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FIRE SAFETY IN MARKET ARCHITECTURE: A CASE STUDY OF KARU MODERN MARKET, ABUJA, NIGERIA

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Abstract
Market fire disasters in Nigeria continue to pose serious risks to lives, property, and economic stability, largely due to weak safety infrastructure, poor enforcement of building codes, and low user preparedness. The Modern Market in Karu, Abuja, exemplifies these vulnerabilities, where inadequate escape routes, absence of suppression systems, and poor accessibility for firefighting increase susceptibility to catastrophic outbreaks. This study examines the effectiveness of incorporating fire safety design measures in the market's development. Specifically, it assesses awareness and compliance among shop users, identifies essential fire safety features, and explores the challenges of implementation. A mixed-method approach using surveys and field observations was adopted. Findings reveal low awareness of fire safety practices, poor compliance with existing measures, and critical infrastructural gaps. Market users emphasized the need for fire-resistant materials, smoke management systems, and regular safety drills. Challenges include weak enforcement of standards, inadequate training, and poor equipment maintenance. The study concludes that deliberate integration of fire safety design measures is crucial to enhance resilience, safeguard livelihoods, and contribute to sustainable urban development.

Keywords: *Fire disaster, Fire safety, Market, Modern market, Nigeria*

1.0 INTRODUCTION

Fire disasters remain a global challenge, causing extensive human, infrastructural, and economic losses (Mathew et al., 2025). Markets are particularly vulnerable due to overcrowding, clustered combustible goods, and extensive electrical installations (Sholanke et al., 2025). In Nigeria, such incidents have become alarmingly frequent, leading to displacement of traders, loss of livelihoods, and disruption of local economies. Beyond immediate destruction, market fires also contribute to environmental hazards through toxic emissions and waste, underscoring the need for proactive safety strategies in market development (Oluwole et al., 2022).

Despite advances in fire safety standards, many Nigerian markets lack essential safety infrastructure such as smoke detectors, suppression systems, escape routes, and fire-resistant materials (Alabi et al., 2022; Agbili et al., 2024). Weak enforcement of building codes, overcrowded layouts, and poor access for firefighting services further heighten risks. The Ultra-Modern Market in Karu, Abuja, reflects these vulnerabilities, with deficiencies in fire safety integration that make it highly susceptible to catastrophic outbreaks, similar to those recorded in Lagos' Balogun Market and Kano's Sabon Gari Market.

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Compounding these infrastructural gaps is the limited fire safety awareness among traders and market users. Many lack training on electrical safety and handling of flammable goods, while safety equipment, where available, is poorly maintained or underutilized (Elenwo et al., 2019). These weaknesses reduce market resilience and highlight the systemic neglect of fire safety measures in market design.

This situation underscores the problem: Nigerian markets, including the Modern Market in Karu, remain highly vulnerable to fire disasters due to inadequate infrastructure, poor compliance, and low awareness. Such deficiencies not only endanger lives and property but also undermine broader sustainability objectives, particularly SDG 11 (Sustainable Cities and Communities) and SDG 3 (Good Health and Well-being) (United Nations, 2023).

Addressing these challenges requires deliberate incorporation of fire safety design measures to safeguard livelihoods and strengthen socio-economic resilience. Given these concerns, this study aims to examine the effectiveness of incorporating fire safety design measures in the development of the Modern Market in Karu, Abuja, Nigeria. Specifically, the study seeks to: (1) assess the level of awareness and compliance with fire safety design measures among different categories of market shop users, (2) identify key fire safety design features considered essential by market users for inclusion in the proposed ultramodern market and (3) examine the challenges associated with implementing fire safety design measures in the context of the ultramodern market in Karu, Abuja.

Through this study, the Modern Market can serve as a model for integrating fire safety into market design in Nigeria, offering valuable lessons for enhancing resilience, safeguarding livelihoods, and aligning with global best practices in fire safety.

1.1 The Nigerian National Building Code (2006)

The Nigerian National Building Code, 31 which is responsible for establishing standard building criteria, has significantly addressed aspects of building design and construction-related fire safety and protection. It was emphasized that materials with weak fire resistance, such as timber, should be adequately treated to substantially minimize the rate of combustion. As stated in Section 5.3.5, reinforced concrete and steel should constitute the main materials used for staircase construction, with non-combustible materials as the tread and riser finishes. Section 5.3.7 indicates that automatic sprinkler systems should be installed in buildings with a height above 22.5 m. Smoke detectors connected to an alarm system should also be provided to ensure that users are aware and kept safe in case of an emergency.31 The alarm system installed should have a backup in case of an unexpected breakdown so as not to depreciate the functionality of the fire alarm systems.

