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Development Pattern of Minna Traditional Core Area and its Vulnerability to Fire Hazards

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Fire hazards pose significant threats to urban sustainability in rapidly developing cities, particularly in densely populated core areas with inadequate infrastructure and weak regulatory enforcement. Globally, rapid and largely unplanned urban growth has emerged as one of the defining challenges of the twenty-first century, and nowhere is this more acute than in sub-Saharan Africa, where cities are expanding at rates that consistently outpace infrastructural capacity and regulatory oversight. Within such contexts, fire hazards have come to represent not merely isolated incidents, but systemic expressions of deeper structural vulnerabilities embedded in the urban fabric. This study assessed the development pattern and fire vulnerability of Minna traditional core area, comprising five neighbourhoods: Keteren Gwari, Kwangila, Makera, Limawa, and Sabon Gari. Primary data were collected through structured questionnaires administered to 374 respondents, field observations, and secondary data from Niger State Fire Service records spanning 2021 to 2024. A Composite Fire Vulnerability Index incorporating urban structural variables, fire incidence patterns, and community preparedness indicators was developed and spatially mapped using ArcGIS 10.8. Findings reveal that Sabon Gari emerged as the most vulnerable area, with 74.7% of residents experiencing more than three fire incidents, 81.9% of buildings extremely congested with minimal spacing, and 68.7% of residents unaware of fire safety practices. Electrical faults accounted for over 41% of fire incidents across all neighbourhoods, whilst 91.6% of households in Sabon Gari lacked basic firefighting equipment. The vulnerability map classified Sabon Gari, Limawa, and Keteren Gwari as high-risk zones requiring immediate intervention. The study concludes that fire vulnerability is systematically embedded in the physical structure, behavioural patterns, and institutional failures of the urban system. Key recommendations include enforcement of building codes in high-density areas, quarterly fire safety inspections, community-based public awareness programmes, subsidised provision of firefighting equipment, and integration of the vulnerability map into land use planning and disaster risk reduction strategies.
Keywords: Urban structure, fire hazards, vulnerability assessment, spatial mapping, disaster risk management

Introduction

Urban fire hazards represent one of the most persistent and devastating threats to sustainable development in rapidly urbanising cities across the developing world. Across the globe, development patterns in cities of the Global South have undergone profound transformation over the past five decades (Wamukoya & Muindi, 2025). The convergence of rural-urban migration, population growth, and economic restructuring has produced dense, heterogeneous urban forms in which residential, commercial, and artisanal functions coexist often without adequate spatial planning or regulatory mediation. Such mixed-use, high-density settlements are well-documented as environments of heightened hazard exposure, where fire in particular emerges as a recurring consequence of inadequate infrastructure, substandard construction materials, and limited institutional oversight (Wai *et al*., 2026; Baquedano-Juliá *et al*., 2025). The National Aeronautics and Space Administration reported in 2024 that fire incidents occur continuously across the Earth's surface, with developing regions bearing disproportionate impacts due to inadequate infrastructure, weak regulatory frameworks, and limited emergency response capacity (Firms, 2022). Fire disasters in urban environments result in significant economic losses, property destruction, displacement of populations, and loss of human lives, particularly in informal settlements characterised by high building density, use of flammable construction materials, and poor access to emergency services (Afrin *et al*., 2026).

The vulnerability of urban structures to fire hazards is influenced by a complex interplay of factors including building materials, population density, land use patterns, accessibility to fire services, climate conditions, and enforcement of safety regulations (Baquedano-Juliá *et al*., 2025). The relationship between development patterns and fire vulnerability warrants particular scrutiny. Where urbanisation proceeds without adequate zoning controls, buildings of mixed combustibility cluster without sufficient spacing, access routes narrow with informal encroachment, and electrical systems operate well beyond their designed capacity. These are not incidental failings they are structural conditions that systematically amplify fire risk across entire urban areas (Thandar *et al*., 2025; Ogunbode & Olutola, 2023). In developing nations such as Nigeria, these vulnerabilities are amplified by rapid urbanisation that outpaces infrastructural development, resulting in unplanned settlements with minimal compliance with building codes and fire safety standards. Studies suggest that Nigeria records approximately 2,000 fire incidents annually, with over 70% occurring in urban areas where poor construction quality, overcrowding, and lax enforcement of fire safety regulations create highly combustible environments (Oloke *et al*., 2022). Nigeria experiences urban growth at an annual rate of 4.3%, among the highest globally, contributing to the proliferation of densely populated urban centres with inadequate planning and safety infrastructure (Idowu, 2013). This rapid urbanisation has led to the emergence of mixed-use neighbourhoods characterised by the coexistence of residential, commercial, and artisanal activities within congested spaces lacking proper zoning controls. The fire risk implications of such mixed-use, high-density patterns are well established in international literature. Research in Mandalay, Myanmar, for instance, found that historic precinct areas characterised by dense, mixed-use development exhibited markedly higher fire incident rates than planned residential zones, underscoring the significance of urban form as a determinant of fire propagation potential (Wai *et al*., 2026). Comparable patterns have been documented in Dhaka, Jakarta, and Nairobi, where the intersection of informality, high density, and flammable materials creates conditions for rapid and destructive fire spread (Islam & Şahin, 2023). Such conditions create multiple ignition sources including electrical faults, cooking activities, and open flames in proximity to flammable materials, significantly increasing fire propagation risks (Kumar *et al*., 2022; Geyer, 2024). International evidence from cities such as Dhaka, Bangladesh, where 60% of buildings were found non-compliant with fire safety standards, demonstrates the catastrophic consequences of inadequate fire risk management in rapidly urbanising contexts (Islam & Şahin, 2023).

