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Relationship between Safety Culture and Climate on Construction Sites

Jonathan Ademola Ayangade[1]
[1]*Department of Building, Obafemi Awolowo University, Ile-Ife,Nigeria*

ABSTRACT
Safety climate has been described as a surface manifestation of safety culture. However, past studies on safety culture and safety climate have not conducted an in-depth exploration of the link between safety climate and safety culture. Hence, this study explored the relationships between safety climate and safety culture on construction sites. A questionnaire survey of professionals employed by construction contractors in the south-western states of Nigeria was conducted. The data analysis was conducted using mean score, t-test and Pearson correlation test.The study found that safety culture is highly and positively correlated with safety climate; and that poor safety culture will contribute to unhealthy safety climate on the construction sites. The study concluded that as the safety culture practices increase, the overall safety climate on the construction site is enhanced.

KEYWORDS*: safety climate, safety culture, construction sites, construction safety*

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I. INTRODUCTION

The construction industry plays a vital role in boosting the economy of any country, especially a developing country. It provides the infrastructure required for other sectors of the economy to flourish. Studies have shown that the construction industry reflects the level of economic development within the country (Idoro, 2004, Biggs et al., 2013). The construction industry is unique when compared to manufacturing and service industries. Mohammed (2002), Andi (2008),Kines*et al.* (2010),Frazier, Ludwig, Whitaker, and Roberts (2013) reported that each construction project is different from another because the conditions and challenges always differ during execution. The construction industry is characterized by the process of converting architectural and engineering drawings and specifications into real structures this involves a complex inter-relationship among good business, management and technology.

Dangers to health and safety exist within the construction industry because of its fragmented nature, the uncertain and technically complex nature of construction works, the uncontrollable environment in which production takes place, the employment practices, and the financial and time pressures imposed upon project participants (King and Hudson, 1985; HalenderandHolborn, 1991; Mohammed 2002; Guldenmund, 2007).

Construction processes involve hazardous activities, such as risky working heights, manual handling of, and, or exposure to hazardous materials, demolition, erection and lifting operations, high level scaffolding, and bulk materials and heavy equipment handing. These run alongside changing jobsite personnel and worksites.To crown it all, the unfavorable high supervisor worker ratio is the characteristic feature of the industry that makes the management of the sector to be more troublesome. Supervisors with close personal and positive relationship with workers are credited with more favorable safety performance records (Hinze, 1997; Levitt and Samelson, 1993; Toole, 2005). This relationship tends to be difficult to develop if the ratio is too high, as is generally the case within the construction industry (Smallwood, 2000).

According to Kamang (1992), and Choudhry and Fang (2008), construction methods have witnessed changes with the current trends tending towards industrialization, mechanization, prefabrication and the automation of all processes involved in the erection and installation of structures. A resultant effect of the above according to Ayangade (2001) is that construction sites have become more accident prone.In order to reduce and eventually eliminate construction accidents, researchers have attempted to identify or investigate the major causes of accidents on constructions sites. Levitt and Samelson (1987) were able to identify human behaviour and unsafe acts by workers as major safety variables.

The adverse effects of site accidents, according to Mohamed (1999), not only de-motivate workers, disrupt site activities, delay project progress and productivity, but impacts on the reputation of the construction industry as well. Safety climate is a 'snapshot' of workers perception about safety (Mearns et al.,2003). The concept of safety climate emphasizes the importance of how organization manages safety in the workplace. Any changes made to the operation of a business will have an impact on workers perception. These perceptions have

a psychological utility in serving as a frame of reference for guiding appropriate and adaptive task behavior. As the workers environment changes around them, they adapt their perception and ultimately their behaviours.

Safety culture is generally described as safety attitudes, values, and practices that exist at deeper level than safety climate. The term safety culture was first introduced in the International Safety Advisory Group [INSAG]'s *Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident* by the International Atomic Energy Agency (IAEA, 1986). The term safety climate had appeared several years earlier in an investigation of safety attitudes in Israeli manufacturing (Zohar, 1980). Safety culture was defined by *Safety Culture* (*International Safety Advisory Group, Safety-Series75-INSAG-4)* as the assembly of characteristics and attitudes in organizations and individuals, which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance (IAEA, 1991). Since then, a considerable number of definitions of safety culture have abounded in the safety literature (Choudhry *et al.*, 2007; Guldenmund, 2000; Wiegmann, Zhang, Haden, Sharma, and Gibbons, 2004).

Wiegmann*et al.* (2004) identified a set of critical features regardless of the particular industry from the various definitions of safety culture. These critical features include a concept defined at the group level or higher that refers to the shared values among all the group or organization members; formal safety issues in an organization and closely related to, but not restricted to, the management and supervisory systems; emphasis on the contribution from everyone at every level of an organization; organization's impact on members' behavior at work; contingency between reward systems and safety performance; and organization's willingness to develop and learn from errors, incidents, and accidents.

Zohar (1980) first defined safety climate as a summary of "perceptions that employees share about their work environment".Flin, Mearns, Gordon and Fleming, (1998)defined safety climate as the perceived state of safety of a particular place at a particular time. It is therefore relatively unstable and subject to change depending on features of the operating environment. Much later, Zohar, (2003) suggested, "safety climate relates to shared perceptions with regard to safety policies, procedures and practices". Although literature has not presented a generally accepted definition of safety climate, "many definitions do have commonalities and differ from safety culture in important waysWiegmann*et al* (2004). The commonalities are that safety climate is a psychological phenomenon that is usually defined as the perceptions of the state of safety at a particular time; closely concerned with intangible issues such as situational and environmental factors; and a temporal phenomenon, a 'snapshot' of safety culture, relatively unstable and subject to change.

In this study, safety culture will refer to "individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the proficiency of organizations safety management". Safety climate will refer to workers' perception of how safety is managed in the workplace and the likelihood those perceptions will contribute to a workplace accident. The importance of safety climate rest on its ability to predict safety behaviour (Larsson and Torner 2008). It also has the ability to identify detailed and precise troubles or difficulties that can be considered critical to improving safety. Safety climate is assumed to act as a frame of reference which guide behaviour such that employees develop "a coherent sets of perceptions and expectations regarding behaviour –outcome contingencies and behave accordingly. In brief, safety climate is a surrounding concept describing the safety ethic in an organization or workplace which is reflected in employee's belief about safety and is thought to predict the way employees behave with respect to safety in that workplace.

