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The Impact of Confined Construction Sites Condition on Project Team Health and Safety in Port Harcourt, Rivers State

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Abstract

This study investigates the impact of confined construction sites on project team health and safety in Port Harcourt, Rivers State, Nigeria. The research addresses the growing safety challenges faced by construction teams working in confined sites. Through a quantitative research approach, the study examined multiple confined construction sites to assess how spatial constraints affect workplace safety and identify the most significant risk factors. The methodology employed purposive sampling to select fifteen confined construction sites in Port Harcourt. Data collection was conducted through structured questionnaires distributed to construction professionals, including project managers, structural engineers, safety officers, and site supervisors. Statistical analysis, including descriptive statistics and regression analysis, was used to examine the relationships between confined site conditions and safety outcomes. The findings revealed that limited access routes, restricted movement space, and poor ventilation are the most significant challenges that influence safety outcomes in confined construction sites. Space limitation emerged as the strongest predictor of safety incidents, followed by ventilation issues and restricted access routes. The study also found that material storage constraints and lighting conditions, while important, had a relatively lesser impact on safety outcomes. The research demonstrated a strong relationship between confined site conditions and the frequency of safety incidents, with site conditions explaining a substantial portion of the variation in accident occurrence. The findings highlight the need for specialized safety protocols and management strategies for confined construction sites, particularly in rapidly urbanizing areas. The study's results can inform the development of more effective safety policies and practices that suits confined construction environments. This will ultimately contribute to improved workplace safety in urban construction projects.

Keywords: Confined Construction Sites, Health and Safety, Construction

1. Introduction

The construction industry plays an important role in Nigeria's economic development, especially in rapidly growing urban centers like Port Harcourt, the capital of Rivers State. As the city experiences urban expansion, the demand for infrastructure and buildings has increased which has led to increased construction activity in densely populated areas (Nna, 2012). This urban density has resulted in a rise of confined construction sites which are characterized by limited space, restricted access, and close proximity to existing structures. Confined construction sites present unique and substantial health and safety risks, worsening an already concerning safety record in Nigeria's construction industry (Isah, 2019). The sector, while contributing significantly to the nation's GDP, has been plagued by poor safety practices and high accident rates (Ogbu, 2011; Umeokafor *et al.*, 2014). In confined sites, hazards such as limited maneuverability, elevated risks of falls and collisions, inadequate ventilation, and challenges in emergency evacuation are intensified (Manu *et al.*, 2018; Abdelhamid and Everett, 2000). These conditions not only affect workers' physical health but also increase stress levels, which may further contribute to accidents. Additionally, the proximity of these sites to public areas raises concerns about the safety of both the construction teams and the surrounding community. Despite an increasing awareness of occupational health and safety in Nigeria, the specific risks associated with confined construction sites, particularly in Port Harcourt, remain underexplored. While previous studies have addressed general construction safety (Idoro, 2011; Diugwu *et al.*, 2012), the unique challenges of space-constrained environments in urban areas like Port Harcourt have not been thoroughly examined. This gap in knowledge hinders the development of effective safety management strategies that suits the unique challenges of confined construction sites. Therefore, this study seeks to address this gap by investigating how confined construction site conditions in Port Harcourt impact the health and safety of project teams. The findings aim to inform more effective safety practices and policies that can mitigate risks and enhance worker well-being in Nigeria's fast-growing urban construction sector.

2. Literature Review

2.1 Construction Health and Safety in Nigeria

Health and safety in construction have been the focus of numerous studies globally which reflects the inherent risks of construction activities. This literature review examines general health and safety issues within the construction industry in Nigeria, focusing specifically on confined construction sites in Port Harcourt. It also highlights key gaps in the existing research that this study seeks to address.