2.0 LITERATURE REVIEW

2.1 Fire Safety Vulnerabilities in Nigerian Markets

Studies highlight recurrent fire disasters in Nigerian markets due to poor infrastructure, weak regulation, and lack of preparedness (Okwuonu et al., 2022; Isah et al., 2023; Oluwunmi, 2023). For instance, markets often feature overcrowded stalls, obstructed emergency access, and inadequate water sources all of which

severely impede fire fighting efforts and worsen outcomes. In Lagos, regulatory failures especially illegal wiring and blocked pathways were directly linked to numerous fire incidents. These findings underscore the structural and regulatory risks facing markets like Karu's.

2.2 Passive Fire Safety & Market Design

Passive fire safety measures such as fire-resistant materials, clear escape routes, smoke vents, and compartmentalization are critical yet frequently underutilized in Nigerian markets (Alom et al., 2023; Obida & Aminu, 2023; Sholanke et al., 2025). A design-focused study in Benin City identified that most markets lacked these passive measures, recommending their integration into modern market design for sustainable protection.

Similarly, research in Garki Model Market (Abuja) documented deficiencies including narrow exits, lack of signage, and no emergency access routes, and proposed detailed design guidelines (e.g., adequate exit width, smoke vents, spacing between buildings) to enhance fire preparedness.

2.3 Challenges in Implementing Fire Safety Measures

Multiple studies attribute implementation gaps to several factors: financial constraints, weak enforcement, and low stakeholder awareness. In Awka, lack of enforcement, limited funds, and poor training were identified as key barriers to fire safety in commercial buildings. In higher institutions in the Niger-Delta, aged electrical systems and insufficient fire risk budgets posed major challenges. These align closely with challenges likely to be faced in Karu's ultramodern market context.

2.4 Theoretical Framework

This study is anchored on **Layers of Protection Analysis (LOPA)** and **Effective Fire Safety Management Framework**, both of which provide the conceptual foundation for examining the effectiveness of incorporating fire safety design measures in the development of the Ultra-Modern Market in Karu, Abuja.

2.4.1 Layers of Protection Analysis (LOPA)

LOPA provides a structured method for assessing potential fire hazards by identifying initiating events, estimating their frequency, and evaluating the effectiveness of independent protection layers such as passive design features, active suppression systems, and human interventions (Center for Chemical Process Safety [CCPS], 2018; Khan & Amyotte, 2019). This ensures that multiple, redundant barriers are considered in mitigating fire risks within the market context (Figure 1)

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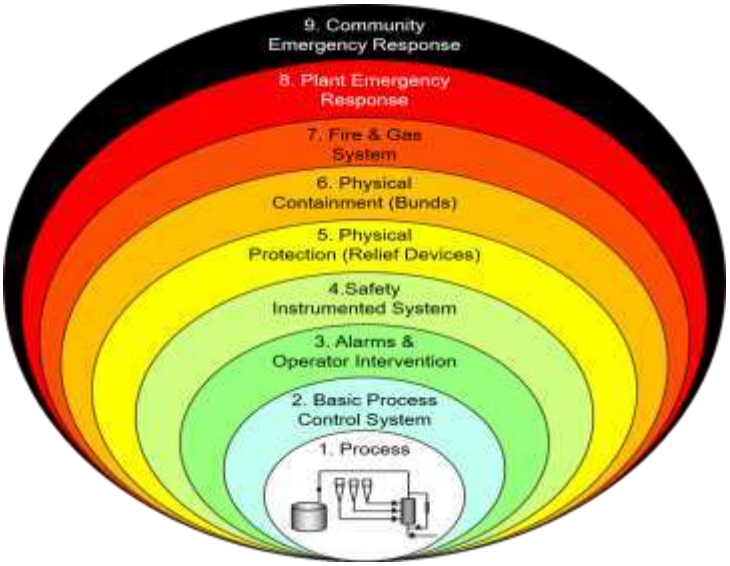

Figure 1: Layers of Protection Analysis (LOPA) Model
Source: Adapted from CCPS, (2001)

2.4.2 Effective Fire Safety Management Framework

The EFSMF emphasizes the integration of preventive measures, preparedness and awareness, infrastructure and design, alongside regulation and enforcement. It highlights that effective fire safety extends beyond technical controls to include socio-technical factors such as user training, maintenance culture, policy enforcement, and stakeholder participation (Abunyewah et al., 2023; Alabi et al., 2022). While LOPA focuses on hazard quantification and layered technical protections, the EFSMF broadens the scope by embedding these measures within a holistic management system that enhances resilience (Figure 2).