The need for the concept has risen from various areas, including the need to describe the factors underpinning safe behaviour in the workplace, the need to define the "flavour" of safety in an organization, and as one of the factors which will moderate change in workplace.The concept of safety culture according to Teo and Feng (2009) is a means of reducing the potential for accidents associated with routine tasks which is synonymous with construction industry. It is also a mean of the attributes causing many injuries and fatalities in the construction industry is the poor safety culture (Alasamri *et al*., 2012).

The aforementioned commonalities extracted from various definitions of safety culture and safety climate indicate that the two terms should not be viewed as alternatives. Safety climate is only a surface manifestation of safety culture (Schein, 1990; Choudhry *et al*., 2007).Cox and Flin, (1998) further suggested that the nature of culture and climate and their relationship has also been related to the concepts of personality and mood, whereas culture represents the more trait-like properties of personality and climate the more state-like properties of mood. Past studies on safety culture and safety climate have not conducted an in-depth exploration of the relationships between safety climate and safety culture (Alasamri *et al.*, 2012; Choudhry *et al*., 2007). Hence, this study explored the relationships between safety climate and safety culture on construction sites.

II. LITERATURE REVIEW

2.1 Safety climate and safety culture

Safety climate and culture are respectively considered subsets of organizational climate and culture (Coyle, Saleeman, and Adams, 1995), and both have received considerable attention in the safety literature. The

advisory committee on the safety of Nuclear Installation (ACSNI, 1993) has defined safety culture in a comprehensive manner in their view:

Safety culture is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to safety and the life style and proficiency of an organization's health and safety management (p. 23)

Safety culture is important because it forms the context within which individual safety attitudes develop and persist and safety behaviors are promoted (Zohar, 1980). It is interesting to note that the concept of safety culture was developed in response to major organizational accidents; however, it is now being more widely applied to explain accidents at the individual level (Mearns *et al.*, 2003). Safety climate is regarded as a manifestation of safety culture in the behaviour and expressed attitude of employees (Cox and Flin, 1998). Coyle *et al* (1995) define safety climate as an objective measurement of attitudes and perceptions towards health and safety issues. Indeed safety climate, as with organizational climate, can be regarded as the surface features of culture derived from a sample of employees' attitudes and perceptions at a particular point in time (Flint *et al*, 2000). Neal and Griffin (2000) found that safety climate operates as a mediating variable between organizational climate and safety performance, which describes individual perceptions of the value of safety within the work environment.

Safety climate has been researched for the last twenty five (25) years, dominantly in four directions: (i) designing psychometric measurement instruments and ascertaining their underlying factor structures, (ii) developing and testing theoretical models of safety climate to ascertain determinants of safety behavior and accidents; (iii) examining the relationship between safety climate perceptions and actual safety performance; and (iv) exploring the links between safety climate and organizational climate (Cooper and Philips, 2004).

Several safety climate – related studies have been conducted to determine the factors that contribute to safety climate. Table 1 displays various safety climate studies, ascertaining various underlying safety climate factor structures. The table does not include other studies that dealt with safety climate factors in a generic form (i.e. not targeting any specific sector).

Zohar (1980) constructed the first measure and validated a 40 – item measure of organizational climate for safety on twenty (20) industrial samples in Israel. Zohar's measures of safety climate was developed by first undertaking a review of safety literature with the goal of defining the characteristics and practices that differentiated between companies that experienced a high rate of accidents and those that experienced low rates. The underlying assumption was that the perception of those dimensions within the plant forms the basis of the safety climate. Zohar organized the questionnaire into eight (8) different dimensions based on the literature review (i) perceived management attitudes on safety; (ii) perceived effects of safe work practice on promotion; (iii) perceived effects of safe conduct on social status of individuals (iv) status of safety officer (v) status of safety committee (vi) perceived effectiveness of safety training (vii) perceived level of risk at the workplace; and (viii) the importance of safety training programs. After administrating the questionnaires to 120 production workforce, the data were factor-analyzed using principal component analysis, resulting in eight (8) factors that largely overlapped with the original dimensions. Based on the results, Zohar concluded that safety climate is directly related to a company's safety record, and could provide a means for identifying the areas of safety within a company that can be improved.

Table 1: Chronological documentation of safety climate factors derived for specific sectors

Study	Sector (s), country	Factors extracted
Zohar (1980)	Manufacturing, Israel	Safety training Management attitudes Risk in workplace Promotion Work pace Status of security officer Social status Status of safety committee
Brown and Holmes (1986)	Manufacturing, USA	Management concern Management activity Risk perception
Debobbeleer and Beland (1991)	Construction, USA	Management commitment Work involvement
Cox and Cox (1991)	Offshore Environment, Europe	Personal skepticism Individual responsibility Safeness of work environment Effectiveness of safety arrangements Personal immunity
Niskamen (1994)	Road construction, Finland	Changes in job demand Attitude to safety in organization Values of work Safety as a part of productive work

Glendon, Stanton and Harrison (1994)	Electricity, UK	Communication Relationship Incident investigation ,Procedure development Adequacy of procedures Work pressure Personal proactive equipment Spares Safety rules
Coyle, Sleeman and Adams (1995)	Office, Nursing and Social Workers, Australia	ORGANISATION 1 Maintenance and management issues Company policy Accountability Training and management attitudes Work environment Policy/procedure Personal authority ORGANISATIONS 2 Work environment Personal authority Training and enforcement of policy
Williamson Feyer, Caromsand Biammotti (1997)	Manufacturing, Australia	Personal motivation Positive safety practice Risk justification Fatalism Optimism
Means, Flin Gordon and Fleming (1998)	Offshore Oil and Gas, UK	Speaking up Supervisors Site management Visitations Rules/regulations Work clarity Work pressure Communication
Glendon and Litherland (2001)	Road Construction and Maintenance, Australia	Communication and support Relationships Adequacy of procedures Work pressure Personal proactive equipment Safety rules
Garavan and O'Brien (2001)	Manufacturing, Ireland	Employees willingness to participate in safety management Negative stereotype workers Belief about employees who have accidents Management commitment Rockiness in job Belief in accidents proneness Safety Strict adherence to rules Employees safe conscious
Mohamed (2002)	Construction, Australia	Management Risk perception Work pressure Competence Safety rules