2.2 Health and Safety in the Nigerian Construction Industry

It is important to provide secure working environments for construction workers due to the inherent dangers and risks in every construction task (Olutuase, 2014). According to Oresegun (2009), the effectiveness of construction personnel is closely tied to the safety of their working environment. Kheni *et al*. (2008) expanded on this, emphasizing that both the physical and mental well-being of workers, along with those whose health could be negatively impacted by construction activities, must be prioritized. Idoro (2011) highlighted that the construction sector in Nigeria has a poor safety record and one of the highest accident rates among all industries. Umeokafor *et al*. (2014) further noted that the absence of comprehensive national policies on occupational safety and health, specifically suited to the construction sector worsens this issue. Despite the existence of regulations, such as the Factories Act of 1987 and the Labour, Safety, Health, and Welfare Bill of 2012, enforcement remains a major concern (Diugwu *et al*., 2012). Many construction firms in Nigeria, especially small and medium-sized enterprises (SMEs), prioritize profit and project completion over worker safety, as noted by Umeokafor *et al*. (2014). This practice further undermines health and safety efforts. In Port Harcourt, Wokekoro and Owei (2014) observed that rapid urban development and the booming oil-driven economy have led to a rise in construction activities, often in unsafe environments. However, a notable gap exists in the collection of localized data on construction-related accidents in Port Harcourt which indicates a need for more research into the specific health and safety challenges within the city.

2.3 Confined Construction Sites

Confined construction sites are typically characterized by limited space, restricted access, and proximity to existing structures or public spaces (Manu *et al*., 2018). These sites are increasingly common in urban areas like Port Harcourt due to land scarcity and the need for urban regeneration. The spatial constraints inherent in these sites present unique challenges, particularly in terms of health and safety. Ommelein and Zouein (1993) argued that space on construction sites should be managed as critically as other physical resources, as poor spatial management can increase the likelihood of accidents and reduce overall productivity. According to Pradhananga and Teizer (2014), space constraints on urban construction sites lead to additional safety hazards, especially when multiple crews and heavy machinery operate simultaneously within the same confined area. Similarly, Mossman (2008) emphasized that smaller workspaces are often more dangerous due to the increased proximity of workers to machinery, materials, and other potential hazards. Spillane and Oyedele (2013) defined confined construction sites as those where permanent works occupy most of the available footprint, leaving little room for essential operations like material storage, equipment movement, and worker coordination. It is important to differentiate confined construction sites from confined spaces, as defined by the Occupational Safety and Health Administration (OSHA) (2017). Confined spaces refer to spaces that are large enough for worker entry but are not intended for continuous occupancy, such as storage tanks, boilers, or tunnels. These spaces pose additional hazards, including the risk of toxic substances, oxygen deficiency, and flammable gases (Michigan Institute of Safety and Health Administration, 2015). In the Nigerian context, Okoye *et al*. (2016) found that many construction projects lack proper site planning and organization which leads to cluttered and hazardous work environments. These issues are particularly pronounced in confined construction sites, where spatial constraints make the coordination of resources, personnel, and equipment even more difficult.

2.4 Health and Safety Practices in Confined Construction Sites

Managing health and safety in confined construction sites requires unique practices to address the specific hazards posed by limited space, restricted access, and the presence of heavy machinery. Zhao *et al*. (2021) emphasized the importance of comprehensive risk assessments, noting that confined construction sites often introduce additional risks not found in conventional construction environments. These risks necessitate a multidisciplinary approach to risk assessment, involving input from various stakeholders, including project managers, safety professionals, and workers. Li and Peng (2023) highlighted the importance of adequate worker insurance coverage in high-risk environments like confined construction sites. Their study found that sites with comprehensive insurance coverage not only protected workers financially but also incentivized companies to adhere to higher safety standards. A positive correlation was noted between the extent of insurance coverage and overall safety performance on confined projects.

Thompson *et al*. (2022) advocated for the use of digital tools in the documentation and monitoring of health and safety practices on confined sites. Their research showed that the use of digital platforms for real-time safety reporting resulted in a 30% reduction in workplace incidents compared to traditional paper-based systems. This highlights the potential benefits of leveraging technology to improve safety management in confined spaces.

Research by Chen and Wang (2024) demonstrated that construction companies with well-defined, site-specific health and safety policies experienced fewer accidents and injuries on confined sites. Their study emphasized the need for policies that address the unique challenges of confined sites, such as limited access points and restricted movement of personnel and equipment. Other studies underscore the importance of emergency preparedness and proper equipment on confined sites. Rodriguez *et al*. (2023) found that sites with emergency medical kits and properly fitted personal protective equipment (PPE) reported 40% fewer severe injuries compared to sites with inadequate provisions. Kim and Lee (2022) demonstrated that confined sites with full-time safety officers and adequate fire safety equipment experienced 50% fewer fire-related incidents.