Figure 2: Effective Fire Safety Management Framework Source: (Oladokun & Emmanuel, 2019).

Together, these frameworks provide a comprehensive approach to examining the effectiveness of incorporating fire safety design measures. In the case of Kaur's UltraModern Market, LOPA ensures that critical fire risks are systematically identified and layered protections embedded, while the EFSMF ensures

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that these protections are supported by institutional policies, user awareness, and regulatory compliance. The synergy of both frameworks strengthens resilience, minimizes vulnerabilities, and enhances the sustainability of the market's fire safety strategy.

3.0 METHODOLOGY

This section describes the methodology used in this study. It describes the study location, the study area and methods chosen for this study.

3.1 The Study Area: Abuja

Abuja is the study area located in the central part of Nigeria north of the confluence of the Niger and Benue Rivers. This city lies between the latitude of 8°25`N to 9°25`N and longitude 6°45`E to 7°45`E and has a land area of 8000 km^2 which makes it almost two and a half times the size of Lagos State. It is bounded by Kaduna State to the North, Kogi State to the south, and Niger State to the West and Nasarawa State to the East (Isma'il, & Abubakar, 2024). Abuja has a population of about 8 million as projected from 2006 National Population Commission Census (NPC, 2019) (Figure 2).

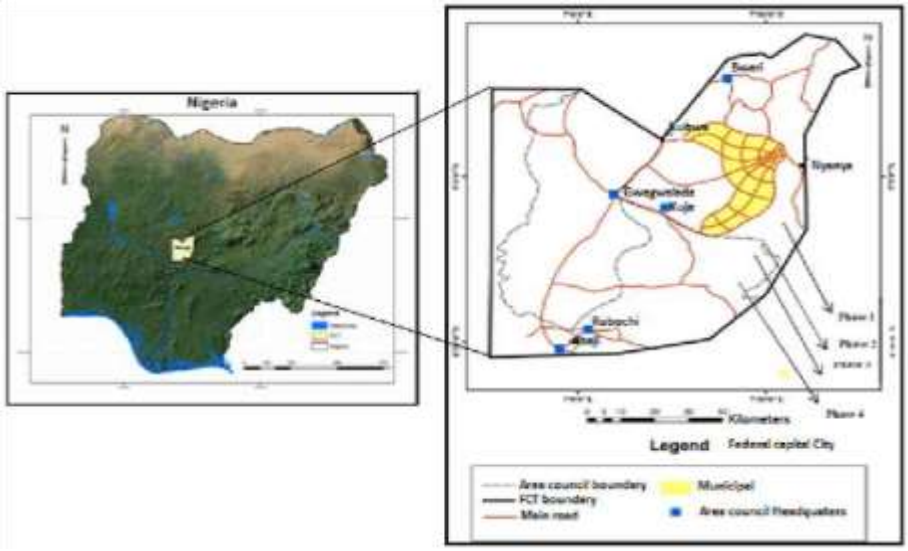

Figure 2: Map of Abuja in National context Source: Adopted from Noma, et al., (2022).

3.2 Research Design

This study adopts a mixed-method research design, combining both quantitative and qualitative approaches to provide a comprehensive understanding of fire safety design measures in the Modern Market at Karu, Abuja. This design ensures triangulation of data, thereby improving the reliability and validity of findings.

3.3 Population and Sample

The target population for this study comprises all users of the proposed Ultra-Modern Market in Karu, Abuja. This includes traders occupying 1,405 lock-up shops of varying sizes as well as open market stall operators. These groups represent the core stakeholders whose opinions and experiences are essential in evaluating awareness and compliance with fire safety design measures.

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In addition to traders, expert respondents including architects and fire safety officials were considered as part of the population. Their inclusion provides professional insights into technical aspects of fire safety design, potential implementation barriers, and the cost implications of adopting international best practices within the Nigerian context.

3.4 Sample Size

The sample size for this study was calculated using the Taro Yamane's formula (1967) for sample size was used. The formula is expressed below:

n = N / [1 + N (e) ^2] - - - Equation 1 Where:

n = sample size

N = population size (1,405)

e = margin of error (typically 0.05 for 95% confidence level) n =1,405 / [1 + 1,405(0.05) ^2] n = 1,405 / [1 + 1,405(0.0025)]

n = 1,405/ (4.5125)

n ≈ 311.35

3.5 Sampling Technique

The study employed a proportional stratified random sampling technique to guarantee fair representation of the different categories of market users. This method ensured that traders in small, medium, and large lock-up shops, as well as open market stalls, were proportionately represented in the survey (Table 1).