In Minna, the capital city of Niger State, core neighbourhoods including Keteren Gwari, Kwangila, Makera, Limawa, and Sabon Gari exemplify these vulnerabilities through their unplanned development patterns, high population density, and widespread use of flammable materials such as wood and corrugated iron sheets. Historical fire incidents in the area, including the 2020 Kure Market fire that destroyed over 50 shops and the 2019 Sabon Gari residential fire that displaced multiple families, underscore the urgent need for systematic fire vulnerability assessment (Abdullahi *et al*., 2023). Despite these recurring incidents, there exists a critical gap in comprehensive, data-driven evaluation that identifies high-risk zones based on integrated structural, infrastructural, and behavioural factors.

Whilst Idowu and Musa (2008) provided foundational insights into Minna's urban structures and fire hazard exposure, that study was conducted over a decade and a half ago, prior to significant phases of urban expansion. The urban landscape has since changed considerably; population density has increased, commercial activity has intensified, and infrastructure has continued to deteriorate. More recent studies such as Shittu *et al*. (2022) and Oloke *et al*. (2021) examined fire risk dimensions in Minna and comparable Nigerian cities, yet a spatially explicit, multi-dimensional vulnerability assessment that integrates structural, behavioural, and institutional factors remains absent from the literature. This gap is not merely academic it has direct consequences for emergency planning, urban governance, and community resilience.

Recurrent fire incidents in Minna core area highlight a critical deficiency in urban fire risk management. Whilst anecdotal evidence and emergency response reports confirm the severity of the problem, there exists no systematic, spatially explicit evaluation that identifies high-risk zones based on comprehensive integration of structural characteristics, historical fire patterns, infrastructural capacity, and community preparedness levels. Existing studies provide partial insights but lack the spatial resolution and multi-dimensional assessment framework necessary for targeted intervention planning (Shittu *et al*., 2022; Oloke *et al*., 2021). Without a formal vulnerability index or GIS-based mapping system, planning authorities and emergency services operate reactively rather than proactively, responding to fire incidents after occurrence rather than preventing them through evidence-based risk reduction strategies.

This knowledge gap impedes effective resource allocation, urban planning interventions, and community preparedness programmes. The absence of empirical data on neighbourhood-level variations in fire vulnerability means that policy responses remain generic and potentially ineffective, failing to address the specific risk factors that distinguish high-vulnerability zones from lower-risk areas. Furthermore, the interaction between urban form variables such as building density and spacing, material composition, and road accessibility and behavioural factors including awareness levels and equipment availability, remains insufficiently understood in the context of Minna's urban development trajectory. This study addresses these gaps by investigating how urban structural characteristics interact with human behaviour and infrastructure quality to create differential fire vulnerability across Minna's core neighbourhoods.

The aim of this study is to assess the pattern of development within Minna core area and its vulnerability to fire hazards with a view to developing a spatial vulnerability map for fire high-risk incidence areas. To achieve this aim, the study was guided by the following objectives: (1) to assess the urban development structure in Minna core area; (2) to examine the frequency and causes of fire incidence within Minna core area; (3) to evaluate the level of preparedness and fire risk awareness among residents of the area; and (4) to develop a vulnerability map identifying high-risk fire incidence zones.

Literature Review

This study is anchored in four interrelated theoretical frameworks that provide a comprehensive understanding of fire vulnerability in urban settings. The Pressure and Release (PAR) Model developed by Wisner *et al*. (2004) explained disasters as outcomes of converging pressures from root causes such as poverty and rapid urbanisation, through dynamic pressures including population growth and land speculation, culminating in unsafe conditions such as overcrowded housing and poor infrastructure. In the context of Minna, the absence of enforced zoning regulations and building codes creates unsafe environments where minor ignition sources can escalate into major fire disasters. This theoretical lens illuminates how historical patterns of urban development, characterised by speculative land use and minimal regulatory oversight, may systematically increase fire vulnerability across different neighbourhoods (Adelekan, 2022; Adiba. 2023).

