Assessing Dimensions of Resilient Safety Culture in Construction Firms in Abuja

[1*]Shehu I.U., [2]Bala K., [2]Aliyu S.S., [2]Muhammad S. & [2]Kado D.
[1]Department of Building, Federal University, Birnin-Kebbi (FUBK), Kebbi State
[2]Department of Building, Ahmadu Bello University, Zaria
[*]Corresponding author: ismail.umar@fubk.edu.ng

Received: 23/06/2024 **Revised: 14/10/2024** **Accepted: 23/10/2024**

A resilient safety culture involves continuous improvements in safety performance and the ability to foresee and anticipate the changing nature of safety risks in complex sociotechnical systems. This study aims to assess the dimensions of resilient safety culture (RSC) in Nigerian construction firms. A total of 132 questionnaires were distributed to medium and large construction firms within Abuja metropolis. The study found that construction firms in the area studied have implemented eight (8) safety practices each for psychological resilience and behavioural resilience. The implementation of these safety practices showcases the construction firms' commitment to enhancing both the mental well-being of employees and the behavioural aspects that contribute to overall safety. Additionally, nine (9) safety practices have been implemented for managerial resilience, emphasising the critical role of top management in fostering a resilient safety culture. These findings collectively suggest that the construction firms are actively striving to foster a resilient safety culture throughout their organisations. Based on these findings, the study recommends that construction firms can define, assess, and enhance their RSC by implementing psychological, behavioural and managerial resilience framework. The assessment of these three dimensions suggests that maintaining consistently high safety performance in construction firms requires addressing not only project-specific hazards but also unexpected events, such as human error and unforeseen hazardous situations. The outcomes of this research contribute to construction safety management knowledge by advancing a theoretical foundation and empirical basis for defining and assessing resilient safety culture within the construction firms.

Keywords: Safety culture, resilient safety culture, resilience engineering, safety practices, construction firms

https://dx.doi.org/10.4314/etsj.v15i2.6

Introduction

The construction industry (CI) is among the most hazardous industrial sectors, with significantly higher accident rates than other industries (UK Health and Safety Executive, 2019; Safe Work Australia, 2016; US Bureau of Labor Statistics, 2016). While the CI employs approximately 7% of the global workforce, it accounts for 30 to 40% of workplace fatalities (BLS, 2016). In the UK, the CI employs 5% of the workforce but is responsible for 31% of fatal work injuries (HSE, 2019). Similarly, in Hong Kong, the CI was the most dangerous in 2023, accounting for 25.5% of total fatalities (Legislative Council Panel on Manpower, 2023). In developing countries, the H & S situation is much worse due to a lack of supportive environments, insufficient resources, and low technology usage for safety issues (Umeokafor, 2017; Idoro, 2011). For instance, Hamalainen *et al*. (2017) found that the occupational accident fatality rate in Ghana is 21.1 fatalities per 100,000 workers, which was far worse than the rates in developed countries. In Nigeria, Ibrahim *et al*. (2018) and Okeola (2009) highlighted the absence of reliable data on construction-related accidents in Nigeria, noting that contractors neither report such incidents to the relevant authorities nor maintain proper records. As a result, numerous fatalities have occurred on construction sites, and many individuals have been left permanently disabled due to work-related injuries (Ibrahim *et al*., 2018). This emphasises the urgent need for effective occupational health and safety (OHS) measures for construction workers, as the impact of accidents is significant not only for the individuals involved but also for employers and society as a whole. Ibrahim *et al*. (2018) further pointed out that the poor safety culture in Nigeria's construction industry may be linked to the lack of legislation enforcing OHS standards. Similarly, Windapo and Jegede (2014) observed that many contractors in Nigeria prioritize cost savings over worker safety. This may explain why the International Labour Organisation (ILO) reported that between 2014 and 2016, there were 238 fatalities and 3,361 injuries in Nigeria, with the construction industry accounting for approximately 40% of these incidents (ILO, 2017). The poor global safety performance associated with the construction industry, as depicted by the accident and fatality rates, makes it imperative for construction firms to develop various innovative strategies and interventions to improve the CI's safety.

Developing and sustaining a positive safety culture (SC) is recognised as a key approach to enhancing safety performance on construction sites (Feng, 2015; Fang & Wu, 2013; Choudhry *et al*., 2007). Since the 1980s, numerous studies have explored the concept and theoretical models of SC (Fang & Wu, 2013; Choudhry *et al*., 2007; Cooper, 2000; Geller, 1994). For instance,

Geller (1997) introduced the 'total SC' model, incorporating the 'safety triad' that highlights the interplay between person, environment, and behaviour. Similarly, Grote and Kunzler (2000) proposed a socio-technical model connecting safety management systems and SC to the broader organisational structure. Cooper (2000) also developed the reciprocal model, emphasising the dynamic interactions among internal psychological factors, safety-related behaviours, and objective situational factors, noting that safety culture reflects the observable commitment of all organisational members towards daily safety improvements.

SC models focus on prevention and protection, aiming to neutralise hazards by preventing initiating events and safeguarding against outcomes (Feng, 2013; Mitropoulos *et al*., 2005). Hollnagel (2008) argued that SC models are effective in preventing the recurrence of known safety risks. However, the efficiency of these models is constrained by the evolving and unpredictable nature of safety risks arising from the growing complexity of construction projects in terms of uniqueness, technology, tasks, and organisational structures (Wehbe *et al*., 2016).