Zohar's model was replicated by Brown and Holmes (1986) and Coyle *et al* (1995) on different samples. Brown and Holmes (1986) at first used the same model as Zohar's on the manufacturing industry in the United States of America (USA), while Coyle *et al* (1995) added a number of questions that had been developed through polling employees about safety issues at their subject facilities which were important in those facilities. Both studies failed to replicate Zohar's exact factor solution. The reason attributed to this difference was simply the differences within the organizations themselves, and possibly to the differences in the cultures within which the facilities were located (Zohar - Israel, Brown and Holmes - USA, Coyle *et al*, - Australia). Brown and Holmes (1986) therefore, in their next step used existing American data to refine the model utilizing an exploratory approach to factor analysis model building, based on their extracted factors for safety climate, they were able to determine only three (3) principal factors employee perception of how concerned management was with employees' wellbeing; employee perception of how active management was in responding to this concern; and employee physical risk perception.

Dedobbeleer and Beland (1991) tested Brown and Holmen's three-factor safety climate model on construction workers. Their sample consisted of American construction workers at nine different constructing

sites. Using a maximum likelihood factor solution with various rotations, they were able to replicate Brown and Holmes' solution; however, they went on to recommend that their own two-factor solution was better. The reasons given for the improvement was the different industry sampled. The two factors were interpreted as management commitment to safety and worker's involvement in safety.

A study by Cox and Cox (1991) of employees' attitudes within an industrial organization produced five factors personal skepticism individual responsibility; the safeness of the work environment and the effectiveness of arrangements for safety and personal immunity. A three-factor model of safety climate was produced by Seppala (1992), organizational responsibility for safety; workers' concern about safety, and workers' indifference towards safety. Niskanen (1994), in his study of road construction workers, found two separate four-factor solutions for workers and for supervisors. Both included attitudes towards the safety of the organizations, changes in work demands, value of work, and safety as part of productive work.

Using a safety climate questionnaire, Glendon *et al* (1994) conducted research to identify performance shaping factors that would be generic to all organizations. This study concluded with nine factors namely: communication and support, adequacy of procedures work pressure, personal protective equipment spares, relationships safety rules, incident investigation, and development of procedures. Hofmann and Stetzer (1996) used the Dedobbeleer and Beland (1991) and Zohar (1980) measure of safety climate to examine safety climate at the different group level of the organization. They demonstrated that safety climate was correlated with both reported rates of unsafe behavior and actual accidents. This finding provides some critical evidence, indicating that safety climate has some criterion – related validity a relationship that had previously not been established.

Williamson et al (1997) proposed a 67 – item measure of safety climate. Factor analysis on this study revealed five factors personal motivation for safe behaviour, positive safety practice; risk justification, fatalism and optimism. Flin *et al* (2000), on the basis of the intensive reviews in their study, found the most frequently measured factors were related to management, risk and safety arrangements. Work pressure and competence were two other emerging, although less frequently used, factors in this particular study.

Glendon and Litherland (2001), in their study on an Australian road construction organization, investigated the relationship between safety climate and safety performance by using a modified version of Gelendon *et al* (1994) safety climate factor questionnaire. Their study revealed the presence of six factors as compared to the nine factors of Glendon *et al* (1994).The factors were communication and support; relationship, adequacy of procedures, work pressure, personal proactive equipment; and safety rules. This study could not establish the relationship between safety climate and safety performance. The reasons attributed to such failure included, the safety climate measure may tap a different aspect of safety than the behavioural measure of safety. The safety climate questionnaire used in the research was a subjective self-report measure, while behavioural observation is a more objective method.

Different measurement methods may reflect different aspects of safety. Garavan and O'Brien (2001) found evidence of a positive relationship between safety climate and safe behavior. This study also showed strong effects of age, gender and experience, but there were no effect of accident history variables on the perception of safety climate.

Mohamed (2002), using structural equation modeling, studied the impact of safety climate on safe work behaviour at nineteen (19) Australian construction sites. Five independent sets of safety climate factors (Management, safety, risk, work pressure and competence) were taken directly from the study of Flin *et al*, (2000) support was found in this study for the influence of management, safety and risk systems on safety climate. Mohamed's results showed a significant positive relationship between safety climate and safe work behaviour. He (1995) argued that recent studies have investigated the impact of one for more elements of the five factors on construction safety climate (Rowlinson and Lingard, 1996; Sawacha *et al*, 1999; Mohammed, 1999), however individual relationship of these factors with safety climate had not been measured specifically.

Means et al (2003) conducted safety climate surveys on thirteen (13) offshore oil and gas installation over two years' time spans. The questionnaire surveys were developed from the previous studies of Rundmo (1994, 1997) and Means *et al* (1997, 1998). Their 2003 study aimed to explore the association between safety climate and safety performance and between safety management practices and safety performance. On the basis of their hypothesis formation, they found partial support for the association between safety climate, management practices and performance.

An exploratory study on safety climate factors and their relationship with safe behavior, by Cooper and Phillips (2004), revealed the importance of safety training as an important factor, predicting actual levels of safe behavior. This study was the extension of the old behavioural study of Cooper *et al* (1994). The safety climate survey was distributed to manufacturing employees. 'Twelve months after the first safety climate survey, a second survey was conducted using the original survey content. The results showed an empirical link between a limited set of safety climate perception and actual safety behaviour.

2.2 Role of safety perception and attitudes in safety climate

In understanding a workplace's safety climate, the perception and attitudes of the workforce are important factors in assessing safety needs. Needed safety solutions may fail if these prevailing attitudes and perceptions are not taken into account (Williamson *et al,* 1997). Attitudes are defined as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour" (Eagly and Chaiken, 1993). Neal and Griffin (2004), in their study, found that attitude measures exhibited greater variability than did perceptional measures, as attitudes are influenced by individual differences in addition to environmental factors. Thus, they argue that attitudes and perceptions of safety should be clearly differentiated.

