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Development of Framework for Optimizing Safety Culture and Climate on Construction Sites

Ayangade Jonathan Ademola*

Department of Building, Obafemi Awolowo University, Ile-Ife, Nigeria
*Corresponding author: jayangade@yahoo.com

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Abstract There is a lack of understanding of the factors for optimising safety culture and climate on construction sites. Therefore, a framework that will not only provide the factors for optimizing safety culture on construction sites, but will also intrude into the components of the safe situation or environment or organization is very desirable, particularly to unmask how these factors enhances the safety culture and climate of construction sites. This work aims to fill this gap by proposing a generic framework for optimising safety culture and safety climate on construction site. In this paper, an original conceptual framework has been developed based on a rigorous analysis of the most relevant concepts of safety culture and climate that have been proposed by past studies. The outcome of this framework shows that there are factors for enhancing safety culture and climate on construction sites, and which are: developmental, operational, and strategic factors. In addition to that, the identified factors in the framework were supported by the findings of past studies.

Keywords: *safety climate, safety culture, safety management, construction safety*

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1. Introduction

The construction industry is unique among other industries as the activities of construction often take place in the outdoor, under conditions not conducive for safety and health. Workers on the construction sites have to face constant changes in the nature of work, the location of work and the mix of workers. Most of the people tend to relate construction industry with dangerous working environment and high risk as compared to others. The reputation of construction industry is that of relying on the expertise of implementation and management of safety and also how it can be completed safely and meets the consumer's requirements [1,2,3,4]. These requirements led to the conceptualisation of safety culture and safety climate as metrics for determining safety management. Numerous studies have been conducted to explain safety culture and climate. For example, [5] tried to interpret the concept of safety culture in terms of reciprocal determinism based on social cognitive theory, and derived three components: behaviour, person and environment. [6] adopted Bandura work and made an excellent effort to identify the characteristics for each component and that leading to the development of a model called 'total safety culture.' Bandura's model was also adopted and developed by [7] who asserted through his new model that safety culture is a product based on interactions between people, jobs and organisations.

[8] developed a model called the total "safety culture table model which involved person, environment, behaviour and organisation, and they pointed out that safety culture is similar to the table that is constructed on four legs. [9] developed a snap-shot assessment model based on Bandura's conception with different names, people, process and value, using 31 characteristic hierarchies as positive culture indicators. [10] adopted Cooper's model with some modification in order to make it suitable for use in the construction industry. [11] adopted Cooper's model to develop a framework for operationalization of construction safety culture in Malaysia which involved three phases: Psychological (value and beliefs), behavioural and situational (observable practices and provided environment) and safety officers and supervisors (communication, trust, and commitment).

The review of the cardinal determinants of the predominant models on safety reveals the followings icons; [5] - behaviour, person and environment; [6] - person, behaviour and environment; [7] - people, jobs and organisations; [12] - persons, environment, behaviour and organization; and [11] - psychological, behavioural, situational and safety officers. According to [11] a recurrent feature of these five models is either the environment, the situation or the organization. A major characteristic of organization is that the senior management is usually the foundation of organisations and major determinants of their activities. Most things that are done well are either initiated by top management or

enjoyed its support. Therefore, if the safety culture of construction organisations would be enhanced, it is expedient that the senior management functions optimally in this regard. However, the models of safety culture and climate proposed by [5,6,7,12], and [11] have only contributed to the understanding of safety culture and climate. There is a lack of understanding of the factors for optimising safety culture and climate on construction sites. Therefore, a framework that will not only provide the factors for optimizing safety culture on construction sites, but will also intrude into the components of the safe situation or environment or organization is very desirable, particularly to unmask how these factors enhances the safety culture and climate of construction sites.

2. Literature Review

2.1. Conceptual Framework

Figure 1 shows the conceptual framework for optimizing safety culture and climate on construction sites, as proposed by this study. The framework proposes the internal psychological and external observation factor for optimising safety climate and culture. As illustrated in the framework, the internal psychological factor that are required to be put in place toward an improved or optimised safety climate by top management and workers include attaching importance to safety, management involvement in safety, management commitment to safety, increased safety compliance, and increased safety knowledge. The external observation factor that are required for an improved safety culture are safety management system, behaviour sampling, and reduction in incident rates.