Researchers have identified RSC as a potential solution to the lack of effectiveness of SC models in addressing the evolving and unpredictable safety risks inherent in increasingly complex sociotechnical systems (Pecillo, 2016). RSC aims to enhance an organisation's capability to anticipate, monitor, respond and learn to manage changing & evolving safety risks before adverse events occur (Trinh *et al*., 2020; Woods & Hollnagel, 2006). Consequently, Akselsson *et al*. (2009) and Trinh *et al*. (2018) have explored the concept of RSC and its application in the construction industry. In Nigeria, Abubakar *et al*. (2021) examined the potential of adopting RSC towards improving construction organisations' safety performance, finding a strong positive relationship. These studies have significantly contributed to integrating resilience into workplace H & S and developing the concept of RSC. Building on the work of Abubakar *et al*. (2021), this study seeks to advance scientific inquiry by assessing the dimensions of RSC in Nigerian construction firms, which has been recognised as a multidimensional concept (Trinh *et al*., 2019; Lengnick-Hall *et al.*, 2011; Pillay *et al.*, 2010). To achieve the aim of this study, the following specific objectives were formulated: (1) to identify the dimensions of RSC and (2) to assess the dimensions of RSC for construction firms in Nigeria.

Literature Review

Safety culture models

SC is often viewed as a subset of organisational culture (OC), encompassing attitudes, perceptions, beliefs, and values specifically related to H & S (Clarke, 1999). Several studies have attempted to clarify SC by developing theoretical models. Two commonly used models are: (1) layer models (Guldenmund, 2000; Reason, 1997) and (2) triad models (Cooper, 2000; Geller, 1994). Layer models posit that understanding the content of OC allows for the analysis and improvement of safety aspects. However, these models are frequently criticized for their inability to accurately measure SC and for neglecting its dynamic nature (Choudhry *et al*., 2007; Cooper, 2000). In contrast, triad models focus on the interplay between psychological, behavioural, and situational elements in safety management (Cooper, 2000; Geller, 1994).

The theoretical underpinnings of triad models are: (1) the interactive relationship between psychological, situational, and behavioural factors, as noted in various accident causation models, and (2) social learning theory (Bandura & McClelland, 1977) and social cognitive theory (Bandura, 1986). Based on these foundations, Geller (1994) proposed a comprehensive SC model that highlights the dynamic interaction between person, environment, and behaviour. Similarly, Cooper (2000) developed a reciprocal model of SC comprising three elements: (1) internal psychological factors (how people feel), (2) safety-related behaviours (what people do), and (3) objective situational features (what the organisation has).

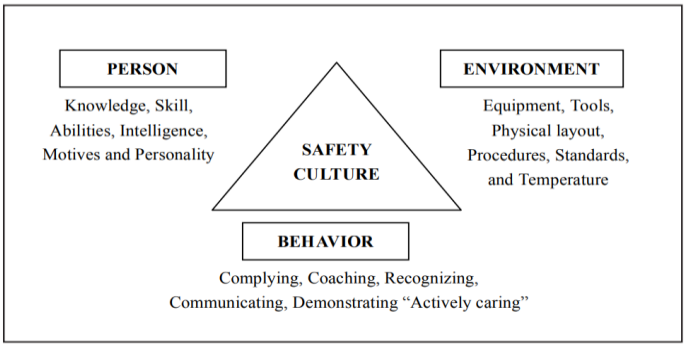

Figure 1: Geller's total safety culture model (Geller, 1994, 1996)

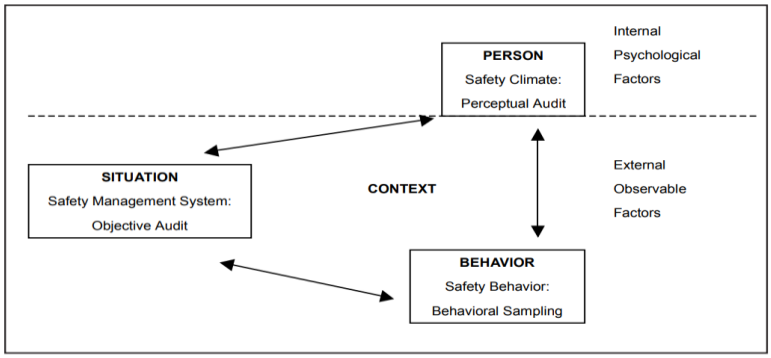

Figure 2: Reciprocal safety culture model (Cooper, 2000)

Resilience engineering theory and resilient safety culture

The review of organisational resilience (OR) literature by Righi *et al.* (2015) revealed that an extensive number of meanings of resilience exist in the literature. The most common understandings within definitions of the term resilience are as follows: (1) resilience is a capacity or the proficiency of an organisation to "adapt/react, learn and anticipate" to withstand changes, pressures, disruptions, and so forth and to continue performing in times of adversity; (2) resilience is a property of organisations; and (3) the development of OR is a continuing process (Pecillo, 2016; Woods & Hollnagel, 2006).

Westrum (2006) identified three types of safety risk (regular threats, irregular threats, and unexpected threats) to the state of workplace safety that OR protects against. The fundamental idea behind resilience engineering is that, in a world of limited resources, irreducible unpredictability, and multiple conflicting goals, an organisation manages safety risks proactively and create safety via four resilience processes (or capabilities), which includes anticipating (knowing what to expect), monitoring (knowing what to look for), responding (knowing what to do), and learning (knowing what can happen) (Pecillo, 2016; Shirali *et al*., 2015). RE theory has two implications for safety management (Trinh *et al*., 2019). Firstly, since RE theory is based on four resilience processes, resilience processes (or capabilities) can serve as the theoretical basis for developing and implementing safety management practices for safety performance improvement in all workplace environments (Trinh *et al*., 2020, 2019). Secondly, since a resilient organisation is characterised by those four capabilities, the level of OR can be determined based on the four resilience capabilities (Trinh *et al*., 2020, 2019).