The Protection Motivation Theory (PMT) originally proposed by Rogers (1975) provided crucial insights into individual and household-level responses to fire threats. This theory posits that protective action is determined by threat appraisal including perceived severity and vulnerability and coping appraisal, encompassing response efficacy and self-efficacy. Research applying PMT to urban fire contexts suggests that despite high awareness of fire risks, actual implementation of preventive measures tends to remain limited when residents perceive low personal capacity to respond effectively or when access to safety equipment is constrained by economic factors (Thandar et al., 2025). This framework helps explain the observed gap between risk awareness and preparedness action documented in multiple Nigerian urban contexts, where knowledge of fire hazards does not automatically translate into investment in safety equipment or adoption of preventive behaviours.

The Urban Risk Transition Theory, articulated by Cannon (2008) and further developed by subsequent scholars, links stages of urban development to evolving risk profiles. The theory suggests that rapidly urbanising cities pass through a transitional phase where economic growth and population expansion outpace infrastructure provision and regulatory capacity, creating heightened vulnerability to various hazards including fire (Marcotullio *et al*., 2003). Minna exemplifies this transitional stage, experiencing rapid commercial and residential expansion without commensurate investment in fire safety infrastructure, building code enforcement, or emergency response capacity. The theory suggests that fire risk is likely to continue escalating unless proactive interventions disrupt the trajectory of unplanned growth (Shi *et al*., 2025).

Finally, the Broken Windows Theory proposed by Wilson and Kelling (1982), whilst initially developed to explain crime patterns, has proven applicable to urban disaster risk analysis. The theory suggests that visible signs of disorder and neglect—cluttered streets, illegal structures, exposed electrical wiring, and poor maintenance—signal low levels of monitoring and enforcement, thereby encouraging further deterioration and risky behaviours. In Minna's core neighbourhoods, observable disorder including uncontrolled waste accumulation, unauthorised electrical connections, and encroachment onto access routes appears to correlate with inadequate fire safety practices and delayed incident reporting. This theoretical perspective underscores the importance of environmental cues in shaping community vigilance and institutional responsiveness (Christine, 2024).

Collectively, these theoretical frameworks support all four research objectives by linking macro-level urban processes with micro-level behaviours, justifying the integration of physical indicators—such as building spacing and material composition with behavioural variables including awareness and equipment ownership into a unified analytical framework. They provide the conceptual foundation for developing a Composite Fire Vulnerability Index that captures the multi-dimensional nature of fire risk.

Recent empirical studies on urban fire vulnerability demonstrate the complex interactions between physical environment, human behaviour, and institutional capacity. Shittu *et al*. (2022) conducted a comprehensive assessment of fire safety compliance in residential buildings within Minna, identifying electrical faults, cooking-related accidents, and inadequate safety equipment as primary risk factors. Their study revealed that despite moderate educational levels among residents, over 68% lacked basic fire extinguishers, and knowledge of emergency procedures remained critically low. However, their analysis did not incorporate spatial dimensions or develop neighbourhood-level vulnerability classifications, limiting its utility for targeted intervention planning. Furthermore, their study predated recent urban expansion and did not account for the increasing commercialisation of formerly residential zones, a trend that significantly alters fire risk profiles.

International research provides valuable comparative insights. Islam and Şahin (2023) examined fire vulnerability in Dhaka's informal settlements, demonstrating that non-compliance rates exceeding 60% for basic safety standards, combined with dense building patterns and narrow access routes, created catastrophic fire propagation potential. Their study employed Geographic Information Systems (GIS) to map vulnerability hotspots, integrating structural data with socio-economic indicators. Similarly, research in Cape Town's informal settlements by Pharoah (2012) highlighted how socio-spatial exclusion and limited access to safety resources shape disaster outcomes, revealing that fire vulnerability reflects not merely material conditions but also patterns of social marginalisation and institutional neglect. Viewed alongside the Minna context, these international examples underscore that the structural preconditions for devastating fire events are neither unique nor inevitable they are products of planning systems that have consistently prioritised growth over safety.