Studies such as [7,11,13,14,15,16,17,18,19], and [10] provide support for the propositions in the conceptual framework. For example, [11] observed that the characteristics of the three original components of person, behaviour and environment cannot be fully created until the senior management have a positive culture. [13] observed that those in top management have a greater ability to create and extend the safety culture in organisations. [7] defined culture as the product of multiple goal- directed interactions between people (psychological), jobs (behavioural) and the organization (situational). [14] posited that safety culture is that observable degree of effort by which all organizational members directs their attention and actions toward improving safety on daily basis.

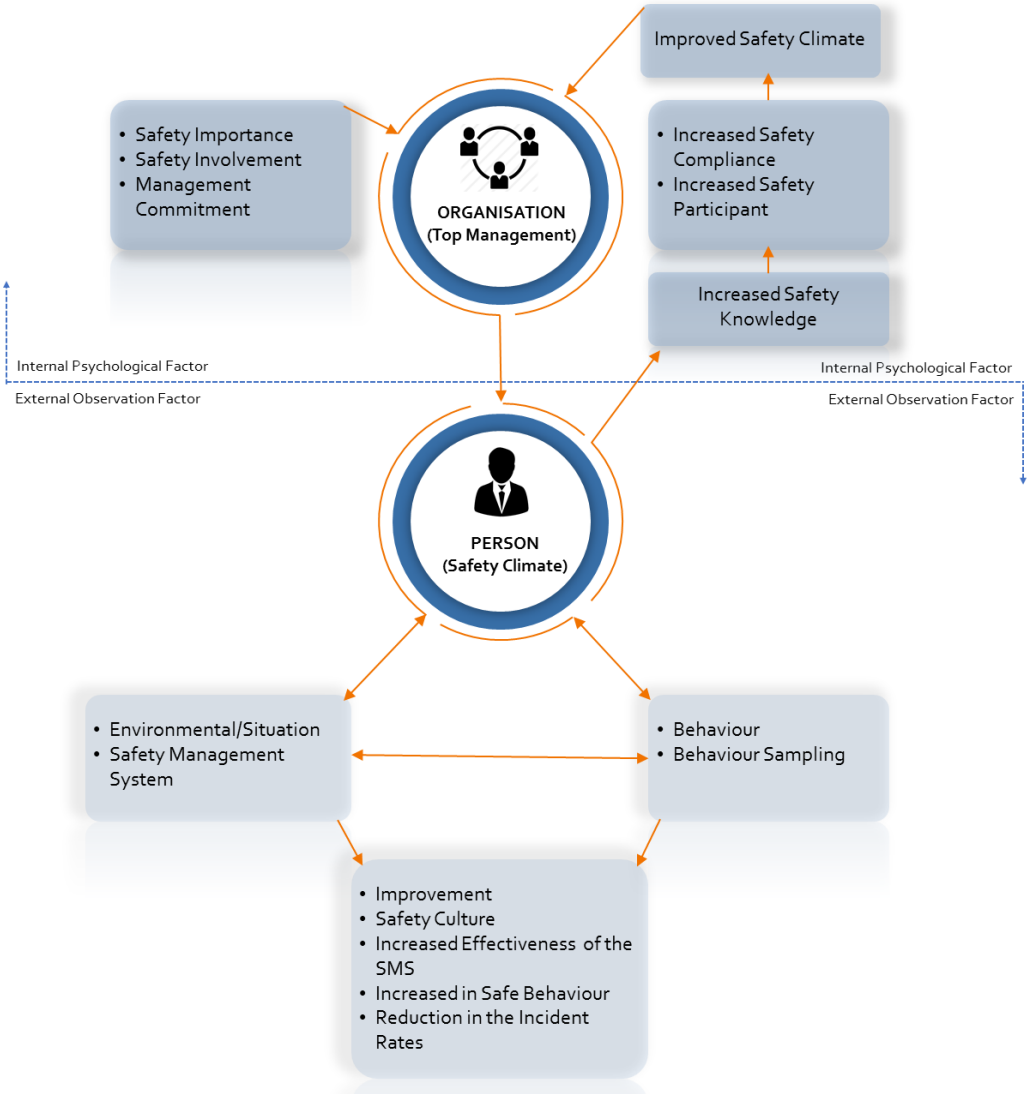

Figure 1. A Conceptual Framework for the Study

[9] pinpointed the importance of workers (person) in safety climate optimisation. The study describes them as the site personnel who are responsible at the project level for decision making (such as site engineers, project manager, etc.) and also those in the front line who spend much time working on the site (such as workers, foremen, crafts people).

[14] argued that safety climate (value and belief) refers to safety perception of employees of the safety management system of the organization, and considered as product of safety culture. [15] indicated that one of the main influencing keys of the safety climate is the perceptions of senior management through considering the safety as important. Thus, when the organization have great understanding of the safety importance then it reflects their ability to improve safety climate by increasing employee's knowledge and the provision of motivation for compliance, and participation in safety activities.

According to [16], it is important to sample how people think, behave; respond to a situation and how the environment influences people's behaviours. [17] indicated that the positive and negative attitudes towards safety of the top management have a great impact on people's behaviour. [18] considered as important the relationship between the senior leadership and followers in the process to achieve the organizational safety target.