Dimensions of resilient safety culture

OR is a multidimensional concept (Lengnick-Hall *et al.*, 2011; Pillay *et al.*, 2010). A review of the literature by Pillay *et al.* (2010) identified three dimensions of OR (psychological/cognitive, behavioural, & managerial/contextual. Similarly, previous studies on SC models recognised the interactive relationships among the psychological/cognitive, managerial/contextual, and behavioural factors, which had been accepted as the three dimensions of measuring SC (Fang & Wu, 2013; Choudhry *et al.*, 2007; Cooper, 2000; Geller, 1994). A comparison of the SC dimensions and OR dimensions revealed a similar structure of factors for both concepts, and therefore it can be inferred that the concept of RSC can also be assessed and examined under the framework of the psychological, behavioural, and managerial factors.

Psychological resilience refers to employees' abilities to interpret, analyse, and respond to both regular and irregular safety risks on site; behavioural resilience involves employees' competencies and behavioural patterns in recognising, understanding, predicting, and reacting to various hazardous situations on site; managerial resilience encompasses the construction firm's capacity to support responses to identified and evolving safety risks (Trinh *et al*., 2019, 2018). A resilient organisation manages safety risks - whether regular, irregular, or unexpected - through four core capabilities: anticipating, monitoring, responding, and learning. Each dimension of RSC can be assessed based on these capabilities reflected in measurable safety practices which are implemented in construction firms. Specifically, anticipating involves identifying potential safety threats to be prevented or avoided, monitoring entails tracking indicators of predetermined regular threats to detect if they change or require readiness to respond, responding includes deploying appropriate actions to manage both regular and irregular threats on site, and learning focuses on deriving lessons from past experiences of successes and failures in safety management (Pecillo, 2016; Shirali *et al*., 2015). Based on prior research efforts (Shirali *et al*., 2016, 2015, 2013; Pecillo, 2016, Azadeh *et al*., 2015), 41 measurable scales were developed to

assess these dimensions: 14 for psychological resilience, 14 for contextual resilience, and 13 for behavioural resilience. Table 1 summarises the 41 safety practices used in assessing the three dimensions of RSC.

Table 1: Summary of Safety Practices for assessing Dimensions of RSC

S/N	Dimensions of resilient safety culture
A	**Psychological/cognitive resilience**
A1	Workers are concerned with their working conditions & appropriate preventive measures on-site
A2	Workers on-site are aware of the negative consequences to their health & safety due noncompliance with safety rules & regulations.
A3	Workers on-site acknowledge that unexpected hazardous events can occur anytime & anywhere
A4	Workers on-site are mindful of project hazards even when recognized & controlled by preventive measures
A5	Employees on-site have sufficient knowledge to identify potential project hazards
A6	Workers in a work group carry out their tasks safely & always know exactly what their co-workers are doing
A7	Employees on-site are aware of the major worries and concerns about health & safety issues
A8	Workers on-site have sufficient knowledge to carry out their work tasks appropriately & safely.
A9	Workers have a tendency to refuse to work when hazards & safety risks related to their work tasks are not clear
A10	Workers refuse to work when appropriate preventive measures (personal protection equipment (PPE), hazard control programs) are not provided
A11	Workers have a tendency to refuse to work when it is not clear how to execute a work task
A12	Employees on-site are aware of the importance of discussion and exchange of views about safety risks
A13	Safety manager and project supervisors encourage site workers to share their safety experiences
A14	Employees on-site use past hazardous events/experiences for improving on-site safety performance
B	**Behavioural resilience**
B1	Site supervisors frequently conduct safety meetings to discuss about potential safety issues
B2	Site supervisors appreciate when workers express their feelings about potential hazards on-site
B3	Site supervisors conduct sufficient site inspections
B4	Workers on-site always report hazardous conditions & risky behaviours when encountered
B5	Workers on-site make comprehensive enquiries on hazards related to their work tasks
B6	Site supervisors do not send workers to sites that involve physical and mental harm
B7	Site supervisors act decisively when encountering health & safety issues
B8	Workers always work safely even when they are not being supervised
B9	Employees on-site react quickly to emergency situations (i.e., injury, damage to properties)
B10	Site supervisors listen to feedback from their workers
B11	Workers talk to site supervisors about hazardous events without concern, even if they contribute to the occurrence of such events
B12	When an incident/accident occurs on-site, an investigation is begun to draw conclusions for the future
B13	During incident/accident investigations, site supervisors aim to prevent future similar accidents rather than blame their workers for such events
C	**Managerial/contextual resilience**
C1	Sufficient analysis of potential hazards & their risks of accidents is carried out continuously on-site
C2	Resources required to achieve safety targets associated with potential project hazards are assessed
C3	Safety issues (e.g., qualifications, injury records) of subcontractors and their employees are clearly identified before tendering
C4	Potential changes in working conditions that might present a risk of accidents are assessed
C5	Observed hazards are minimized at an acceptable level of risk
C6	Workers have access to up-to-date information about safety risks before commencing work on-site
C7	Changes in working conditions are monitored continuously
C8	Safety & site supervisors ensure risky behaviours of workers are noticed
C9	Top management provide adequate resources (financial, technical, human) to achieve safety targets on site
C10	All safety rules on-site are appropriate, practical, and easy to follow
C11	Appropriate preventive measures are immediately provided following any changes to working conditions
C12	Resources (facilities & instructions) for dealing with emergency situations are accessible to workers on-site
C13	Feedback on & revisions to safety issues are collated & distributed to workers on-site
C14	Past hazardous events such as risky behaviours are documented & used in developing future accident-preventive measures

Research Methodology

This study adopted a cross-sectional quantitative research approach. A questionnaire survey was employed to gather data due to its effectiveness in capturing comprehensive information on the dimensions of resilient safety culture practices in an effective and efficient manner (Uma & Roger, 2016). The questionnaire was designed in two sections. The first section inquired about the demography of the respondents and their respective organisations. The second section of the questionnaire assessed the level of agreement of respondents on the three (3) dimensions of RSC based on safety practices implemented in their respective construction firms on a 5-point Likert scale, where, 1 - Strongly disagree, 2 - Disagree, 3 - Neither disagree nor agree, 4 - Agree, and 5 - Strongly agree.