Mandalapu *et al*. (2024) advanced methodological approaches through their evaluation of fire vulnerability and emergency service accessibility in Austin, Texas, employing Principal Component Analysis and Enhanced Two-Step Floating Catchment Area methods to assess spatial accessibility. Their findings suggested that neighbourhoods with lower socio-economic status and reduced access to fire stations experienced disproportionately severe fire outcomes. Whilst their sophisticated analytical techniques offer valuable methodological insights, direct application to Nigerian contexts requires adaptation to account for different data availability, regulatory environments, and urban development patterns. The present study builds upon these methodological innovations whilst maintaining sensitivity to local contextual factors that shape fire vulnerability in Minna's specific urban environment.

Studies focusing on fire incidence patterns reveal consistent themes across diverse urban contexts. Oluwunmi (2023) analysed fire outbreaks across major Nigerian urban centres between 2010 and 2020, identifying electrical faults as the leading cause accounting for over 42% of incidents, followed by cooking-related accidents at 28%. Their research documented seasonal patterns with fire outbreaks peaking during dry harmattan months due to reduced humidity and increased use of open flames. However, their national-level analysis lacked the granularity necessary for neighbourhood-specific intervention planning in secondary cities such as Minna. The present study addresses this gap through focused examination of localised fire patterns within Minna's core area, combining official fire service records with community-reported incidents to capture the full spectrum of fire events including those not formally documented.

Research on community preparedness consistently reveals gaps between awareness and action. Ogbonna *et al*. (2015) surveyed 400 residents across five high-density areas in Port Harcourt, finding that whilst 88% recognised fire as a serious threat, only 18% possessed fire extinguishers and fewer than 10% had participated in fire drills. Their application of Protection Motivation Theory identified economic constraints, limited access to safety equipment, and absence of community-level training programmes as primary barriers to preparedness. Similar patterns emerged in Yunus' (2021) study of market traders in Kano Metropolis, where despite commercial activities generating substantial fire risk, preventive measures remained minimal due to cost considerations and weak enforcement. These studies collectively suggest that vulnerability reduction requires interventions addressing not only awareness deficits but also structural barriers limiting household and business-level investment in safety measures.

The present study synthesises insights from these diverse empirical investigations whilst advancing beyond previous work through development of a spatially explicit Composite Fire Vulnerability Index that integrates structural characteristics, historical fire patterns, infrastructural capacity, and community preparedness into a unified analytical framework. This comprehensive approach enables identification of specific neighbourhoods requiring prioritised intervention whilst providing empirical foundation for evidence-based urban planning and disaster risk management strategies tailored to Minna's particular circumstances.

Study Area

Minna, located at latitude 9°35'00.69"N and longitude 6°31'00.69"E, serves as the administrative and commercial capital of Niger State in North-Central Nigeria. The city occupies a transitional ecological zone between the Guinea savanna and Sudan savanna belts, with a tropical climate characterised by distinct wet and dry seasons. Temperatures range from approximately 22°C during the coolest months of July to September, rising to between 38°C and 42°C during the peak dry season months of February to April. Annual rainfall averages between 1,100 and 1,600 mm, concentrated between July and September, whilst the harmattan dry season, extending from October to March, brings relative humidity below 30%, significantly increasing fire danger through reduced moisture content of combustible materials and enhanced wind-driven spread potential (Dabul, 2025).

Minna has experienced rapid urbanisation over the past two decades, with population growth driven by rural-urban migration and its strategic position as a state capital. Based on the 2006 National Population Census, Minna recorded a population of approximately 350,000; current estimates, extrapolating observed growth rates, suggest the metropolitan population may now exceed 600,000, reflecting annual growth of approximately 3–4% (Dabul, 2025). The core area under investigation comprises five densely populated traditional neighbourhoods (see Figures 1 and 2): Sabon Gari, Limawa, Keteren Gwari, Makera, and Kwangila. These neighbourhoods collectively represent the historical commercial and residential heart of the city, characterised by mixed land use patterns, high building density, and informal development trajectories that predate contemporary urban planning interventions.

Sabon Gari functions as the primary commercial centre within Minna's core area, hosting major markets including Kure Market and serving as a hub for retail trade, artisanal activities, and small-scale manufacturing. The neighbourhood exhibits extreme building density with minimal spacing between structures, predominant use of mixed construction materials including wood and corrugated zinc sheets, and intensive commercial-residential integration. Limawa presents moderate density with a blend of residential and small-scale trading activities, while Keteren Gwari maintains predominantly residential character interspersed with commercial corridors along major thoroughfares. Makera is distinguished by high concentration of traders and artisans, particularly in metalworking and textile sectors, whilst Kwangila serves primarily as a transit zone with lower-intensity commercial and residential functions.