[19] argued that top management plays a major role in the promotion of safe behaviour for workers directly through their perception and behaviour. The study by [10] suggests that behaviour should be improved to become a safe habit by using behaviour-based safety (BBS) - a systematic approach to identify the critical behaviour through observation techniques which identifies base-period scores and aim to change these scores by arranging meetings and setting goals for improvements. Also, [7] stated that strong commitment and involvement in safety within the organization by senior management depends upon the extent of their perception of the value of safety.

2.2. Overview of Related Past Studies

According to [7], "The prevailing organizational culture is reflected in the dynamic reciprocal relationships between members' perceptions about, and attitudes towards, the operation of organizational goals; members' day-to-day goal-directed behavior; and the presence and quality of the organization's systems and sub-systems to support the goal directed behavior". The reciprocal relationships between the three factors have been recognized and reflected in several major models of safety culture [5,6,7,20].

In order to develop the concept of safety culture, Bandura's model was adapted by [7], who suggested that "organizational culture is the product of multiple goal-directed interactions between people (psychological); jobs (behavioral); and the organization (situational)". Figure 2 shows the concept of safety culture as proposed by [7].

Figure 2 explained that the internal psychological aspects of safety culture, such as attitudes and perceptions, can be assessed by safety climate questionnaires. The observable behavioral aspects of safety culture can be accessed through peer observations, self-report measures and/or outcome measures; and the objective situational aspects of safety culture, such as safety rules and procedures, can be accessed through safety management systems audits/ inspections.