For this research, the population comprised of medium and large construction firms whose head offices were located at Abuja (FCT). According to the FIRS, there were 200 medium and large construction firms registered with the Corporate Affairs Commission (CAC) under Abuja metropolis as at 31st December 2021. In view of the kind of information that is requested for in the survey questionnaire, safety managers, construction managers and site supervisors were the target respondents while Abuja (FCT) of Nigeria was chosen as the study area. These target respondents were considered because these individuals play an important role in H & S programmes as they are actively involved in developing and implementing methods to control hazards on construction sites (American Society of Safety Engineers, 2013), while, Abuja was chosen as the study area because it is the capital city of Nigeria and one of the most developed areas where most indigenous and multinational construction firms have their headquarters situated (Kadiri *et al*., 2014).

Therefore, the following equation developed by Morgan and Krejcie (1970) for determining a representative sample for proportions was used to calculate the sample size (see equation 1).

$$S = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, S is the desired sample, X^2 is gotten from the table of values of chi-square for 1 degree of freedom at the desired confidence level (3.841), N is the population size, P is the population proportion (assumed to be 0.50), and d is the degree of accuracy expressed as a proportion (0.05). The resulting sample size was determined to be 132. Therefore, a total of 132 questionnaires were self-administered to the medium and large construction firms randomly selected from the list of 200 tax compliant construction firms obtained from the FIRS. Finally, the study employed both descriptive (frequency tables, mean item score, & standard deviation) and inferential (one-way ANOVA) statistical analyses tools to analyse the data collected. Out of the 132 questionnaires distributed, 129 were duly completed and returned representing a response rate of (97%).

Table 2 gives the decision rule adopted to determine the level of agreement of the H & S practices

.

Table 2: Decision Rule for Ranking Health and Safety Practices

SCALE	MEAN SCORE	Decision/Remark
1	0.00 to 1.49	Strongly Disagree
2	1.50 to 2.49	Disagree
3	2.50 to 3.49	Neutral
4	3.50 to 4.49	Agree
5	4.50 to 5.00	Strongly Agree

Results

Characteristics of respondents

Table 3 shows that 39 (30%) of the construction firms studied engage in building construction projects only, 27 (21%) engage in civil engineering projects only, and 63 (49%) engage in both (building & civil engineering projects). Regarding annual turnover, 55 (43%) of the firms have annual turnover between N10,000,000.00 and N20,000,000.00, while 74 (57%) have annual turnover of greater than N20,000,000.00. Additionally, 55 (43%) of the firms have a workforce between 71 & 200 employees, while the remaining 74 (57%) have a workforce greater than 200 employees. In terms of the nature of jobs undertaken by the respondents, it can be seen that 44 (34%) are safety managers, 54 (42%) construction managers, & 31 (24%) are site supervisors. Educational qualifications varied across the respondents, with 14 (11%) of the respondents having secondary school certificates (SSCE) and below, 20 (16%) had National Diplomas, 14 (11%) had Higher National Diplomas, 57 (44%) had Bachelor's degree, 23 (18%) had up to a Master's degree while

only 1 (1%) of the respondents hold a Ph.D. In terms of years of experience of the respondents, 19 (15%) had between 1 to 5 years, 28 (22%) had between 6 to 10 years of experience, 46 (36%) have between 11 to 15 years of experience, while 27 (21%) of the respondents have between 16 to 20 years of experience, & 9 (7%) have above 20 years of experience. This implies that the respondents possess requisite experience in the jobs to provide accurate answers to the questions in the research questionnaire. Finally, the scope of operations of the construction firms shows that 45 (35%) are multi-national construction firms, while the majority of the construction firms 84 (65%) were National in terms of scope of operations. This therefore, means that, the results obtained from the analysis of data collected from these construction firms can be used for generalisation across Nigeria.

Table 3: Characteristics of Respondents

Demographics	Classification	Frequency	%
Type of Project Undertaken	Building Construction	39	30
	Civil Engineering	27	21
	Building & Civil Engineering	63	49
	Total	**129**	**100**
Annual Turnover	Greater than N10,000,000 but less than N20,000,000	55	43
	Greater than N20,000,000.00	74	57
	Total	**129**	**100**
Number of employees	Between 71 & 200 Employees	55	43
	Greater than 200 Employees	74	57
	Total	**129**	**100**
Job title of respondents			
	Safety Manager	44	34
	Construction Manager	54	42
	Site Supervisor	31	24
	Total	**129**	**100**
Educational Qualification	Secondary School	14	11
	National Diploma	20	16
	Higher National Diploma	14	11
	Bachelors	57	44
	Masters	23	18
	PhD	1	1.1
	Total	**129**	**100**
Years of Experience	1-5 Years	19	15
	6-10 Years	28	22
	11-15 Years	46	36
	16-20 Years	27	21
	ABOVE 20 Years	9	7
	Total	**129**	**100**
Scope of operations	Multi-national	45	35
	National	84	65
	Total	**129**	**100**

Assessing dimensions of resilient safety culture

41 H & S related factors were used to assess the three (3) dimensions of RSC in construction firms using a five-point Likert scale (from 1 - strongly disagree to 5 - strongly agree. The results of the ratings of the H & S

practices are summarised in Tables 4.2 - 3.4 respectively.

Psychological resilience

Table 4 shows that eight (8) health and safety practices were implemented in construction firms to achieve psychological resilience with mean scores ranging between 4.74 and 4.06. These safety practices range from "*workers acknowledge the occurrence of unexpected hazards anytime & anywhere on site*" which is the highest ranked (Mean=4.74; SD=0.47) to "*workers on site use past hazardous events to enhance their safety* performance" which is the least ranked (Mean=4.06; SD=0.79). Overall, the group mean for all the psychological resilience factors was 3.59. This suggests that, on average, the respondents agree that majority of these factors to be important for assessing the psychological resilience in construction firms, particularly in relation to their ability to recognise and respond to hazards on site.