In an earlier work Neal and Griffin (2000) defined safety perception as "how workers view safety related policies, procedures and other workplace attributes concerned with safety". They proposed a framework for investigating perception of safety within organizations. This framework differentiates between individual perceptions of the work environment and the factors that may mediate individual work performance from perceptions of the workplace. Zohar (1980) conceptualized safety climate as a summary of the beliefs and perceptions of employees about safety within the workplace. In its original conception it was assumed that the safety climate acts as a frame of reference that guides behaviour, such that employees develop "coherent sets of perceptions and expectations regarding behaviour – outcome contingencies and behave accordingly" (Zohar, 1980),

Donald *et al.,* (1991) revealed three (3) facets of safety attitudes people or the organizational role that make up the safety climate; attitudes behavior or aspects of an individual's safety behaviour; and safety activity or type of safety behaviour. Neal and Griffin's (2000) study considered only those perceptions related to safety climate, viz those involve individuals' assessment of workplace attributes concerned with safety. For example, employees' views about management values for safety, and personnel policies about safety, are clear perceptions about values and procedures within the wider work environments. So in short safety climate as a concept describes the safety ethic within a workplace, which is reflected in workers beliefs about safety and is supposed to predict the way workers behave with respect to safety within that workplace (Williamson *et al,* 1997).

III. Methods

The study population required for this research was made up of professionals employed by construction contractors classified under the general category from the archive of Public Procurement Departments in the south-western states in Nigeria. These comprised Lagos, Ogun, Ondo, Oyo, Osun and Ekiti States. The construction professionals included builders, engineers, architects, and quantity surveyors that were in the employment of the construction contractors studied. The data for the study were sourced through the use of questionnaire administration. The sample frames used for the study were the registered contractors in the South Western Nigeria. The registered Construction Contractors as obtained from the Public Procurement Departments in the south western states in Nigeria are represented in table 2.

Table 2: Registered construction contractors by state in South-Western Nigeria

State	Number of registeredcompanies selected	30% of companies	No. of questionnaire returned
Lagos	257	77	69
Ogun	183	55	42
Ondo	142	43	35
Oyo	154	46	37
Osun	132	40	30
Ekiti	119	35	29
Total	987	296	242

Out of the total nine hundred and eighty seven (987) Construction Contractors registered in the six states, thirty percent (30%) of the total number were purposively sampled for the study. This gives a total sample size of two hundred and ninety six (296) construction firms.

The questionnaire used for the study was divided into two sections. Section A was designed to gather data and information about the Respondents. The general information requested from the respondent included the academic and professional qualifications, years of working experiences in the construction industry and the length of time on their present position. The questions were structured and specifically designed to check whether respondents have appropriate knowledge and experience and hold appropriate position in the industry which would give credence to collected data. The assessments were covered in question 1-10 of the section. Section B of the questionnaire sought to investigate the relationship between safety culture and safety climate. For data analysis, mean score, t-test and Pearson correlation test were used to establish the relationship between safety culture and climate on construction sites.

IV. Results, findings, and discussion

4.1 Profile of respondents

As presented in Table 3, two hundred and forty-two (242) construction firms were surveyed. One hundred and forty-five (145) were the medium sized construction firms representing 59.92% while the large construction firms accounted for 40.08%. These two construction firm categories (medium and large sized companies) were considered because they had formal units or sections and department within their organizational setup to oversee safety related issues. Small sized firms were not included since their modes of operation were not formal and they hardly have units within their organizations to specifically manage safety related issues.

Table 3: Organizational set up of the studied firm

Firm studied	Frequency	%	Cumulative %
Medium construction companies	145	59.92	59.92
Large construction companies	97	40.08	100
Total	242	100	-

The study examined the ownership of the construction firms. Ownership implied whether the firm is wholly owned by only Nigerians or foreigners or by mixture. The findings showed that one hundred and forty three (59.1%) of the firms studied were wholly indigenous. Fifty five (22.7%) were multinational firms while nationalized and wholly foreign firms studied were 15.7% and 2.5% respectively. The result of the finding is presented in Table 4.

Table 4: Description of the studied firm

Nature	Frequency	%	Cumulative %
Wholly indigenous	143	59.1	59.1
Multinational	55	22.7	81.8
Wholly foreign	6	2.5	84.3
Nationalized	38	15.7	100.0
Total	242	100	

Another important aspect of the firms under survey is the type of projects the firm undertook. It was established that 63.7% of the firms were involved in both building and civil engineering projects. Those that engaged only in building projects were 28.2% while the least were firms that engaged in only civil engineering projects alone (8.2%). This is presented in Table 5. This result revealed that the opinion of majority of the respondents was not sectional but cuts across both building and civil engineering constructions. The result is as illustrated in Figure 3 in the appendix.

Table 5: Types of projects the company undertakes

Type	Frequency	%	Cumulative %
Building Projects	68	28.10	28.10
Civil Engineering Projects	19	7.85	35.95
Both Building and Civil	155	64.05	100.0
Total	242	100.0	-

The academic qualifications of the respondents in the surveyed construction firms were presented in Table 6. An observation showed that workers with first degree (B.Sc/B.Tech) constituted 40.5% (the highest) in the medium and large construction companies. Next in importance were workers with M.Sc degree holders representing 27.69% while H.N.D holders represented 24.79%. The least workers were those with PGD certificate holders. These category of workers accounted for 5.37%. The above findings showed that the workers of the construction firms studied were highly educated. By these levels of education, it can be assumed that the workers would not only be able to understand safety policies and objectives but would also be able to direct the entire workforce about the guidelines for its implementation.

Table 6: Academic qualification of workers in the studied firms

Academic qualification	Frequency	Percentage	Cumulative %
HND	60	24.79	24.79
BSc/B.Tech.	98	40.50	65.29
M.Sc	67	27.69	92.98
PGD	13	5.37	98.35
Ph.D	4	1.65	100.0
Total	242	100	-

The professional status of the respondents in the studied construction firms was also studied. The result is presented in Table 7.