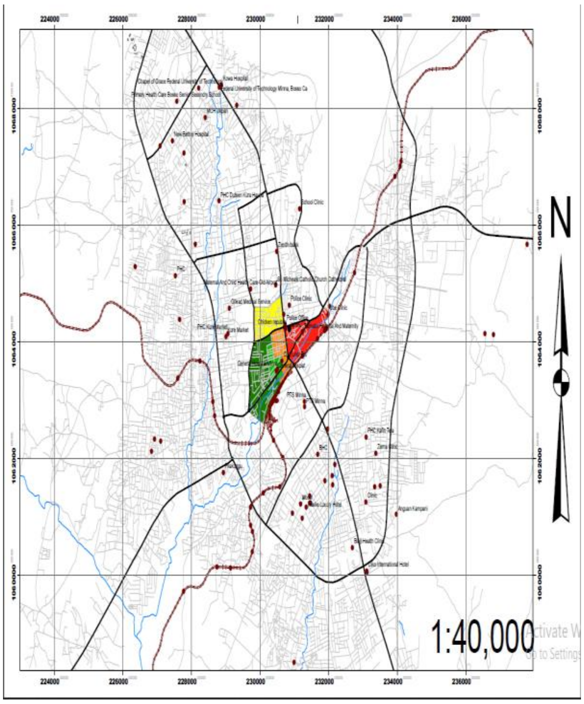


Figure 1: Minna Core Area in the Town Context

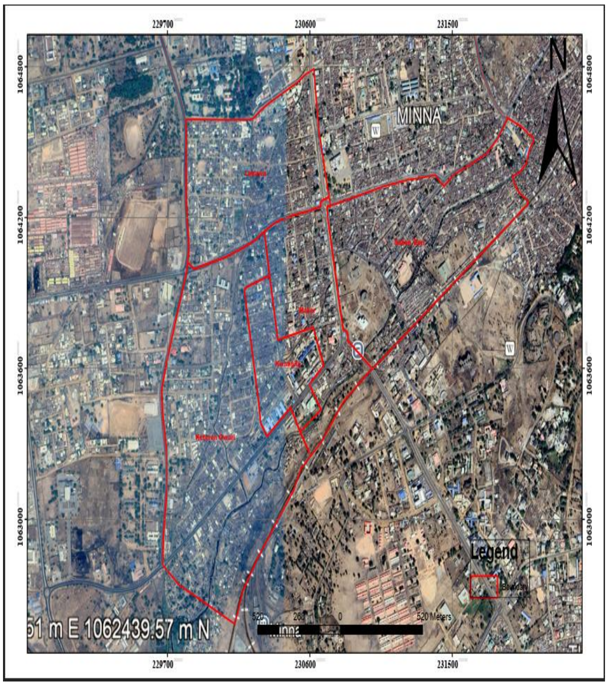


Figure 2: A Satellite imagery of Minna Core Area

Source: Google Earth Pro (retrieved December, 2024)

Infrastructure provision varies substantially across the study area. Road networks in older sections of Sabon Gari and Limawa consist primarily of narrow unpaved lanes, many of which have been encroached upon by commercial structures, severely limiting emergency vehicle access. Water supply relies on a combination of municipal distribution systems, private boreholes, and wells, with coverage and reliability varying significantly. Fire service provision is concentrated at a single station serving the entire metropolitan area, with response times to core neighbourhoods ranging from 15 to 45 minutes depending on traffic conditions, road quality, and time of day. The ecological conditions of the dry season interact with these infrastructural deficiencies in ways that amplify risk considerably. When harmattan winds blow across already congested neighbourhoods with high proportions of combustible building materials and minimal spacing, the potential for rapid fire propagation across building clusters is substantially elevated (Pakhira *et al*., 2025; Cicione *et al*., 2019).

Research Methodology

This study adopted a cross-sectional survey research design employing quantitative methods to assess fire vulnerability across Minna's core neighbourhoods. The adoption of a survey research design was informed by the need to systematically collect standardised data across a large and spatially distributed sample population, enabling reliable neighbourhood-level comparisons. Whilst purely observational approaches can yield valuable insights into built environment conditions, they are insufficient for capturing the behavioural and perceptual dimensions of vulnerability particularly preparedness levels and risk awareness that are central to this study's objectives. The integration of structured questionnaires with field observation and secondary data therefore reflects a deliberate methodological choice to triangulate across different data types, strengthening the validity of vulnerability assessments (Cutter *et al.*, 2012; Wisner *et al*., 2004). The research integrated primary data collection through structured questionnaires and systematic field observations with secondary data from official fire service records and satellite imagery. This multi-source approach enabled triangulation of findings and comprehensive characterisation of fire vulnerability dimensions spanning urban structure, incident patterns, and community preparedness.