Table 4: H & S Practices for Assessing Psychological Resilience

Psychological Resilience Factors	Mean	SD	Rank	Decision
Workers acknowledge the presence of unexpected hazards always on site	4.74	0.47	1st	SA
Workers have sufficient safety knowledge to execute tasks	4.55	0.67	2nd	SA
Workers have sufficient knowledge to identify project hazards	4.51	0.71	3rd	SA
Workers in a group work safely & are aware of co-workers' activities	4.50	0.63	4th	SA
Workers refuse to work when PPEs are not provided	4.49	0.76	5th	A
Workers are aware of safety consequences of non-compliance with safety rules	4.14	0.62	6th	A
Workers refuse to work when it is not clear how to execute the work	4.07	0.58	7th	A
Workers use past hazardous events to enhance safety performance	4.06	0.79	8th	A
Workers know the importance of exchange of views on safety risks	2.85	0.85	9th	N
Workers are concerned with working conditions & preventive measures on site	2.77	0.82	10th	N
Workers are aware of the major safety issues on site	2.63	0.82	11th	N
Workers are conscious of hazards even after they are recognised & controlled	2.53	1.19	12th	N
Safety managers & supervisors encourage workers to share their safety experiences	2.29	1.17	13th	D
Workers refuse to work when project hazards & safety risks are not clear	2.17	1.04	14th	D
Group mean	**3.59**	**0.79**		

D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

Behavioural resilience

It is shown in Table 5 that eight (8) health and safety practices were implemented in construction firms to achieve behavioural resilience with mean scores ranging between 4.57 and 3.77. These safety practices range from "*site supervisors conduct sufficient site inspections*" which is the highest ranked (Mean=4.57; SD=0.65) to "*site supervisors conduct safety meetings frequently to discuss safety issues*" which is the least ranked (Mean=3.77; SD=0.66). The overall group mean for all the behavioural resilience factors was 3.67, indicating that, on average, the respondents agreed with the majority of these factors to be relevant for assessing the behavioural resilience in construction firms, particularly in how workers and supervisors interact and respond to safety challenges.

Table 5: H & S Practices for assessing behavioural resilience

Behavioural Resilience Factors	Mean	SD	Rank	Decision
Site supervisors conduct sufficient site inspections	4.57	0.65	1st	SA
Site supervisors listen to feedback on safety issues from workers	4.54	0.57	2nd	SA
Site supervisors do not expose workers to sites that involve physical & mental harm	4.42	0.63	3rd	A
Site supervisors act promptly when confronted with health & safety issues on site	4.34	0.55	4th	A
Employees on site respond quickly to emergency situations	4.17	0.55	5th	A
Whenever an incident happens on site, investigations are carried out to draw conclusions	4.15	0.61	6th	A
Incident investigation aims to prevent future occurrence rather than blame the victim(s)	4.07	0.73	7th	A
Site supervisors conduct safety meetings frequently to discuss safety issues	3.77	0.66	8th	A
Workers on site always report hazardous conditions & risky behaviours encountered	2.98	0.91	9th	N
Site supervisors appreciate when workers express feelings on potential hazards on site	2.88	0.75	10th	N
Workers on site make comprehensive enquiries on project hazards related to their work	2.84	0.75	11th	N
Workers always work in a safe manner even when they are not supervised	2.78	0.93	12th	N
Workers report hazardous events to supervisors even if they contribute to their occurrence	2.24	1.05	13th	D
Group mean	**3.67**	**0.72**		

D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

Managerial resilience

From Table 6, it is found that nine (9) H & S practices were implemented in construction firms to achieve managerial resilience with mean scores ranging between 4.35 and 4.16. These safety practices range from "*potential hazards & their risks of accidents are analysed continuously*" which is the highest ranked (Mean=4.35; SD=0.50) to "*document past hazardous events for developing future accident preventive measures*" which is the least ranked (Mean=4.16; SD=0.43). The overall group mean of 3.74 and SD of 0.66 indicate that, on the average, the factors assessed are considered relevant by the respondents. The emphasis is clearly on the importance of resource allocation, continuous monitoring, and proactive safety measures as key components of managerial resilience.

Table 6: H & S Practices for Assessing Managerial Resilience

Managerial Resilience Factors	Mean	SD	Rank	Decision
Potential hazards & their risks of accidents are analysed continuously	4.35	0.50	1st	A
Resources for achieving safety targets are assessed	4.30	0.49	2nd	A
Top management provide adequate financial, technical & human resources for safety	4.29	0.60	3rd	A
Safety officers & site supervisors notice risky behaviours of workers on site	4.28	0.60	4th	A
Observed project hazards are minimised to acceptable level	4.27	0.66	5th	A
Changes in working conditions that could lead to risk of accidents are assessed	4.24	0.58	6th	A
Workers have access to safety resources for dealing with emergencies on site	4.24	0.58	7th	A
Preventive safety measures are implemented after changes to work conditions on site	4.18	0.53	8th	A
Document past hazardous events for developing future accident preventive measures	4.16	0.43	9th	A
Changes in working conditions are monitored on continuous basis	3.25	0.71	10th	N
All safety rules on site are appropriate, practical & easy to follow for workers	3.08	0.68	11th	N
Collation & distribution of feedback or revisions on safety issues to workers on site	2.81	0.78	12th	N
Workers on site have access to up-to-date data on safety risks prior to wok execution	2.79	0.71	13th	N
Safety records of subcontractors & their employees are required before tendering	2.07	1.45	14th	D
Group mean	**3.74**	**0.66**		

D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

Furthermore, in order to establish whether or not there exists statistically significant difference in the mean scores of the various groups of respondents, and to empirically make more sense of the results, a one-way ANOVA was conducted. Results in Table 7 shows that there is no statistically significant difference at the $p<0.05$ in mean scores across respondents as determined by one-way ANOVA $F(2,126) = 3.055$, $p = 0.051$) for psychological resilience; $F(2,126) = 0.777$, $p = 0.462$) for behavioural resilience; and $F(2,126) = 0.992$, $p = 0.374$) for managerial resilience respectively. The consensus among the respondents as regards the safety practices implemented is not surprising because as rightly observed by the ASSE (2013) and National Occupation Research Agenda (2008), the respondents are actively involved in developing and implementing safety policies for controlling and managing hazards on construction sites.