Table 1: Proportional Sample Distribution for Questionnaire Survey

Category	**Population (N_i)**	**Sample Size (n_i)**
Small Lock-up Shops	750	166
Medium Lock-up Shops	400	89
Large Lock-up Shops	150	33
Open Market Stalls	105	23
Total	**1,405**	**311**

Source: Field work, 2025.

In addition, purposive sampling was employed to select architects and fire safety officials for the qualitative strand of the study. This was necessary to ensure the inclusion of experts with relevant knowledge and professional experience in fire safety design.

3.6 Method of Data Analysis

Quantitative data obtained from the questionnaires were coded and analyzed using the Statistical Package for the Social Sciences (SPSS)**.** Descriptive statistics such as frequencies, percentages, and mean scores were employed to present awareness levels, compliance rates, and perceived importance of fire safety design features. Inferential statistics, such as chisquare tests, were used to examine relationships between demographic factors and fire safety awareness.

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Qualitative data from interviews were analyzed thematically. Responses were transcribed, categorized, and interpreted to identify recurring themes and insights on challenges, costs, and best practices in fire safety design. The integration of quantitative and qualitative results enabled a holistic interpretation of findings in line with the study objectives.

4.0 RESULTS AND DISCUSSION

This section presents the results obtained from the 311 questionnaire responses distributed across various categories of market users in the proposed Ultramodern Market, Karu, Abuja.

4.1 Objective 1: Awareness and Compliance with Fire Safety Design Measures Results presented in Table 2 reveal that while a significant proportion of market users (68.8%) indicated awareness of fire safety regulations, only 41.5% had received any form of fire safety training. This finding suggests a gap between knowledge of fire safety requirements and practical preparedness among market users.

In terms of facility availability, 55.0% of respondents reported knowing the location of the nearest fire escape. However, only 37.9% confirmed the presence of fire extinguishers in their trading environment, while 45.7% indicated there were none, and 16.4% were unsure. This uncertainty highlights deficiencies not only in the provision of firefighting equipment but also in their visibility, accessibility, and maintenance.

Table 2: Awareness and Compliance with Fire Safety Measures (n = 311)

Response Item	Yes (n)	Yes (%)	No (n)	No (%)	Not Sure (n)	Not Sure (%)
Awareness of fire safety regulations	214	68.8%	97	31.2%	–	–
Received fire safety training	129	41.5%	182	58.5%	–	–
Availability of fire extinguisher	118	37.9%	142	45.7%	51	16.4%
Knows nearest fire escape	171	55.0%	140	45.0%	–	–

Source: Field work, 2025.

These findings corroborate previous studies (Abunyewah et al., 2023; Alabi et al., 2022), which revealed that limited training and inadequate fire safety facilities are among the major contributors to fire disasters in Nigerian markets. The results suggest that while awareness exists at a conceptual level, actual compliance and preparedness are insufficient, underscoring the urgent need for structured fire safety training and improved access to firefighting equipment.

4.2 Objective 2: Preferred Fire Safety Design Features for the Proposed Market To identify priority fire safety features for integration into the proposed Ultra-Modern Market, respondents were asked to indicate preferred facilities (Table 3). Fire extinguishers (77.2%) and fire exits (71.7%) ranked highest, reflecting the users' preference for immediate fire fighting tools and safe evacuation routes. Other important features

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included fire alarms (61.1%), designated assembly points (53.1%), fire service posts (48.9%), and sprinkler systems (40.5%).

Table 3: Preferred Fire Safety Design Features (Multiple Responses Allowed, n = 311)

Fire Safety Feature	Frequency Selected	Percentage (%)
Fire extinguishers	240	77.2%
Fire exits	223	71.7%
Fire alarms	190	61.1%
Assembly points	165	53.1%
Fire service post	152	48.9%
Water sprinklers	126	40.5%

Source: Field work, 2025.

Further analysis revealed strong support for clearly marked fire exits, with 70.1% rating them as "very important," and 26.4% considering them "important." Only 3.5% of respondents did not consider them essential (Table 4).