The study population comprised all residential and commercial buildings within the five target neighbourhoods, totalling 5,723 structures based on field enumeration conducted in December 2024. Sample size was determined using Yamane's formula at 95% confidence level with a 5% margin of error, yielding a minimum required sample of 374 buildings. Proportional stratified random sampling was employed to ensure representation from each neighbourhood proportional to its building stock. Distribution was as follows: Keteren Gwari (119 buildings), Kwangila (21 buildings), Makera (71 buildings), Limawa (80 buildings), and Sabon Gari (83 buildings). Within each neighbourhood, systematic random sampling was applied, selecting every nth building along predetermined routes to minimise selection bias.

Primary data collection utilised structured questionnaires administered to building owners or occupants between January and February 2025. The questionnaire instrument captured socio-demographic characteristics, building structural attributes including construction materials and spacing, fire incident history, awareness of fire risks, knowledge of emergency procedures, and availability of firefighting equipment. Field observations were conducted across all five neighbourhoods, systematically documenting physical characteristics including building density patterns, road accessibility conditions, visible electrical infrastructure, and the spatial distribution of fire hazards such as fuel storage and waste accumulation. It is important to note that field observations were confined to externally visible and publicly accessible features; the study did not require or claim access to the interiors of private buildings to observe these conditions. Systematic photographic documentation was carried out during field surveys, with photographs taken at predetermined locations along transect routes established for each neighbourhood, supplemented by purposive documentation of specific hazard conditions encountered. The photographic record served both as observational evidence and as a cross-referencing tool for subsequent spatial analysis.

Secondary data included fire incident records obtained from Niger State Fire Service covering the period 2021–2024. These records were sourced directly from the Niger State Fire Service headquarters in Minna through a formal data request, and contain information on fire locations, dates, times, reported causes, response times, and damage assessments. Government planning documents relating to land use and development control within the study area were obtained from the Niger State Urban Development Board, whilst previous research reports were sourced through systematic literature searches of peer-reviewed databases. Google Earth Pro imagery dated December 2024 facilitated spatial analysis of building distribution and density patterns. Additional secondary sources included meteorological data from the Nigerian Meteorological Agency characterising seasonal climate patterns relevant to fire risk.

The time frame of 2021–2024 for fire service records was selected for methodological consistency and data quality. This four-year period captures contemporary fire incidence patterns under current urban conditions, whilst offering sufficient temporal depth to identify recurring hotspots and seasonal patterns. Earlier records were found to be incomplete and inconsistently formatted, reducing their analytical utility._Data analysis proceeded through multiple stages aligned with research objectives. For Objective 1, descriptive statistics including frequencies and percentages characterised land use patterns, building types, construction materials, spacing configurations, and road accessibility. Results were presented in tabular format enabling cross-neighbourhood comparison. Kernel density analysis in ArcGIS 10.8 generated spatial representations of building concentration patterns. For Objective 2, both household survey responses and fire service records were analysed using frequency distributions and percentages to identify temporal patterns, spatial concentrations, and causal factors. Integration of these dual data sources provided more comprehensive coverage than either source alone, capturing both formally reported incidents and unreported community experiences.

For Objective 3, evaluating preparedness and awareness, questionnaire responses regarding fire safety knowledge, emergency procedure familiarity, and equipment availability were analysed using descriptive statistics. Cross-tabulation examined relationships between demographic characteristics and preparedness levels. For Objective 4, developing the vulnerability map, a Composite Fire Vulnerability Index (CFVI) was constructed through systematic indicator selection, standardisation, and weighting. Seven key indicators were selected based on theoretical relevance and empirical evidence: building spacing, road accessibility, electrical condition, fire incidence frequency, fire safety awareness, knowledge of emergency number, and availability of firefighting equipment. Each indicator was standardised on a 1–5 scale where 1 represented low vulnerability and 5 indicated extreme vulnerability. Thresholds for each score level were determined through data-driven analysis of the observed range and distribution of values across neighbourhoods.

Weights were assigned to each indicator based on their relative contribution to fire risk, drawing on the empirical dominance observed in the dataset as well as expert judgement informed by literature review. This approach to weight determination is consistent with methodological practice in comparable composite index studies, where the absence of sufficient local data to conduct full Analytic Hierarchy Process (AHP) or Delphi exercises necessitates reliance on empirically grounded expert estimation (Baquedano-Juliá *et al*., 2025; Mandalapu *et al*., 2024). The weights adopted in this study reflect the relative importance of each variable as evidenced by: (a) the dominance of electrical faults as a documented cause of fire in the dataset; (b) the critical role of building spacing and road accessibility in determining fire spread and emergency response outcomes; and (c) the proportional contribution of preparedness deficits to overall vulnerability, as evidenced in comparable Nigerian and African urban fire studies. Electrical condition received the highest weight (0.25) reflecting its dominance as a fire cause. Building spacing and road accessibility each received weights of 0.20 given their critical roles in fire spread and emergency response. Fire incidence frequency was weighted at 0.15 to capture historical risk patterns. Absence of firefighting equipment received a 0.10 weight reflecting household-level vulnerability. Fire safety awareness and knowledge of emergency number each received 0.05 weights as supporting indicators. Total weights summed to 1.00 ensuring mathematical validity.