Table 7: Result of ANOVA on dimensions of RSC

		Sum of Squares	Df	Mean Square	F	Sig.
PR	Between Groups	.649	2	.324	3.055	.051
	Within Groups	13.376	126	.106		
	Total	14.025	128			
BR	Between Groups	.065	2	.032	.777	.462
	Within Groups	5.249	126	.042		
	Total	5.314	128			
MR	Between Groups	.282	2	.141	.992	.374
	Within Groups	17.905	126	.142		
	Total	18.187	128			

Discussion

Psychological resilience

Psychological resilience in construction firms is achieved through eight key safety practices, including workers' acknowledgment of unexpected hazards (PR3), sufficient knowledge for safe task execution (PR8), identification of project hazards (PR5), safe group work awareness (PR6), refusal to work without provided personal protective equipment (PR10), awareness of consequences for non-compliance with safety rules (PR12), the ability to refuse unclear tasks (PR11), and learning from past hazardous events

(PR14). These practices reflect workers' perceptions addressing both regular threats (project hazards) and irregular threats (unexpected failures/events) on construction sites. The importance of safety risk perception, knowledge, experience, hazard recognition, and decision-making in enhancing safety is supported by various studies (Choudhry & Fang, 2008; Guo *et al*., 2012; Abubakar *et al*., 2019). Workers' safety attitudes and risk perception are crucial, as low risk perceptions can lead to both fatal and non-fatal accidents. Limited knowledge and experience increase the risk for workers, emphasizing the need to enhance their understanding of safety hazards (Choudhry and Fang, 2008). Additionally, studies by Cigularov *et al*. (2010) and Mitropoulos *et al*. (2005) highlighted the existence of unexpected factors and the importance of corresponding safety practices. Construction worker errors, influenced by time pressures, mental pressures, fatigue, task novelty, distractions, and overconfidence, contribute to unpredictable hazardous situations (Mitropoulos *et al*., 2005; Cigularov *et al*., 2010).

Behavioural resilience

Behavioural resilience in construction firms is characterized by eight key health and safety practices implemented by site supervisors. These practices include conducting sufficient site inspections (BR3), listening to worker feedback on safety issues (BR10), avoiding exposure of workers to physical and mental harm (BR6), prompt action on health and safety issues (BR7), quick response to emergency situations (BR9), thorough investigation of incidents with a focus on prevention rather than blame (BR12), and frequent safety meetings to discuss safety issues (BR13). These practices reflect the safety behaviour and attitude of site supervisors, effectively managing both project hazards and unexpected events/failures. This observation aligns with previous studies, such as Fernandez-Muniz *et al*. (2007) and Aksorn and Hadikusumo (2008), which emphasised the significant role of project site management and supervisors in enhancing safety practices and outcomes.

Managerial resilience

Managerial resilience in construction firms is established by nine key health and safety practices. These practices include continuous analysis of potential hazards and their risks (MR1), assessment of resources for safety targets (MR2), provision of adequate financial, technical, and human resources for safety by top management (MR9), identification of risky behaviours by safety officers and site supervisors (MR8), minimization of observed project hazards to an acceptable level (MR5), assessment of changes in working conditions for potential risks (MR4), provision of safety resources for workers dealing with emergencies (MR12), implementation of preventive safety measures after changes in work conditions (MR11), and documentation of past hazardous events for developing future accident preventive measures (MR14). These practices reflect a robust safety management system adopted by construction firms to plan and manage both identified project hazards and unexpected events. This finding is corroborated by various studies, including Hinze and Gambatese (2002) and Aksorn and Hadikusumo (2008). According to Hinze (2002), safety pre-project or pre-task planning is crucial for enhancing safety performance in construction firms, and studies by Tam *et al*. (2004) and Aksorn and Hadikusumo (2008) emphasise the positive impact of sufficient resource allocation to safety on overall safety performance in the construction industry.

Conclusion

The study investigated resilient safety culture (RSC) in construction firms across multiple dimensions. It successfully identified and assessed 41 safety practices for dimensions of RSC in construction firms. The research findings revealed a robust implementation of safety practices across multiple dimensions. Specifically, the study found that construction firms in Abuja (FCT) have implemented 8 safety practices each for psychological resilience and behavioural resilience. This dual focus underscores their commitment to enhancing both the mental well-being of employees and the behavioural aspects that contribute to overall safety. Additionally, the study highlights that 9 safety practices have been implemented for managerial resilience, emphasising the critical role of top management in fostering a resilient safety culture. This includes aspects such as leadership commitment to safety, effective communication of safety protocols, and proactive management of safety risks. These findings collectively suggest that construction firms in Abuja (FCT) are actively striving to foster a resilient safety culture throughout their organisations. By addressing psychological, behavioural, and managerial aspects of resilience, these firms are poised to improve safety outcomes and create safer working environments for their employees. Moving forward, it is recommended that construction firms should develop and implement targeted safety interventions that focus on the identified safety practices within psychological, behavioural, and managerial resilience dimensions. Tailoring these safety initiatives to address specific areas identified in the study will be crucial for further enhancing and sustaining resilient safety culture and reducing accidents in the Nigerian construction firms.