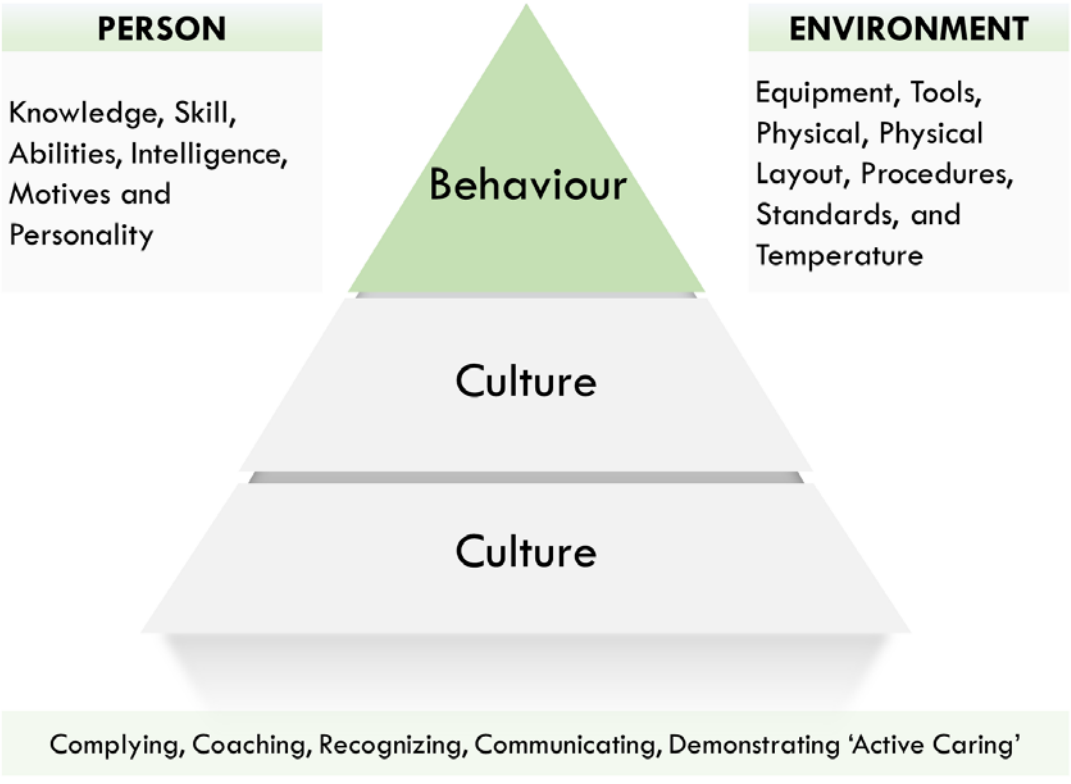

Figure 2. The concept of safety culture by [7]

Other researchers, such as [10] have also put forward models to reflect the concept of safety culture. The Total Safety Culture model by [6,20] distinguished three dynamic and interactive factors: Person, Behavior, and Environment. The only difference between Geller's model and Cooper's model is that the term environment is used in the former model while the term situation is used instead in the latter model.

The model presented by [10] is presented in Figure 3. The model was built upon Cooper's model and in the context of construction industry, with the distinction that the construct environment and situation in Cooper's model are incorporated into a new construct - situation/ environment - to reflect not only the situational aspects of the organization but also the specific conditions of the construction project (Figure 3). The model shows that the reciprocal interactions among psychological, behavioral and environmental/situational variables, which have been recognized and reflected in the major safety culture models, indicate that the three dimensions to measure the overall safety culture of an organization are psychological, behavioral and situational/environmental aspects of safety culture.

Studies have also focused on the measurement of safety culture and climate. As reported by [21], the measurement of a safety climate may be used to supplement traditional measures of safety as it overcomes many of the limitations of traditional safety measurement, such as reporting biases and after the fact measurement. [22,23] reported that the prime research method for investigating safety climate is the questionnaire typically completed by sufficient numbers of employees to allow statistical analysis to reduce a large number of items to a small number of dimensions. Many of the safety management researchers have focused on developing and using surveys in tools when appropriately applied. For example, [21] claimed that safety climate surveys will deliver information on employee's perception of management's commitment to safety, detect areas for improvement and provide benchmarks for different organizations. [24] argued that any effort to improve safety should be perceived as such by employees and that the only way to measure the safety climate is through conducting a safety climate survey. [25] suggested that the potential uses for safety climate questionnaires are considerable. The perception of management commitment to safety can be measured by safety climate questionnaires, allowing feedback to management about how brokers perceive management behaviour.

Safety climate surveys are constituted with factors that can also be termed as the determinants of the safety climate. A list of common safety climate factors has yet to be uncovered. The reasons for this non-uniformity in safety climate factors have been identified in literature. For example, [26] administered a safety climate questionnaire to two (2) similar organizations to investigate the uniformity of the safety climate factors in similar organizations using the same questionnaire. They factor-analyzed each organization's questionnaire separately, but failed to find a consistent safety climate factor structure. As a result, they concluded that obtaining a universal stability of safety climate factors is highly doubtful. Also, they argued that failing to produce a specific factor solution did not mean that the comparison of safety climate factors was meaningless. Instead, they prostituted that the identification of different factor sets for a given organization as an effective means of determining where attention might be most usefully focused.