The Weighted Linear Combination method was applied to compute final CFVI scores for each neighbourhood by multiplying standardised indicator values by their respective weights and summing the products. Resulting scores ranging from 1.00 to 5.00 were classified into three vulnerability zones: High Vulnerability (3.50–5.00), Moderate Vulnerability (2.50–3.49), and Low Vulnerability (1.00–2.49). These classifications were spatially represented in ArcGIS 10.8 to generate the final vulnerability map identifying priority zones for intervention.

Results and Discussion

Socio-demographic characteristics of respondents

Understanding the demographic composition of the sample population is important for contextualising fire risk and preparedness, as factors such as gender distribution, age, education, occupation, and duration of residence all shape exposure to hazards and capacity to respond. These variables are critical for identifying vulnerable groups and for understanding the social dynamics that underlie fire safety behaviour. As Cutter *et al*. (2012) have argued, social vulnerability is as constitutive of disaster risk as physical vulnerability a point that the demographic profile of Minna's core area appears to confirm. Analysis of socio-demographic characteristics in Table 1 (see appendix) reveals important patterns shaping fire vulnerability across the study area.

Gender distribution was relatively balanced across neighbourhoods, with slight male predominance in Keteren Gwari (51.3%), Kwangila (57.1%), Limawa (57.5%), and Sabon Gari (57.8%), whilst Makera showed a marginal female majority (50.7%). This near parity in gender distribution is significant. Both men and women are essentially exposed to the same fire risk conditions within these neighbourhoods. Their roles in risk creation and management may differ, however, given the domestic and economic activity patterns documented through fieldwork an observation that future studies with a specifically gendered analysis might productively explore.

Age distribution concentrated in the 26–35 years bracket across all neighbourhoods, representing 39.5% in Keteren Gwari, 33.3% in Kwangila, 40.0% in Limawa, 28.2% in Makera, and 28.9% in Sabon Gari. This youthful demographic reflects economically active populations primarily engaged in trading and artisanal activities. The 36–45 age group was substantial in Keteren Gwari (33.6%) and Sabon Gari (38.6%), suggesting established resident populations with deep ties to these neighbourhoods. Population aged 46 years and above remained relatively small except in Makera (36.6%), indicating that area's long-term settlement character.

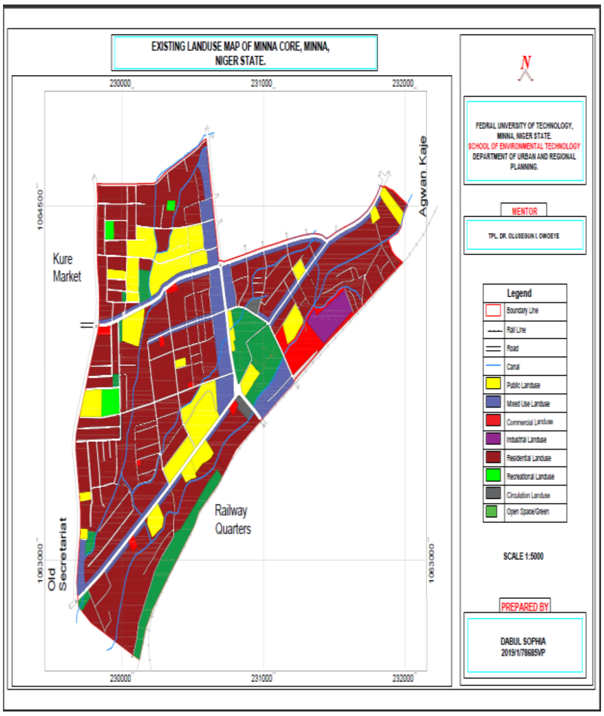
Educational attainment levels were notably high across the study area, which at first glance might appear to contradict assumptions that fire vulnerability primarily affects poorly educated populations. Over 80% of respondents across all neighbourhoods had completed at least secondary education, with tertiary education particularly prevalent in Kwangila (81.0%), Makera (77.5%), and Sabon Gari (65.1%). Yet, as Table 1 reveals, high educational attainment did not correspond with improved fire preparedness. This finding is consistent with the predictions of Protection Motivation Theory (Rogers, 1975), which holds that coping appraisal one's perceived capacity and resources to act on risk can constrain protective behaviour even where threat appraisal is relatively high. In the Minna context, economic constraints, limited access to safety equipment, and the absence of institutional support systems appear to be more decisive determinants of preparedness behaviour than educational background alone. This is not a failure of education per se; it points, rather, to the structural and institutional conditions that mediate between knowledge and action (Thandar *et al*., 2025; Akaninyene *et al*., 2024).