Table 7: Professional qualification of the respondents

Professional qualification	Frequency	Percentage	Cumulative %
NIA	25	10.33	10.33
NIQS	31	12.81	23.14
NIOB	91	37.60	60.74
NIESV	6	2.48	63.22
NITP	2	0.83	64.05
NSE	79	32.64	96.69
CIOB	3	1.24	97.93
No Response	5	2.07	100
Total	242	100	-

It was established through the study that 37.6% of the respondents had professional qualification of the Nigerian Institute of Building while 32.64% of the workers were members of the Nigerian Society of Engineers. Furthermore, 12.81% of the workers were members of the Nigerian Institute of Quantity Surveyors. Other professional bodies like Nigerian Institute of Estate Surveyors and Valuers, Nigerian Institute of Town Planners and Chartered Institute of Building, United Kingdom accounted for 2.48%, 0.83% and 1.24% respectively (Table 7). These result showed that apart from being knowledgeable educationally, the workers were also professionally qualified. This implied that the workers operated under the ethics of their profession and this would likely enhance their performance with regards to safety on construction sites. From the results, it can be shown that respondents were academically and professionally well grounded, therefore, information provided for the purpose of this research can be relied upon. The period of professional experience of the respondents in the construction industry was investigated and presented in Table 8. From the table it is deductible that 40.91% of the respondents surveyed had between 6 to10 years of professional experience, eighty (28.51%) had between 1 and 5years of experience, thirty six (14.88%) had 11 to 15 years of experience while thirty eight (15.70%) had over 16 years of experience.

Table 8: Years of experience of the respondents

Years of experience	Frequency	%	Cumulative %
1-5	69	28.51	28.51
6-10	99	40.91	69.42
11-15	36	14.88	84.3
16-20	25	10.33	94.63
Over 20	13	5.37	100.0
Total	242	100	

It was also established through the field survey that 68.5% of the respondents had over 5 years of professional experience. The personal interview with the respondents revealed that many of them with less than 5 years of working experience even though professionally qualified had just been recruited by their firms. It can therefore be concluded that most of the respondent (more than two-thirds) who participated in the study were experienced in construction activities and therefore, could be relied upon for the supply of consistent and suitable information. In addition, the length of time in which the respondents were in their present position is presented in Table 9.

Table 9: Length of time over which workers have been in their present position

Length of time	Frequency	%	Cumulative %
1-5	152	62.81	62.81
6-10	60	24.79	87.6
11-15	19	7.85	95.45
Over 15	2	0.83	96.28
No response	9	3.72	100
Total	242	100	-

As presented in Table 9, one hundred and fifty two (62.81%) of the respondents had been in their present post between 1 and 5 years,24.79% of the respondents had been on the job for 6 to 10 years and about 1% of the respondents had been over 15years of being on the position they presently occupy. It may therefore be concluded that a lot of the respondents who participated in the study were well oriented and experienced in their schedule of duties.

4.2 Relationship between safety culture and climate on construction sites

To study the nature of the relationship between safety culture and safety climate in the construction industry as presented in tables 10 and 11 respectively spearman rank correlation coefficient was used to correlate variables in tables 8 and 9 as it is suitable for nominal (categorical) variables. This is presented in Table 10 below. The result of the analysis revealed that at 0.05 level of significance, the resulting Spearman's rho correlation coefficient is 0.842 while the 'p' value is 0.00, reported as r (246) = 0.842, p < 0.05. It was also observed that p value is less than 0.05 used as significance level. Since the p value is not up to the significance level and the correlation value is high (substantial to evidence a correlation relationship), there is a significantly high correlation between safety culture and safety climate on construction sites. Moreover, safety culture is positively correlated with safety climate. Therefore, it can be inferred from this study that an enterprise with a poor safety culture will contribute to unhealthy safety climate on the construction site. The implication of this result is that, as the safety culture practices increases, the overall safety climate on the construction site is enhanced (or increased). Conversely, as the safety culture practices decreases, the overall safety climate on the construction site decreases. Therefore companies with higher safety culture rating (that maintain safety-related criteria for workers) are expected to improve safety climate on the construction sites.

Table 10: Correlation between the outcome of safety culture and safety climate

	Statistical parameter	Safety culture
Safety climate	Spearman's rho Correlation Coefficient	0.842
	P	0.00
	N	246

In order to further examine the relationship between safety culture and climate on construction sites, information further generated and data collected from the questionnaire (Table 11), were subjected to relative significant index analysis based on their perception for each of these qualitative items depicting working interrelationship between safety culture and climate items.

Table 11: Relationship between safety culture and climate on construction sites

Factors	**Safety premium index**			**Ranking**
	TWV	SPI	(SPI –SPI)	
A company should have a major responsibility for the health and welfare of its injured worker	989	0.798	0.71	1st
Safety training can help me in improving my attitude to work more safely	987	0.796	0.70	2nd
It would help in improving the site safety, if my co-workers support safe behaviour	970	0.776	0.60	3rd
A safe place to work has a lot of personal meaning to me and my co-workers	953	0.766	0.55	4th
Safety problems are openly discussed between workers and supervisors	912	0.744	0.44	5th
I am always encouraged to raise any safety concern with my site supervisor	921	0.742	0.43	6th
Safety rules should not be broken, even when workers believe it affects the progress on site	909	0.730	0.37	7th
Co-workers often give tips to each other on how to work safely	883	0.720	0.32	8th
Safety decision made by the management usually seems to be more effective than decisions made by workers	882	0.706	0.25	9th
I prefer to work with larger company as they have more effective safety practices on site than the smaller ones	877	0.704	0.24	10th
I am allowed to act decisively if I find any situation contrary to safe conditions on sites	855	0.690	0.17	11th
Managers and superiors do encourage feedback regarding safety issues from site workers	851	0.684	0.14	12th
Workers are always being consulted regarding preparation for site safety plans	821	0.660	0.02	13th
Generally workers follow safety rules without being told to do so	787	0.648	-0.04	14th
Safety decision made by me alone are usually more effective than decision made by my co-workers together	787	0.630	-0.13	15th
I prefer the company having less strict rules and where I feel easy to work than to a company having more strict rules and long working hours to follow	772	0.628	-0.14	16th
Major decisions regarding site safety issues always take place after consulting with site workers/subcontractors	774	0.622	-0.17	17th