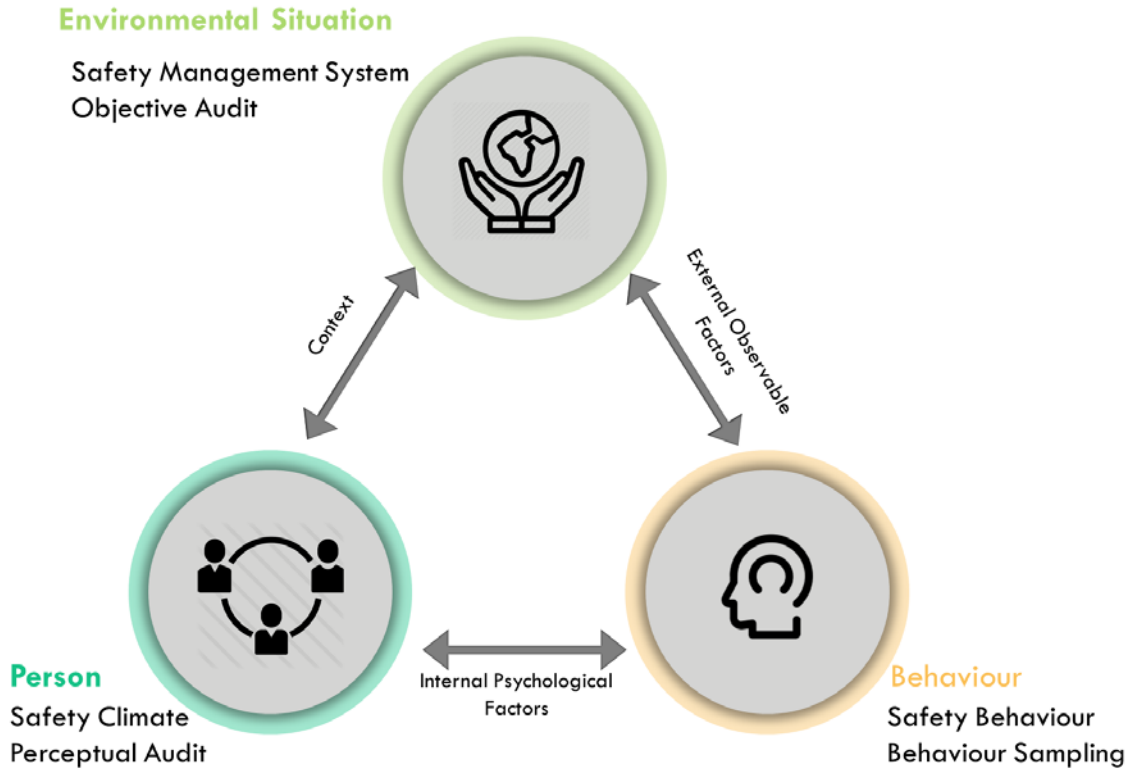

Figure 3. Construction Safety Culture Model (Source: [10])

[27] reviewed existing safety climate measures in an effort to establish a common set of factors that can be grouped into organizational, managerial and human themes. They concluded that, although research into safety climate and safety culture has continued for more than two decades, no universally accepted theory of climate or culture exists. [27] summarized the three (3) most common factors emerging from different studies as perceptions of managements' commitment to safety; perceptions of safety management systems, and perceptions of risk. They also found a few less common (but still important) factors, specifically work pressure consisting of workload, and work pace and competence relating to the general competence level of the workers. One explanation for such inconsistencies in factor structure is the variety of questionnaires, samples and methodologies used by different researchers, as a result no consistency exists in the factor structure of the safety climate [28].

Although safety climate factors have been identified within organizations, there is increasing evidence that a consistent safety climate factor solution may not transfer from one organization to another, especially as organizations differ in their management style and safety regulations [28]. In all the studies reviewed on safety climate, the presence of inconsistencies shows there is no universal set of safety climate factors, however some similarities can be found between the different safety climate studies.