Given the limited space in confined construction sites, lifting apparatus and fall protection systems are crucial. Zhang *et al*. (2023) revealed that the use of compact lifting equipment and comprehensive fall protection systems led to a significant reduction in manual handling injuries and fall-related incidents. While the literature on health and safety practices in construction is robust, there is a clear gap when it comes to confined construction sites in Nigeria, particularly in Port Harcourt. The limited research on spatial constraints and site-specific safety challenges indicates a need for more localized studies. Furthermore, despite the presence of safety regulations, enforcement remains weak in Nigeria, and there is little information on how confined site conditions exacerbate these challenges.

This study aims to fill this gap by examining how the confined conditions of construction sites in Port Harcourt affect the health and safety of project teams. By focusing on localized data, this research will provide insights into the specific hazards faced in urban construction environments and offer practical recommendations for improving health and safety standards in these confined spaces.

3. Research Methodology

This study employs a quantitative research design to investigate the effect of confined construction sites on project team health and safety in Port Harcourt, Rivers State, Nigeria. A purposive sampling technique was used to ensure that the selected sites represent confined construction environments. This sampling method was justified by the need to focus specifically on sites that presented the distinct challenges typically associated with confined construction sites. The identification of 15 confined construction sites was achieved through physical site visits, ensuring that the sample was representative of environments facing the issues under investigation. The primary data collection instrument was a structured questionnaire. Reliability testing was conducted using Cronbach's alpha coefficient to ensure internal consistency of the questionnaire. A Cronbach's alpha value of 0.83 was achieved which indicates that the questionnaire is reliable. The data collection involved distributing five questionnaires at each of the 15 identified confined construction sites, resulting in a total of 75 questionnaires. The target respondents included site managers, safety officers, supervisors, and experienced workers who were directly involved in implementing health and safety practices. A total of 70 questionnaires were returned which represents a 93% response rate. Incomplete or improperly filled questionnaires were excluded from the analysis to maintain the integrity of the data. The collected data were analyzed using descriptive and inferential statistical methods. Descriptive statistics were used to summarize the demographic characteristics of respondents and provide an overview of the sample. For the inferential analysis, regression analysis was selected as the primary method to assess the relationship between confined construction site conditions (independent variables) and safety outcomes (dependent variables). Regression analysis was chosen because it allows the study to quantify the impact of multiple site conditions on safety outcomes. This method aligns with the study's objective of identifying how confined site conditions influence health and safety outcome.

4. Findings and Discussion of Results

The study engaged a diverse range of construction professionals, including Safety Officers, Site Supervisors, and project managers, builders, and engineers. Table 1 provides a summary of the background information of the 70 respondents.

Table 6: Summary of Respondents Background Information

Category	Classification	Frequency	Percentage (%)
Professional Role	Project Manager	18	25.7
	Structural Engineer	14	20.0
	Construction Manager	12	17.1
	Health and Safety Officer	11	15.7
	Site Supervisor	9	12.9
	Architect	6	8.6
	Total	70	100
Educational Background	Bachelor's Degree	38	54.3
	Master's Degree	22	31.4
	Higher National Diploma	10	14.3
	Total	70	100
Years of Experience	Less than 5 years	12	17.1
	5 - 10 years	28	40.0
	11 - 15 years	16	22.9
	16 - 20 years	10	14.3
	Over 20 years	4	5.7
	Total	70	100

Source: Field Survey

The data indicates a diverse representation of professionals. Project Managers constitute the largest group, followed by Structural Engineers and Health and Safety Officers which aligns with the study's focus on safety. In terms of educational background, the majority hold a Bachelor's degree, with a notable portion holding Master's degrees, indicating that respondents are well-qualified to contribute insights on construction safety. Regarding industry experience, 40.0% of respondents have 5-10 years of experience, while 22.9% have 11-15 years which reflects a balance between early-career and experienced professionals. The presence of those with over 20 years of experience adds valuable long-term perspectives. Table 2 shows the safety issues on confined construction sites.