Personally I enjoy the risk aspects associated with my job	758	0.618	-0.19	18th
Workers loose respect for a supervisor, who asks them for their input before he makes any safety decision	740	0.594	-0.31	19th
Many accidents just happen, there is little any one can do to avoid them	696	0.572	-0.42	20th
I will not change my attitude towards safety rules even if my supervisor praises safe work behaviour	702	0.568	-0.44	21st
I often feel nervous or tense at work	661	0.546	-0.55	22nd
It is not always important to have a good working relationship with my supervisor	657	0.532	-0.62	23rd
I prefer the company having higher pay rates but lower safety records to the company having better safety records but average pay rates	646	0.522	-0.67	24th
When workers ignore safety procedures at my workplace, I feel it is none of my business	505	0.408	-1.24	25th

The highest premium (0.71) supposes that a company should have a major responsibility for the health and welfare of its injured worker. When this happens, it will relate the safety culture on construction sites with the safety climate letting workers know that the company cares about their safety at work. This position is in line with Dai (2011) who believed that communication (communicating with the supervisors), workers' welfare pay and monetary bonus, training on skills, safety and health influence performance of the construction works. The respondent's perceived that concentrating on workers' health and welfare could help bridge the gap between safety culture and safety climate so as to influence workers' values, attitudes, perceptions, competencies as well as patterns of behaviour, and ultimately determine the commitment, style and proficiency of the organization's health as well as safety management. A Pearson Correlation Test was also carried out to explore the relationship (if any) between safety culture and climate on construction sites. The result showed a significant linear relationship as expected. The results showed significant linear relationship between safety culture and climate on construction sites ($\chi 2 = 306.343$, $p = 0.00$). (A p-value less than 0.05 shows significant relationship for a= 0.05, i.e. level of significance). Safety climate could influence safety culture such that the degree of observable efforts of all workers will improve safety awareness and activities in their daily life, which can affect employees' attitude and behaviour to consolidate health development and safety performance of the organization (Flin et al, 2000). This research finding is in tandem with Guldenmund (2000), who found out that safety climate is one of the elements which influence safety culture. However, a framework is needed to examine the other elements that influence optimal safety culture.

4.3 Factor analysis relating safety culture and climate on construction sites

By analysing the data gathered from the survey using the principle component analysis with Varimax rotation the suitability of data for the factor analysis was assessed by all the appropriate checks, as shown in Table 12. The sample size of the respondents for this analysis was 242, being well above the minimum permissible limits (Hair *et al.*, 1998).

The test for measuring sampling adequacy (MSA) was conducted with Kaiser-Meyer-Olkin Measure of Sampling Adequacy=0.918, significant Bartlett's Test of Sphericity (χ^2= 3257.256, df = 300, p = 0.00) and average communalities = 0.59852 which is above average of 0.5. All these shows 20 out of a total of 25 variables within the adequacy limits of 0.5 or above. Five variables were found to be short of the limit, therefore it was deemed fit to eliminate them from further analyses of the safety climate and culture relationships. The eliminated five variables are:

i. Major decisions regarding site safety issues, always take place after consulting with site workers /subcontractors.
ii. Safety decision made by the management usually seems to be more effective than decisions made by workers
iii. Personally, I enjoy the risk aspects associated with my job
iv. I prefer to work with larger company as they have more effective safety practices on site than the smaller ones
v. I often feel nervous or tensed at work.

The results revealed the presence of three distinct factors having an eigenvalue of more than unity. A Varimax rotation was then performed to obtain interpretable results for those three factors. The three-factor solution accounted for 59.864 percent of the total variance. Factors were then examined to identify the number of items that loaded on each factor by keeping in mind the rule for selecting only those items which have got the loadings equal to or more than 0.5 (Hair *et al*.,1998). On the basis of such restrictions, five items were loaded on the first factor and accounted for 20.509% of the total variance, seven items were loaded on the second factor and accounted for 20.462% of the total variance and eight items were loaded on the third factor and accounted

for 18.893% of the total variance. Table 12 depicts the 20 items in three factors, and their respective factor loadings, explained variances, eigenvalues and Cronbach's α for three factors.

Table 12: Factor Loadings for the 3-factor model relating safety culture and safety climate on construction sites

Factor 1: Obligational/consequential *(Variance* = 20.509%, *Eigenvalue* = 5.127, *Cronbach's* α = *0*.909*)*	**Loadings**
A company should have a major responsibility for the health and welfare of its injured worker	0.805
Co-workers often give tips to each other on how to work safely	0.682
A safe place to work has a lot of personal meaning to me and my co-workers	0.853
It would help in improving the site safety, if my co-workers support safe behavior	0.784
Safety training can help me in improving my attitude to work more safely	0.809
Factor 2: Collectivism *(Variance* = 20.462%, *Eigenvalue* = 5.115, *Cronbach's* α =*0*.915*)*	
Managers and superiors do encourage feedback regarding safety issues from site workers	0.717
I am always encouraged to raise any safety concern with my site supervisor	0.642
Safety problems are openly discussed between workers and supervisors	0.75
Workers are always being consulted regarding preparation of site safety plans	0.723
Generally workers follow safety rules without being told to do so	0.64
I am allowed to act decisively if I find any situation contrary to safe conditions on site.	0.645
Safety rules should not be broken, even when worker believes it affects the progress on site.	0.675
Factor 3: Individuality *(Variance* = 18.893%, *Eigenvalue* = 4.723, *Cronbach's* α =*0*.853*)*	
Workers loose respect for a supervisor, who asks them for their input before he makes any safety decision	0.678
Many accidents just happen, there is little any one can do to avoid them	0.687
Safety decision made by me alone are usually more effective than decision made by my co-workers together	0.62
It is not always important to have a good working relationship with my supervisor	0.665
I prefer the company having less strict rules and where I feel easy to work than to a company having more strict rules and long working hours to follow	0.664
When workers ignore safety procedures at my workplace, I feel it is none of my business	0.749
I will not change my attitude towards safety rules, even if my supervisor praises safe work behavior	0.633
I prefer the company having higher pay rates but lower safety records to the company having better safety records but average pay rates.	0.681

Each of the three factors was labeled in accordance with the common thread that connects together the set of individual items loaded onto it. The first factor was labeled "**obligational/consequential***"* because it contained five items addressing safety obligation issues and good safety culture consequence or outcome. These items include: company responsibility for the health and welfare of its injured worker, co-workers safety culture, and meaning attached to safety environment, consequence of safety obligation on improving site safety and safety attitude. The majority of these items have relatively large factor loadings (>0.68). The mean and standard deviation scores showed that a majority of the respondents were of the opinion that a company should have a major responsibility for the health and welfare of its injured worker [mean score = 3.9751]; co-workers often give tips to each other on how to work safely [mean score = 3.5821], a safe place to work has a lot of personal meaning to them and their co-workers [mean score = 3.8159],safety would help in improving the site safety, if co-workers support safe behavior [mean score = 3.8706] and safety training can help me in improving my attitude to work more safely [mean score = 3.9751].