From the review of the related studies on safety climate and culture, it can be concluded that the dimensions identified for safety climate appear to be mostly related to employees' perceptions of the organizational characteristics and their own competence, both of which impact upon safety. [29] states that findings on safety climate are in general consistent with definitions of climate constructs found in the organizational literature, viz that individual do attach meanings to and interpret the environments within which they work. Also, the discussion in the sub-sections on safety climate highlights the conclusion that the interpretation or the meanings that an individual attaches to that safe or on-safe environment then influences their behaviour. To further explain their reasoning, [30], in their study, demonstrated that, where supervisors do not place emphasis on safety issues, employees are less likely to perceive safety as an important issue. [29] remarks also support this view that a strong safety climate has the potential to motivate employees to take greater ownership of and responsibility for safety within the organization.

Based on the recent investigations by [14,27,31], the delimitation is to investigate the optimisation of safety climate and culture through the perceptions of workers, top management, and safety supervisors. The information provided by these respondents will be used to develop the framework for optimising safety climate and culture.

3. 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 1.

Table 1. Registered Construction Contractors by State in South-Western Nigeria

State	Number of registered companies 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 five 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 was designed to elicit further information between the culture and climate on construction sites. The questionnaire was structured in closed type format where typical features were identified and listed for Respondents to evaluate. According to [32], a closed type question is easier to respond and consequently improves the response rate. The framework development was carried out through the use of decision tree, conceptual and flow chart to show low to enhance an optimal safety culture and climate on construction sites.

4. Results

As presented in Table 2, 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 2. 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 3.

Table 3. 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 4. This result revealed that the opinion of majority of the respondents was not sectional but cuts across both building and civil engineering constructions.

Table 4. 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 5. 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. This 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 5. 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 6.

Table 6. 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 No Response	3 5	1.24 2.07	97.93 100
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 6). These results 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 Table 5 and Table 6, 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 7. 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. The number of years of experience of the respondents is illustrated in Figure 4 in the appendix

Table 7. 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 8.

Table 8. 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 No response	2 9	0.83 3.72	96.28 100
Total	242	100	-

As presented in Table 8, 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.

5. Findings and Discussions

The main thrust of this paper is to develop a framework that will assist in ensuring the optimal safety culture and climate on construction sites. If the framework is properly captured, rate of occurrence of accidents and potential hazards would be minimized or eliminated. In order to optimize the safety culture and climate of the construction firm, this study investigated the critical variables of the safety culture and climate. This was done to depict the characteristics, classification and magnitude of the variables. These variables were subjected to factor analysis. The expectation was that principal components that will evolve from the factor analysis will be the major classifications of the optimized safety culture and climate and the sub factors loading on the principal components and subcomponents of each category with their respective weights.

In order to assess the suitability of data for the factor analysis all the appropriate checks were performed. The test for measuring sampling adequacy (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) was conducted showing adequacy coefficient of 0.963 within the adequacy limits of 0.5 or above while Bartlett's Test of Sphericity was significant with $\chi^2 = 6099.412$ and $p = 0.00$. The results revealed the presence of three distinct factors having an eigenvalue of more than unity. The three-factor solution accounted for 72.79 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 [8]. The factor loadings were all above 0.5 as revealed in Table 9. The three principal factors were developmental, operational and strategic factors.

Table 9. Factor analysis of safety culture in the construction industry

Rotated Component Matrix[a]			
	Least conservative safety culture (developmental)	Highly conservative safety culture (operational)	Fairly conservative safety culture (strategic)
Does safety policy clearly state that decisions on other priorities should give due regard to construction safety requirements?		.766	
Does the policy commit the organization to full compliance with all relevant health and safety legislation?		.803	
Does the policy set targets for health and safety performance including a commitment to progressive improvement?		.710	
Does safety policy identify key senior personnel for overall coordination and implementation of the policy?		.599	
Is the safety policy explained to new employees as part of their training and orientation before entry to and work on-site?		.657	
Are there effective arrangements for reviewing the safety policy at least once a year?	.	.609	
Does the review arrangement include feedback from employees at all levels?		.545	
Is there a safety training plan and is it reviewed regularly?	.642		
Have all workers received basic general safety training?	.577		
Have all workers received site-specific safety training?	.605		
Have all workers received toolbox training related to their tasks?	.699		
Is safety training a line or compulsory item within the budget?	.739		
Is every employee in a supervisory role being trained in first aid on-site?	.694		
Is the safety material being taught relevant to those being trained?	.683		