The outcome of the study contributed to the body of knowledge of construction safety management through advancing a theoretical foundation and empirical basis

for defining and assessing resilient safety culture within construction Nigerian construction firms. The acknowledgment of resilient safety culture's role in mitigating project hazards and unexpected events to foster exceptionally safe construction organisations.

The limitation of the study is related to the generalisability of the results. The data used in this study were gathered from medium and large construction firms involved in building and civil engineering projects in Abuja, Nigeria. As a result, the findings should be interpreted within the specific context of construction firms in Abuja, Nigeria.

References

Adler, P. S. & Kwon, S.W. (2000). Social Capital: The Good, the Bad, and the Ugly. In E.L. Lesser (Ed.), *Knowledge and Social Capital* (pp. 89–115). Boston: Butterworth-Heinemann. https://doi.org/10.1016/B978-0-7506-7222-1.50008-8.

Akgun, A. E. & Keskin, H. (2014). Organisational Resilience Capacity and Firm Product Innovativeness and Performance. *International Journal of Production Resources*, 52(23), 6918-6937. https://doi.org/10.1080/00207543.2014.910624.

Akselsson, R. Koornneef, F. Stewart, S. & Ward, M. (2009). Resilience Safety Culture in Aviation Organisations. In Proceedings, *17th World Congress on Ergonomics. Paris: International Ergonomics Association*.

Bandura, A. & McClelland, D. (1977). *Social Learning Theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1986). *Social Foundations of Thought and Action: A social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall.

Choudhry, R.M., Fang, D. & Mohamed, S. (2007). The Nature of Safety Culture: A Survey of the State of the Art. *Safety Science*. 45(10), 9931012.https://doi.org/10.1016/j.ssci.2006.9.003.

Collins, J. C. & Porras, J.I. (2005). *Built to Last: Successful Habits of Visionary Companies*. Random House.

Cooper, M. D. (2000). Towards a Model of Safety Culture. *Safety Science*, 36(2), 111-136. https://doi.org/10.1016/S0925-7535(00)00035-7.

Coutu, D. (2002). How Resilience Works, 9.

Edmondson, A. (1999). Psychological Safety and Learning Behaviour in Work Teams. *Administrative Science Quarterly*, 44(2), 350. https://doi.org/10.2307/2666999.

Fang, D. & Wu, H. (2013). Development of a Safety Culture Interaction (SCI) Model for Construction Projects. *Safety Science*, 57, 138-149.https://doi.org/10. 1016/j.ssci.2013.02.003.

Feng, Y. (2013). Effect of Safety Investments on Safety Performance of Building Projects. *Safety Science*, 59, 28-45. https://doi.org/10.1016/j.ssci.2013.04.004.

Feng, Y., Zhang, S. & Wu, P. (2015). Factors Influencing Workplace Accident Costs of Building Projects. *Safety Science*, 72, 97-104. https://doi.org/10.1016/j.ssci.2014.08.008.

Ferrier, W.J., Smith, K.G. & Grimm, C.M. (1999). The Role of Competitive Action in Market Share Erosion and Industry Dethronement: A Study of Industry Leaders and Challengers. *Academy of Management Journal*, 42(4), 372–388. https://doi.org/10.5465/257009.

Freeman, S. F., Hirschhorn, L. & Triad, M.M. (2003). Moral Purpose and Organizational Resilience: Sandler O'Neill & Partners, L.P. In the Aftermath of September 11, 2001. *Academy of Management Proceedings*, 2003(1), B1–B6. https://doi.org/10.5465/ambpp.2003.13792457.

Geller, E.S. (1994). Ten Principles for Achieving a Total Safety Culture. *Professional Safety*. 39(9), 18.

Grote, G. & Kunzler, C. (2000). Diagnosis of safety culture in safety management audits. *Safety Science*, 34(1–3), 131–150.

Guldenmund, F.W. (2000). The Nature of Safety Culture: A Review of Theory and Research. *Safety Science*, 34(1), 215-257. https://doi.org/10.1016/S0925-7535(00)00014-X.

Health and Safety Executive. (2019). *Workplace Fatal Injuries in Great Britain*. Bootle, UK: HSE.

Health and Safety Executive. (2014). Workplace Fatal Injuries in Great Britain. London: *Health and Safety Executive*, UK.

Hinze, J. & Gambatese, J. (2003). Factors that Influence Safety Performance of Specialty Contractors. *Journal of Construction Engineering and Management*, 10.1061/ (ASCE) 0733-9364(2003)129:2(159), 159-164.

Hollnagel, E. (2008). Risk + Barriers = Safety? *Safety Science*, 46(2), 221-229. https://doi.org/10.1016/j.ssci.2007.06.028.

Ibrahim, A., Ibrahim, K., & Shakantu, M.W. (2018). Factors Responsible for Poor Safety Performance of Small and Medium Construction Contracting Firms in Nigeria. *Proceedings of the 10th Construction Industry Development Board (cidb) Postgraduate Conference*. Nelson Mandela University and Central University of Technology, South Africa

Idoro, G.I. (2011). Comparing Occupational Health and Safety (OHS) Management Efforts and Performance of Nigerian Construction Contractors. *Journal of Construction in Developing Countries*

International Labour Organisation (ILO). (2017). Nigeria Country Profile on Occupational Safety and Health 2016. Retrieved on 27 August 2018 from: https://www.ilo.org/wcmsp5/groups/public/—africa/—roaddis_ababa/—ilo abuja/documents/publication/wcms_552748.pdf

Judge, W.Q., Fryxell, G.E. & Dooley, R.S. (2000). The New Task of R&D Management: Creating Goal-Directed Communities for Innovation. In *Knowledge and Communities* (pp. 37–51). Boston: Butterworth-Heinemann. https://doi.org/10.1016/B978-0-7506-7293-1.50006-8.