Table 7: Safety issues on confined construction sites

Injury Type	Frequency	Percentage (%)
Trips and falls	45	64.3
Strain injuries from repetitive movements	40	57.1
Impacts from falling objects	38	54.3
Compression between materials or equipment	33	47.1
Equipment-related accidents	26	37.1
Excavation cave-ins	22	31.4
Falls from elevations	9	12.9
Electric shocks	4	5.7
Combustion or blast incidents	1	1.4

Source: Field Survey

The analysis of injury patterns in confined construction sites reveals several significant safety concerns that merit careful consideration. The predominant hazard identified was trips and falls, affecting 64.3% of respondents, which represents a substantial occupational risk in confined construction environments. This finding aligns with and extends the work of Orji *et al*. (2016), who identified falls as a primary safety concern in urban construction sites across South-Eastern Nigeria. The higher prevalence in confined sites suggests that spatial constraints may exacerbate traditional construction risks. Strain injuries emerged as the second most significant concern, with 57.1% of respondents reporting strain injuries from repetitive movements. This finding builds upon Ajayi *et al*.'s (2017) research by demonstrating the specific impact of spatial constraints on worker ergonomics. The confined nature of these sites often necessitates awkward working positions and repetitive movements, potentially increasing the risk of strain and musculoskeletal disorders among construction workers. The study revealed that impacts from falling objects affected 54.3% of workers, a finding that corresponds with Olutuase's (2014) research on material handling risks. In confined construction environments, this risk appears to be amplified due to limited storage space and restricted movement paths. The data suggests that compression injuries (47.1%) and equipment-

related accidents (37.1%) represent significant secondary risks, likely worsened by the spatial limitations of confined sites.

A notable finding was the relatively lower incidence of falls from elevations (12.9%) compared to other hazards. This contrasts with some previous studies but may reflect the implementation of more stringent safety measures for elevated work in confined spaces. Less frequent but still concerning were incidents of electric shocks (5.7%) and combustion events (1.4%), suggesting that while these risks are present, they may be better controlled in confined construction environments. The findings extend our understanding of construction safety by highlighting how spatial constraints create distinct risk profiles. As Atubi (2015) observed in the Niger Delta region, construction sites face various environmental and operational challenges. Our research suggests that confined spaces introduce additional complexities to these challenges, particularly in terms of movement patterns and material handling. This analysis contributes to the growing body of literature on construction safety in urban environments, where confined construction sites are becoming increasingly common due to spatial limitations in developing cities. Table 3 shows the ratings of how confined construction sites conditions affect health and safety outcomes.

Table 3: Confined Construction Site Conditions

Confined Construction Site Conditions	Mean	SD
Limited access routes and exit routes on the site increase safety concerns	4.23	0.67
Space limitation on our construction site increases safety risks.	4.12	0.73
Lack material storage space increases safety concerns.	4.10	0.71
Poor lighting due to confined space makes it difficult to work safely.	3.95	0.88
Ventilation issues associated with confined site negatively increases safety concerns.	3.85	0.82

Source: Researcher's Analysis, 2024

The analysis of confined construction sites revealed several significant safety challenges through descriptive statistics. Limited access and exit routes emerged as the primary concern, achieving the highest mean score. This strong agreement among respondents aligns with Thompson's (2022) findings on construction logistics, where restricted access points were found to significantly impair both routine operations and emergency response capabilities. The low standard deviation indicates consistent recognition of this challenge across different construction sites. Space limitations represented another critical concern which reflects the substantial challenges workers face in maneuvering within confined environments. This finding corresponds with Wang *et al.*'s (2023) research, which documented a 40% increase in near-miss incidents in spatially constrained construction projects. The lack of material storage space closely followed as a significant concern, indicating how spatial constraints affect not only movement but also material management practices. Poor lighting conditions and ventilation issues were also identified as substantial safety concerns. The relatively higher standard deviations for these factors suggest more varied experiences across different sites, possibly due to differences in site configurations and management approaches. These findings support Kim and Martinez's (2023) research on the relationship between environmental conditions and worker safety in confined spaces. A regression analysis was conducted to further assess the relationship between confined site conditions and health and safety outcomes. The results are presented in table 4 below.

Table 4: R-squared value

Statistic	Value
R-Squared	0.722
Adjusted R-Squared	0.701
F-Statistic	37.45
Significance	0.000

Source: Researcher's Analysis, 2024

The model demonstrated strong explanatory power with an R-squared value of 0.722, indicating that the identified confined site conditions explain 72.2% of the variation in accident frequency. Table 5 below shows the regression coefficients for each predictor which further provides insight into their influence on health and safety.