Table 4: Importance of Clearly Marked Fire Exits (n = 311)

Response	Frequency (n)	Percentage (%)
Very Important	218	70.1%
Important	82	26.4%
Not Important	11	3.5%

Source: Field work, 2025.

In addition, a majority (66.2%) supported the establishment of an emergency response team within the facility (Table 5). This reflects market users' recognition of the importance of proactive management in handling fire-related emergencies.

Table 5: Opinion on Emergency Response Team (n = 311)

Response	Frequency (n)	Percentage (%)
Yes	206	66.2%
No	72	23.2%
Indifferent	33	10.6%

Source: Field work, 2025.

The results demonstrate that market users desire a holistic fire safety framework— spanning preventive equipment (extinguishers, sprinklers), emergency infrastructure (alarms, exits, assembly points), and management structures (response teams). These findings align with international best practices such as BS 9999:2017, which emphasizes a combination of active and passive fire protection systems.

4.3 Objective 3: Challenges Associated with Implementing Fire Safety Design Measures

While awareness of essential fire safety features is evident, several challenges hinder their effective implementation in Nigerian markets, particularly in Karu. Data from expert interviews with architects and fire safety officials revealed the following key barriers:

1. High Cost of Fire Safety Infrastructure: Fire-resistant materials, automated sprinklers, and smoke management systems are often considered expensive by developers, leading to minimal or no investment in such facilities.
2. Weak Regulatory Enforcement: Although fire safety standards exist, enforcement is often inconsistent, allowing markets to operate without adequate provisions.
3. Space and Design Constraints: Congested market layouts limit the feasibility of installing wide escape routes and assembly points.
4. Low Awareness and Training Gaps: Traders often lack knowledge of proper equipment use and emergency protocols, reducing the effectiveness of available facilities.
5. Poor Maintenance Culture: Even where fire extinguishers and alarms are installed, they are rarely serviced or tested, rendering them ineffective during emergencies.

These findings are consistent with previous literature (Elenwo et al., 2019; Nouban & Yunusa, 2020), which identified weak policy enforcement and limited investment in safety infrastructure as critical challenges in fire safety implementation across Nigerian markets.

4.4 Discussion

The results reveal three major insights. First, there is a knowledge practice gap: while many respondents are aware of fire safety concepts, far fewer have received training or complied with safety practices, leaving the market vulnerable. Second, there is a clear demand for integrated fire safety infrastructure**:** respondents prioritize extinguishers, fire exits, alarms, and emergency response systems, which are consistent with international fire safety standards. Third, significant structural and systemic challenges particularly cost, weak enforcement, and poor maintenance remain formidable barriers to achieving fire-resilient markets in Nigeria.

Taken together, these findings highlight the urgent need for a comprehensive fire safety framework that goes beyond awareness to enforce compliance, provide adequate infrastructure, and promote sustainable maintenance practices. For the proposed UltraModern Market in Karu, integrating these measures will not only safeguard lives and property but also sustain the market's economic viability in the face of fire risks.

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5.0 CONCLUSION

The study showed that while market users are largely aware of fire safety regulations (68.8%), actual preparedness remains low, with limited training and inadequate availability of extinguishers and escape routes. Users prioritized fire extinguishers, exits, alarms, and clearly marked escape points as essential features, alongside support for an emergency response team. These findings highlight the need for both user training and robust fire safety infrastructure in the proposed ultramodern market.

6.0 RECOMMENDATIONS

Based on the findings of this study, the following recommendations are put forward:

A. Recommendations for Government and Policy Makers

i. The government should provide fire safety awareness campaigns on compliance with fire safety codes to shop owners and traders in markets.

ii. Fire safety education should combine theory with practical training, such as operating fire extinguishers, to equip individuals for effective fire response.

iii. A notice board displaying key fire hazards, impacts, safety facts, and response procedures is recommended in market places. iv. Only certified professionals should handle electrical wiring in markets, with regular inspections to detect and correct faults.

B. Recommendations for the Built Environment Professionals

i. This study's findings offer insights to guide built environment development, promoting safety, resilience, inclusivity, and sustainability in line with SDG 11.

ii. Building professionals, regulators, and business owners should prioritize effective fire safety management in commercial facility development.

7.0 CONTRIBUTIONS TO KNOWLEDGE

This study contributes to existing body of knowledge by:

1. Providing empirical data on fire safety awareness and preferences in Nigerian markets.
2. Proposing a user-driven framework for integrating fire safety measures in market design.
3. Highlighting the gap between awareness and compliance, pointing to the need for combined infrastructural and behavioral strategies.

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