Kheni, N A., Gibb, A.G.F. & Dainty, A.D.F. (2006). The Management of Construction Site Health and Safety by Small and Medium-Sized Construction Businesses in Developing Countries: A Ghana Case Study. *In:* Boyd, D (Ed) *Procs 22nd Annual ARCOM Conference*, 4-6 September 2006, Birmingham, UK, Association of Researchers in Construction Management, 273-282.

Lengnick-Hall, C.A. & Beck, T.E. (2005). Adaptive Fit Versus Robust Transformation: How Organizations Respond to Environmental Change. *Journal of Management*, 31(5), 738–757. https://doi.org/10.1177/0149206305279367.

Lengnick-Hall, C.A. Beck, T.E. & Lengnick-Hall, M.L. (2011). Developing a Capacity for Organisational Resilience through Strategic Human Resource Management. *Human Resource Management*, 21(3), 243-255.https://doi.org/10.1016/j.hrmr.2010.07.001.

Li, H., Lu, M. & Skitmore, M. (2013). Integrating Real Time Positioning Systems to Improve Blind Lifting and Loading Crane Operations. *Construction Management and Economics*, 31(6), 596-605.

Mallak, L. (1998). Putting Organizational Resilience to Work. *Industrial Management*, 10.

Miller, D. & Chen, M.J. (n.d.). The Simplicity of Competitive Repertoires: An Empirical Analysis. *Strategic Management Journal*, 17(6), 419–439. https://doi.org/10.1002/ (SICI) 1097-0266(199606) 17:63.0.CO; 2-Z.

Mitropoulos, P. Wu, T.S. & Howell, G.A. (2005). Systems Model of Construction Accident Causation. *Journal of Construction Engineering and Management*, 131(7), 816-825. https://doi.org/10.1061/ (ASCE) 0733-9364(2005) 131:7(816).

Morgan, G. (1999). Images de l'organisation. Presses Université Laval.

National Occupational Research Agenda (2008). National Construction Agenda for Occupational Safety & Health Research and Practice in the U.S. Construction Sector. NORA Construction Sector Council. ⟨http://www.cdc.gov/niosh/nora/comment/agendas/construction/pdfs/ConstOct2008.pdf⟩.

Okeola, O.G. (2009). Occupational Health and Safety Assessment in the Construction Industry. Paper presented at the *1st Annual Civil Engineering Conference* University of Ilorin, Nigeria, 26-28 August 2009.

Pecillo, M. (2016). The Resilience Engineering Concept in Enterprises with and Without Occupational Safety and Health Management Systems. *Safety Science*, 82, 190-198. https://doi.org/10.1016/j.ssci.2015.09.017.

Pillay, M., Borys, D., Else, D. & Tuck, M. (2010). Safety Culture and Resilience Engineering-Exploring Theory and Application in Improving Gold Mining Safety Executive. In *Proc., Gravity Gold Conference*. Ballarat, Australia.

Reason, J. (1997). *Managing the Risks of Organisational Accidents*. Aldershot, UK: Ashgate.

Righi, A.W. Saurin, T.A. & Wachs, P. (2015). A Systematic Literature Review of Resilience Engineering: Research Areas and a Research Agenda Proposal. *Reliability Engineering System Safety*, 141, 142-152. https://doi.org/10.1016/j.ress.2015.03.007.

Shirali, G.H.A. & Angali, K.A. (2015). Quantitative Assessment of Resilience Safety Culture Using Principal Components Analysis and Numerical Taxonomy: A Case Study in a Petrochemical Plant. *Journal Loss Prevention*. Process Ind. 40 (Mar): 277-284. https://doi.org/10.1016/j.jlp.2016.01.007.

Sunindijo, R.Y. & Zou, P.X.W. (2012). How Project Manager's Skills May Influence the Development of Safety Climate in Construction Projects. *International Journal of Project Organisation and Management*, 4(3), 286-301.

Sutcliffe, K. M. & Vogus, T.J. (2003). Organizing for Resilience, 26.

Thomas, J.B., Clark, S.M. & Gioia, D.A. (1993). Strategic Sense making and Organisational Performance: Linkages among Scanning, Interpretation, Action, and Outcomes. *Academy of Management Journal*, 36(2), 239–270. https://doi.org/10.5465/256522.

Trinh, M.T., Feng, Y. & Jin, X. (2018). Conceptual Model for Developing Resilient Safety Culture in the Construction Environment. *Journal of Construction Engineering and Management*, 144(7), 06018003. https://doi.org/10.1061/ (ASCE) CO.1943-7862.0001522.

Umeokafor, N. I. (2017). *Realities of construction health and safety in Nigeria*. Unpublished Doctoral thesis, University of Greenwich, London.

Wehbe, F., Hattab, M.A. & Hamzeh, F. (2016). Exploring Associations between Resilience and Construction Safety Performance in Safety Networks. *Safety Science*, 82, 338-351. https://doi.org/10.1016/j.ssci .2015.10.006.

Weick, K. & Sutcliffe, K. (2015). *Managing the Unexpected: Sustained Performance in a Complex World* (3rd Ed.). New Jersey: Wiley

Westrum, R. (2006). A Typology of Resilience Situations. In *Resilience Engineering: Concepts and Precepts*, 55-65. Farnham, UK: Ashgate Publishing.

Windapo, A.O. & Jegede, O.P (2014). A study of health, safety and environment (HSE) Practices of Nigeria Construction Companies. Retrieved from http://www.academia.edu/5981184/A_Study_of_Health_Safety_and_Environment_HSE_Practices_of_Nigerian_ Construction_Companies

Woods, D.D. & Hollnagel, E. (2006). Prologue: Resilience Engineering Concepts. In *Resilience Engineering: Concepts and Precepts*, 1-16. Aldershot, UK: Ashgate.

Wu, C. Song, X. Wang, T. & Fang, D. (2015). Core Dimensions of the Construction Safety Climate for a Standardised Safety Climate Measurement. *Journal Construction Engineering and Management*, 141(8), 1-12. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000996.