Rotated Component Matrix[a]			
	Least conservative safety culture (developmental)	Highly conservative safety culture (operational)	Fairly conservative safety culture (strategic)
Do management and supervisory personnel receive behavior overview training?	.754		
Are safety perception surveys conducted on the project?	.713		
Is the effectiveness of safety training monitored by checking new skills?	.745		
Is the safety booklet or short manual being provided to every worker when joining the company?	.768		
Are there appropriate arrangements to monitor the effectiveness and thoroughness of the inspection?	.766		
Do safety officers and safety supervisors carry out safety inspections at regular intervals?	.699		
Are there appropriate arrangements to ensure that action is taken because of the findings of safety inspections?	.722		
Are there appropriate arrangements to collate and analyze the results of safety inspections?	.823		
Are site managers and supervisors involved in regular safety talks with workers?		.594	
Are there pre-task meetings before executing an activity?			.739
Do all subcontractor workers attend a formal standard safety orientation?			.746
Do subcontractors hold regular safety meetings?			.801
Are the numbers of near misses investigated to help prevent accidents?			.658
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 7 iterations.			

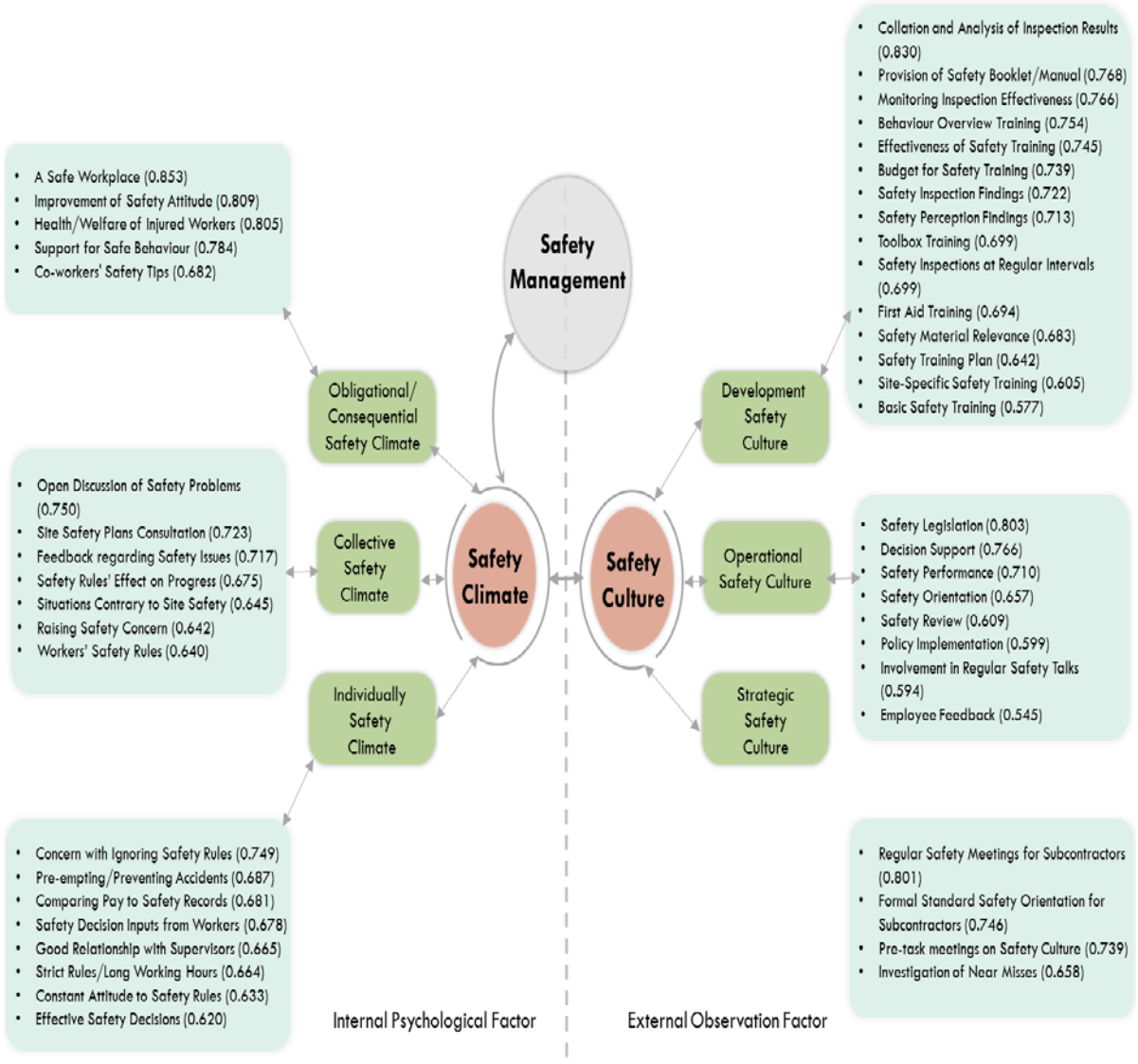

Figure 4. Framework for Optimal Safety Culture and Climate on Construction Sites

Each of the three factors was labelled in accordance with the common thread that connects together the set of individual items loaded onto it. The first factor was labelled "developmental" because it contained items addressing safety culture developmental issues that borders on staff training. Some of the items include: regular safety training plan review, basic general safety training, site-specific safety training, tasks-related toolbox training and safety training inclusion within budget. The second factor was labelled "operational" because it contained items addressing safety culture operational issues that borders on decision making and the overall coordination and implementation of safety culture policy. Some of the items include: priority decisions on construction safety requirements; full compliance with all relevant health and safety legislation; target-setting for health and safety performance; overall coordination and implementation of safety policy and employee feedback. The last factor was labelled "strategic" because