **16**

Calculation of Variances:

Between group variance (S_B²) = $\frac{\text{Between group sum of squares (SS}_B)}{\text{Between group degree of freedom}}$

$$S_B^2 = \frac{\sum_{i=1}^c n_i (\bar{X}_i - \bar{X})^2}{c-1}$$

$$S_B^2 = \frac{180920}{3} = \mathbf{60306.67}$$

Within group variance (S_W²) = $\frac{\text{Within group sum of squares (SS}_W)}{\text{Within group degree of freedom}}$

$$S_W^2 = \frac{\sum_{i=1}^c \sum_{j=1}^{n_i} (X_{ij} - \bar{X}_i)^2}{n-c}$$

$$S_W^2 = \frac{7480}{16} = \mathbf{467.50}$$

$$F\text{-value} = F_{df_1, df_2} = \frac{S_B^2}{S_W^2} = \frac{\text{Between group variance}}{\text{Within group variance}} = \frac{60306.67}{467.50} = \mathbf{129.00}$$

Table 5 shows that calculated F-Value of **129.00** resulted from the relationship between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry. This calculated F-Value is significant since it is greater than the critical F-Value of 5.29 given 3/16 degree of freedom at 0.01 level of significance. Hence, the null hypothesis is rejected while the alternative is accepted. This shows that there is a significant relationship between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry.

Table 5. Computation of analysis of variance on the relationship between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry

Source of variance	Sum of squares	Degree of freedom	Mean sum of squares	Calculated F-value	Table critical F-value	Decision
Between groups	180920	3	60306,67	129.00	5.29	H₀: Rejected
Within group	7480	16	467.50			
Total	188400	19				

Source: Statistical Computation and Table 4.

3.3.2 Test of the second hypothesis

H₀: There is no significant relationship between poor safety culture and increased rate of fatalities in the Nigerian construction industry.

H₁: There is a significant relationship between poor safety culture and increased rate of fatalities in the Nigerian construction industry.

Table 6. Computation of Statistical Variables on the second Hypothesis from table3

S/No.	Strongly agree		Agree		Disagree		Strongly disagree	
	X	X ²	X	X ²	X	X ²	X	X ²
6	290	84100	120	14400	145	21025	45	2025
7	260	67600	110	12100	160	25600	70	4900
8	300	90000	140	19600	90	8100	70	4900
9	370	136900	100	10000	80	6400	50	2500
10	285	81225	135	18225	125	15625	55	3025
Totals	1505	459825	605	74325	600	76750	290	17350

Source: Survey Data, 2013.

Calculation of total sum of square (SS_T)

$$SS_T = \sum_{i=1}^C \sum_{j=1}^{n_i} (X_{ij} - \bar{X}_i)^2$$

$$\sum X^2 = 459825 + 74325 + 76750 + 17350 = 628250$$

$$(\sum X)^2 = (1505 + 605 + 600 + 290)^2 = (3000)^2 = 450000$$

$$N \qquad \qquad 20 \qquad \qquad 20$$

SS_T = 628250 – 450000 = 178250

SS_T = 178250

Calculation of between group sum of squares (SS_B)

$$SS_B = \sum_{i=1}^C n_i (\bar{X} - \bar{X})^2$$

$$\sum (X)^2 = (1505)^2 + (605)^2 + (600)^2 + (290)^2$$

$$n \qquad 5 \qquad 5 \qquad 5 \qquad 5$$

$$= 453005 + 73205 + 72000 + 16820 = 615030$$

$$\sum (X)^2 = (1505 + 605 + 600 + 290)^2 = (3000)^2 = 450000$$

$$N \qquad \qquad 20 \qquad \qquad 20$$

SS_B = 615030 – 450000 = 165030

SS_B = 165030

Calculation of within group sum of squares (SSw)

$$SSw = \sum_{i=1}^c \sum_{j=1}^{n_i} (X_{ij} - \bar{X})^2 \text{ or } SS_W = SS_T - SS_B$$

$$SS_T - SS_B = 178250 - 165030 = 13220$$

$$SS_W = 13220$$

Calculation of Degrees of Freedom

df for the whole group = total number of observation minus one
 df = 20-1 = 19

SS_Bdf = number of group minus 1 = 4-1 = 3

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

Calculation of Variances:

Between group variance (S_B^2) = $\frac{\text{Between group sum of squares (SS}_B\text{)}}{\text{Between group degree of freedom}}$

$$S_B^2 = \frac{\sum_{i=1}^c n_i (\bar{X}_i - \bar{X})^2}{c-1}$$

$$S_B^2 = \frac{165030}{3} = 55010$$

Within group variance (S_W^2) = $\frac{\text{Within group sum of squares (SS}_W\text{)}}{\text{Within group degree of freedom}}$

$$S_W^2 = \frac{\sum_{i=1}^c \sum_{j=1}^{n_i} (X_{ij} - \bar{X}_i)^2}{n-c}$$

$$S_W^2 = \frac{13220}{16} = 826.25$$

$$F\text{-value} = F_{df_1, df_2} = \frac{S_B^2}{S_W^2} = \frac{\text{Between group variance}}{\text{Within group variance}} = \frac{55010}{826.25} = 66.58$$