The second factor, *"***Collectivism***"*, contained seven items addressing the relational aspects of site work. Such items borders on the level of cooperation, feedback and the effectiveness of communication styles between the workforces. Many of the respondents observe that managers and superiors do encourage feedback regarding safety issues from site workers [mean score = 3.4527], they are always encouraged to raise any safety concern with their site supervisors [Mean score = 3.7065] etc.

The third factor, *"***Individuality***"*, contained eight items addressing the individualistic tendencies of the workers as opposed to cooperation on site. The respondents in this study do not support these individualistic views because they are accident prone. They belief that cooperation limits accidents and that each and everyone has a role to play in it. Many of the respondents disagree with the opinion that workers loose respect for a

supervisor, who asks them for their input before he makes any safety decision [mean score = 2.9801] and insist that accidents don't just happen, there is much one can do to avoid them [mean score = 2.9303].

V. Conclusions

This study investigated the relationship between safety climate and safety culture on construction sites. The study found that safety culture is highly and positively correlated with safety climate; and that poor safety culture will contribute to unhealthy safety climate on the construction sites. The study concluded that as the safety culture practices increase, the overall safety climate on the construction site is enhanced. In the study, three groups were identified from the factors that relate the safety culture with safety climate, namely obligational, collectivisim, and individuality factors. Obligational factors entail company *should have a major responsibility for the health and welfare of its injured worker, co-workers often give tips to each other on how to work safely, safe place to work has a lot of personal meaning to me and my co-workers, it would help in improving the site safety, if my co-workers support safe behaviour, and safety training can help me in improving my attitude to work more safely*. Collectivism factors entail *managers and superiors do encourage feedback regarding safety issues from site workers, I am always encouraged to raise any safety concern with my site supervisor, safety problems are openly discussed between workers and supervisors, workers are always being consulted regarding preparation of site safety plans, generally workers follow safety rules without being told to do so, I am allowed to act decisively if I find any situation contrary to safe conditions on site, and safety rules should not be broken, even when worker believes it affects the progress on site*. Individuality factors are *workers loose respect for a supervisor who asks them for their input before he makes any safety decision, many accidents just happen, there is little any one can do to avoid them, safety decision made by me alone are usually more effective than decision made by my co-workers together, it is not always important to have a good working relationship with my supervisor, I prefer the company having less strict rules and where I feel easy to work than to a company having more strict rules and long working hours to follow, when workers ignore safety procedures at my workplace, I will not change my attitude towards safety rules, even if my supervisor praises safe work behaviour, and I prefer the company having higher pay rates but lower safety records to the company having better safety records but average pay rates.*

Finally, *t*he study concludedthat a significant linear relationship between safety culture and climate on construction sites safety climate could influence safety culture such that the efforts of all workers would improve safety awareness and their daily activities can affect employees' attitude and behaviour to consolidate their safety performances.

References

[1]. Advisory Committee on the Safety of Nuclear Installation (ACSNI) (1993). Organizing for Safety. Third report of the Human Factors study group of the Advisory Committee on Safety in the Nuclear Industry. Health and Safety Commission. HMSO. London.
[2]. Andi (2008). Construction Worker Perception towards Safety Culture. Civil Engineering Dimension, 19(1) March, 1-6.
[3]. Ayangade, J. A. (2001). An Evaluation of Safety Practices in Selected Construction Sites in Nigeria. Unpublished M.Sc. Thesis, Department of Building, Obafemi Awolowo University, Ile Ife, Nigeria.
[4]. Biggs, S. E., Banks, T. D., Darvey J. D. and Freeman, J. E. (2013). Safety Leader's Perception of Safety Culture in a Large Australasian Construction Organization. Journal of Safety Science, 52, 3-12.
[5]. Brown, R. L. and Holmes, H. (1986). The Use of a Factor-Analytic Procedure for Assessing the Validity of an Employee Safety Climate Model. Accident Analysis and Prevention, 18(6), 455-470.
[6]. Choudhry, R. M., Fang D. (2008). Why Operation Engage in Unsafe Work Behaviour: Investigating Factors on Construction Sites. Safety Science, 46, 566-584.
[7]. Choudhry, R. M., Fang, D., and Mohamed, S. (2007). Developing a Model of Construction Safety Culture. Journal of Management in Engineering, 23(4), 207-212.
[8]. Cooper, D., Fermery, K., Johnson, M., Harper, C. Clarke, F. L., Holton, P., Wilson, S., Rayson, P., and Bence, H. (1994). Changing Personnel Behavior to Promote Quality Care Practices in an Intensive Care Unit. Incomplete.
[9]. Cooper, M. D. and Philips, R. A. (2004). Exploratory Analysis of the Safety Climate and Safety Behaviour Relationship. Journal of Safety Research, 35, 497-512.
[10]. Cox, S and Cox, T. (1991).The Structure of Employee Attitudes to Safety - A European Example. Work and Stress, 5, 93- 106.
[11]. Cox, S. and Flin, R. (1998). Safety Cultures: Philosophy Stone or Man of Straw? Work and Stress, 12, 189-201.
[12]. Dedobbeleer, N. and Beland, F. (1991). A Safety Climate Measure for Construction Sites. Journal of Safety Research, 22, 97-103.
[13]. Eagly, A. H. and Chaiken, S. (1993). The Psychology of Attitudes. Harcourt Brace Jovaovich Fort Worth.
[14]. Flin, R., Mearns, K., Gordon, R., and Fleming, M. T. (1998). Measuring Safety Climate on UK Offshore Oil and Gas Installations. Paper presented at the SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Caracas, Venezuela.
[15]. Flin, R., Mearns, K., O'Connor, P. and Bryden, R. (2000). Measuring Safety Climate, Identifying the Common Features, Safety Science, 34, 177-192.
[16]. Frazier, C. B., Ludwig T. D., Whitaker, B. and Roberts, S. D. (2013). A Hierarchical Factor Analysis of a Safety Culture Survey. Journal of Safety Research, 45, 15-28.
[17]. Garavan, T. N. and O'Brien, F. (2001). An Investigation into the Relationship between Safety Climate and Safety Behaviours in Irish Organisations. Irish Journal of Management, 22 (1), 141-170.
[18]. Glendon, A. I. and Litherland, D. K. (2001). Safety Climate Factors, Group differences and Safety Behaviour in Road Construction. Safety Science, 39(3), 157-188.