it contained items covering safety culture strategic scheme such as: executing pre-task meetings before executing an activity so as to reach unilateral agreements on safety culture; making all subcontractor workers attend a formal standard safety orientation; holding regular safety meetings for subcontractors and other strategies that can help imbibe safety culture within the organization. Among the three components, operational component is the most significant. These factors were formulated into a framework for optimising safety culture and climate on construction sites as shown in Figure 4.

The factors for optimising safety culture and climate on construction sites as formulated in this paper are in agreement with Biggs et.al [33] who noted that communication (one of the subcomponents under the operational factor) is also one of the key factors contributing to a positive safety culture. Communication prevents a site safety hazard which is why workers must report potential hazards and comply with safety culture instead of being blamed or penalized for hazard. Proper communication and safety management will allow safety climate to affect the paradigms of safety culture (operational, strategic and developmental) towards achieving a safe construction industry.

6. Conclusions

This work was aimed to provide a conceptual framework that shows the concepts of safety culture and climate, as well as the factors for enhancing safety climate and culture on construction sites. Initially, the most relevant concepts of safety culture and climate have been identified from literature based on the concepts that have been proposed by related studies. The factors are regrouped into three components that represent the basis of safety management concept, which are developmental factors, operational factors, and strategic factors. A total of twenty-seven main sub-factors have been found depicting the characteristics, classification, and magnitude of safety culture and climate. This research contributes to the clarification of the implementation image of safety culture and climate in construction firms and on construction sites. Safety management researchers and practitioners may benefit from this study as it aims to provide a general guideline leading to a better understanding of the concept of safety climate and culture, as well as the factors for optimising them. In perspective, future studies will be conducted in the next stage to extend the proposed framework.

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