Table 5: Regression Co-efficients

Predictor Variable	Coefficient (B)	Standard Error	t-Value	p-Value
Constant	0.665	0.304	2.19	0.032
Space Limitation	0.452	0.105	4.30	0.000
Ventilation	0.398	0.121	3.29	0.002

Access Routes	0.373	0.109	3.42	0.001
Lighting	0.230	0.115	2.00	0.048
Material Storage	0.192	0.117	1.64	0.107

Source: Researcher's Analysis, 2024

The regression coefficients revealed space limitation as the strongest predictor of safety incidents, suggesting that restricted space significantly increases the likelihood of accidents. This finding provides statistical validation for the descriptive results and supports Chen *et al.*'s (2023) research on spatial constraints in construction safety. Ventilation emerged as the second most influential factor, followed by access routes. These statistical relationships demonstrate how environmental conditions in confined sites significantly affect safety outcomes. The analysis showed a moderate impact of lighting conditions, while material storage had the weakest influence among the factors studied. The regression results particularly reinforce Rodriguez and Smith's (2023) findings about the compounding effects of multiple spatial constraints on safety outcomes. The strong statistical significance of space limitation, ventilation, and access routes suggests these factors should be prioritized in safety management strategies for confined construction sites. The hierarchical importance of these factors, as revealed by the regression analysis, provides empirical evidence for focusing safety interventions on the most critical aspects of confined construction environments.

4. Conclusions

This research on the impact of confined construction sites on project team health and safety in Port Harcourt has revealed significant insights into the challenges and risks faced by construction professionals in confined construction sites. The study's findings, drawn from a diverse group of construction professionals including project managers, structural engineers, and safety officers, demonstrates the complex relationship between confined site conditions and safety outcomes. The research demonstrates that spatial constraints significantly influence safety conditions in confined construction sites. The study found that limited access and exit routes represent the most pressing safety concern, indicating strong agreement among respondents about this risk factor. This was closely followed by restricted movement space, and limited material storage capacity, forming a trio of critical spatial challenges that directly impact worker safety. Statistical analysis through regression analysis revealed that site conditions explain 72.2% of the variation in accident frequency, with space limitation emerging as the strongest predictor, The significance of ventilation, and access routes in predicting safety outcomes emphasizes the complex nature of safety challenges in confined construction environments. These findings align with contemporary research in urban construction safety, particularly regarding the relationship between spatial constraints and accident rates. Based on these findings, several practical recommendations emerge for improving safety in confined construction sites. Construction managers should prioritize the development of detailed site layout plans that maximize the use of limited space while maintaining clear access routes. This should include the implementation of advanced logistics systems for material delivery and storage, reducing on-site congestion. The strong correlation between ventilation issues and safety risks suggests the need for enhanced ventilation systems, particularly in deeply confined areas where natural airflow is limited. For policy development, the findings support the need for specialized regulations addressing confined construction sites. These should include minimum space requirements for different construction activities, mandatory ventilation standards, and specific emergency response protocols adapted to restricted environments. The high educational qualification of the study participants, with 85.7% holding bachelor's degrees or higher, suggests that the industry has the technical capacity to implement more sophisticated safety protocols. The construction industry in Port Harcourt would benefit from the establishment of a comprehensive training program focusing specifically on confined site safety management. This should incorporate both technical skills for working in restricted spaces and emergency response procedures tailored to confined environments. The experience profile of the respondents, with 40% having 5-10 years of experience, indicates a workforce that could readily adapt to enhanced safety protocols.

Looking forward, several areas warrant further research attention. There is a need to investigate the long-term health impacts of working in confined construction environments, particularly regarding respiratory health given the ventilation concerns identified. Future studies should also explore the application of emerging technologies in monitoring and managing safety in confined sites. The economic implications of implementing enhanced safety measures in confined sites deserve investigation, particularly in the context of developing economies like Nigeria. Additionally, research is needed to understand how cultural and organizational factors specific to Port Harcourt influence safety practices in confined construction environments. This could include examining the relationship between traditional construction practices and modern safety requirements, as well as investigating how local organizational structures affect safety implementation.

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