[19]. Glendon, A. I., Stanton, N. A. and Harrison, D. (1994). Factor Analysing a Performance Shaping Concepts Questionnaire. In S. A. Robertson (Ed.). Contemporary Ergonomics: Ergonomics for all. London: Taylor & Francis.
[20]. Guldenmund, F. W. (2007). The Use of Questionnaires in Safety Culture Research - An Evaluation. Journal of Safety Science, 45, 723-743.
[21]. Halender, M, and Holborn, M. (1991). Sociology Themes and Perspectives (3rd edition). London: Collins Educational.
[22]. He, Z. (1995). Risk Management for Overseas Construction Projects. International Journal of Project Management, 13(4), 231-237.
[23]. Hinze, J. W. (1997). Construction Safety. New Jersey: Prentice Hall Publication.
[24]. Hofmann, D. A., and Stetzer, A. (1996). A cross-level investigation of factors influencing unsafe behavior and accidents personnel. Psychology, 49, 307-339.
[25]. Idoro G. I. (2004). The Effect of Globalization on Safety in the Construction Industry of Nigeria in Proceedings of International Symposium on Globalization and Construction, November, School of Civil Engineering, Asian Institute of Technology Bagdok, Thailand.
[26]. International Atomic Energy Agency (IAEA) (1986). Summary of Report on the Post-Accident Review Meeting on the Chernobyl Accident (International Safety Advisory Group Safety Series 75 - INSAG-1), Vienna.
[27]. Kamang, E. E. (1992). Effective Project Management in the Construction Industry. Builders Magazine, 7(4), Aug/Sept.
[28]. Kines, P., Lars P, Anderson, S., Spangenberg, S., Mikkelson, K. L., Dyreberg, J. and Zohar, D. (2010). Journal of Safety Research, 41, 399-406.
[29]. King, R. W. and Hudson, R. (1985). Construction Hazard and Safety Handbook. London: Butterworth.
[30]. Larsson, P. A. and Torner, M. (2008). Safety Climate Cross-Validation, Strength and Prediction of Safety Behavior. Safety Science, 46, 398-404.
[31]. Levitt, R. E. and Samelson, N. M. (1993). Construction Safety Management. New York: John Willey and Sans Inc.
[32]. Mearns, K, Whitaker, S. and Flin, R. (2003). Safety Climate, Safety Management Practice and Safety Performance in Offshore Environment. Safety Science, 4(8), 641-680.
[33]. Mearns, K., Fin, R., Gordon, R. and Fleming, M. (1998). Measuring Safety Climate on Offshore Installations. Work and Stress, 12, 238-254.
[34]. Mohamed, S. (1999). Empirical Investigation of Construction Safety Management Activities and Performance in Australia. Safety Science, 33, 129-142.
[35]. Mohamed, S. (2002). Safety Climate in Construction Site Environments. Journal of Construction Engineering and Management, 128(5), 375-384.
[36]. Neal, A. and Griffin, M. A. (2000). Perceptions of Safety at Work: A Framework for Linking Safety Climate to Safety Performance, Knowledge, and Motivation. Journal of Occupational Health Psychology, 5, 347-358.
[37]. Niskaneh, T. (1994). Safety Climate in the Road Administration. Safety Science, 17, 237-255.
[38]. Rowlinson, S. and Lingard, H. (1996). Behavioural Safety Management in Hong Kong's Construction Industry, Success and Limitations. In Implementation of Safety and Health on Construction Sites. Alves Dias L. M. and Cobl R. J. (eds), CIB W99 Lisbon, Balkema, RoHerdam. Pp 281-289.
[39]. Rundmo, T. (1994). Associations between Safety and Contingency Measures and Occupational Accidents on Offshore Petroleum Platforms. Scandinavian Journal of Work Environment and Health, 20, 128-131.
[40]. Rundnio, T. (1997). Associations between Risk Perception and Safety. Safety Science, 24, 197-209.
[41]. Sawacha, E., Naoum, S. and Fong, D. (1999). Factors Affecting Safety Performance on Construction Sites. International Journal of Project Management, 17(5), 309-315.
[42]. Schein, E.H. (1990). Organizational Culture. American Psychologist, 45, 109-119.
[43]. Seppala, A. (1992). Evaluation of Safety Measures, Their Improvement and Connections to Occupational Accidents. Cited in Niskanen. T. (1994). Safety Climate in Road Administration. Safety Science, 17, 237-255.
[44]. Smallwood, J. J. (2000). Safety and Health Team Building. In Coble, R. J, Hinze, J. and Havpt, T. (eds) Construction Safety and Health Management. London: Prentice Hall Publication.
[45]. Teo, E. A-L., and Feng, Y. (2009). The Role of Safety Climate in Predicting Safety Culture on Construction Site. Architectural Science Review, 52(1), 5-16.
[46]. Toole, T. M. (2005). Increasing Engineers, Role in Construction Safety: Opportunities and Barriers. Journal of Professional Issues in Engineering Education and Practice, 199-207.
[47]. Wiegmann, D. A., Zhang, H., Haden, T. L., Sharma, G., and Gibbons, A. M. (2004). Safety Culture: An Integrative Review. The International Journal of Aviation Psychology, 14(2), 117-134.
[48]. Williamson, A. M., Feyer, A. M., Cairns, D. and Biancotti, D. (1997). The Development of a Measure of Safety Climate: The Role of Safety Perception and Attitudes. Safety Science, 25(1-3), 15-27.
[49]. Zohar, D. (1980). Safety Climate in Industrial Organizations: Theoretical and Applied Implications. Journal of Applied Psychology, 65, 96-102.

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