Table 7 shows that calculated F-Value of **66.58** resulted from the relationship between poor safety culture and increased rate of fatalities in the Nigerian construction industry. This calculated F-Value is significant since it is greater than the critical F-Value of 5.29 given 3/16 degree of freedom at 0.01 level of significance. Hence, the null hypothesis is rejected while the alternative is accepted. This shows that there is a significant relationship between poor safety culture and increased rate of fatalities in the Nigerian construction industry.

Table 7. Computation of Analysis of Variance on the relationship between poor safety culture and increased rate of fatalities in the Nigerian construction industry

Source of variance	sum of square	Degree of freedom	Mean sum of square	Calculate F-value	Table critical F-value	Decision
Between group	165030	3	55010	66.58	5.29	H₀: Rejected
Within group	13220	16	826.25			
Total	178250	19				

Source: Statistical Computation and Table6.

4. CONCLUSION

The paper has discussed fatalities in the Nigerian construction industry- a case of poor safety culture. It assumes that incorporation of positive safety culture into investment in machines and technology (socio-technical investments) by Nigerian construction companies will result in better safety performance of employees (reduced rate of unsafe acts) and the company (reduced rate of fatalities). The three major findings of the research are as follows:

- ❖ There is a poor safety culture in the Nigerian construction industry.
- ❖ There is a significant relationship between poor safety culture and increased rate of unsafe acts in the Nigerian construction industry.
- ❖ There is a significant relationship between poor safety culture and increased rate of fatalities in the Nigerian construction industry.

Arising from the findings of this paper, it is suggested that captains of construction industry, the relevant government agencies, professional bodies and members of the public should take the following measures to inculcate a positive safety culture in the Nigerian construction:

- 1. Visible top management commitment to organizational safety issues:** This will motivate employees' commitment to safety in the execution of their daily activities. Though, this may involve commitment of time and other resources, the associated benefits outweigh the costs. Visible top management commitment to organizational safety issues may be resisted initially by top management as diversionary; this will be eliminated overtime with persistence awareness campaign.
- 2. Regular staff training on safe work procedures:** This will sharpen and improve their hazard identification skills and reduce unsafe acts/conditions in the workplace. Though, staff training involves expenditure of money, the expenditures associated with fatalities are greater comparatively. Management may resist regular staff training on the basis costs, greater awareness will bring about a change in attitude over a period of time.
- 3. Establishment of safety committees:** Safety committees consisting of upper management, risk managers, safety directors and operational staff should be established to continually discuss and review safety performance in work activities. This will help in overcoming employees' resistance to safe work procedures since they are members of these safety committees that formulate these procedures. Though this may be resisted initially as time wasting, greater awareness will bring about a change in attitude over a period of time.
- 4. Regular site safety audits:** This will facilitate the identification/elimination of potential workplace hazards and enable management to sense the safety climate of the work site. Though, this may involve commitment of time and other resources, the associated benefits of accident elimination far outweigh the costs. This may be resisted initially as time wasting and unproductive, greater awareness will bring about a change in attitude.
- 5. Abolition of productivity/collective bonus schemes:** Productivity bonus schemes have been found to act as an incentive for employees to work faster thus committing unsafe acts while collective bonus schemes can lead to workers being pressurized not to report an accident by colleagues unwilling to lose their bonus. It is important to note that the economic loss (physical pain, physical disability, mental agony, loss of leisure and loss of income) to employees far outweigh the benefits of any productivity/collective bonus scheme. This may be resisted by the shop floor

workers as a measure to reduce their take home pay; greater awareness on the inherent benefits will overcome the resistance over time.

6. **Improvement of internal communication channels:** Management should establish additional channels of internal communication to ensure the free flow of information between management and employees especially on workplace safety issues. This can be achieved at no costs; the associated benefits of flexibility in production will encourage management to improve internal communication channels and overcome the initial resistance to this change.
7. **Recognize success, but hold everyone accountable:** Accountability must be a core component of the safety culture. From individual workers to foremen, project supervisors and executives, everyone needs to be held accountable for safety in their day to day operations. The costs of introducing safety incentive schemes far outweigh the costs of accidents/fatalities in the construction industry. This introduction of safety incentive schemes may be resisted initially as a waste of resources since workers are being paid salaries, greater management awareness will bring about a change in attitude.

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COMPETING INTERESTS

The authors have declared that no competing interests exist.

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