Occupational patterns revealed dominance of trading and artisanal activities, particularly pronounced in Makera (83.1%) and Kwangila (76.1%), reflecting the commercial character of these zones. Civil servants comprised notable minorities in Keteren Gwari (20.2%) and Sabon Gari (13.3%), whilst students maintained a presence across all areas. The reviewer's query regarding the categorisation of traders and artisans relative to 'self-employed' persons is acknowledged. In this study, 'Trader/Artisan' refers to individuals engaged in market-based commercial activities or skilled craft work, typically operating from fixed commercial premises or market stalls. 'Self-employed' captures a broader category, including those running small enterprises from residential premises (e.g., home-based tailoring, food vending) that do not primarily operate from designated commercial spaces. The distinction is relevant because the physical context of work influences ignition risk exposure differently between these two categories. Traders and artisans operating in commercial zones are directly exposed to ignition sources including electrical equipment, open flames, welding activities, and indoor storage of flammable goods conditions that appear, from the evidence, to be

associated with elevated fire incidence in Makera and Sabon Gari.
Length of residence patterns indicated high population stability, with over 70% of respondents across all neighbourhoods having lived in their current locations for seven years or more, reaching 96.4% in Sabon Gari and 95.2% in Kwangila. Long-term residence would, in principle, afford intimate familiarity with local fire risks. Yet this knowledge has not translated into improved structural safety or preparedness a finding that underscores the role of systemic constraints beyond individual awareness in perpetuating vulnerability. Household occupancy sizes varied significantly, with Makera showing the highest proportions of large households (45.1% with 9–12 persons, 11.3% with 13 or more persons), creating evacuation challenges and increasing casualty potential during fire incidents.

Urban development structure and built environment characteristics

Analysis of land use patterns from the authors' own field survey data (Figure 3) reveals pronounced commercial intensity gradients across the study areas. Sabon Gari exhibited the highest commercial land use at 41.0%, followed by Makera (35.2%) and Limawa (25.0%), confirming Sabon Gari's status as the primary commercial hub. Mixed-use development was substantial in Limawa (31.1%) and Sabon Gari (28.9%), reflecting intensive residential-commercial integration that creates multiple simultaneous ignition sources within congested spaces. Keteren Gwari maintained a predominantly residential character (63.0%) with moderate commercial activity, whilst Kwangila functioned primarily as residential (57.1%) with limited commercial development (9.5%). The concentration of commercial activities in Sabon Gari and Makera directly corresponds with observed fire incident frequencies, as commercial operations involve electrical equipment, open flames for cooking, and storage of flammable goods in close proximity to residential structures.
Construction material analysis from the survey data revealed pervasive use of mixed combustible materials across all neighbourhoods (Table 2). Sabon Gari (88.0%), Makera (88.7%), and Limawa (78.8%) showed the highest proportions of buildings constructed with combinations of wood, zinc sheets, and cement blocks. Use of cement blocks alone remained minimal, ranging from 17.6% in Keteren Gwari to 4.8% in Sabon Gari and Makera. Traditional mud construction persisted in small proportions (2.4%–3.4%) in certain areas. The dominance of mixed materials incorporating wood and zinc creates highly combustible urban environments where fires may spread rapidly through entire building clusters. This finding aligns with research in similar contexts demonstrating that building material composition fundamentally shapes fire propagation potential (Pakhira *et al*., 2025).
Building spacing analysis from the field survey data exposed critical congestion in multiple neighbourhoods. Sabon Gari and Makera exhibited extreme density with 81.9% and 81.7% respectively of buildings categorised as very close, severely limiting firebreaks and evacuation routes. Kwangila also showed substantial congestion (47.6% very close), whilst Keteren Gwari maintained moderate spacing (59.7% moderately spaced). Limawa demonstrated relatively better planning with 20.0% of buildings well-spaced and 45.0% moderately spaced. The extreme congestion in Sabon Gari and Makera means that fire originating in any single structure can rapidly propagate to adjacent buildings, overwhelming suppression efforts and creating conditions for potentially catastrophic losses. International research on informal settlement fire dynamics confirms that building spacing is one of the most critical variables determining fire spread rates and ultimate damage extent (Cicione *et al*., 2019).



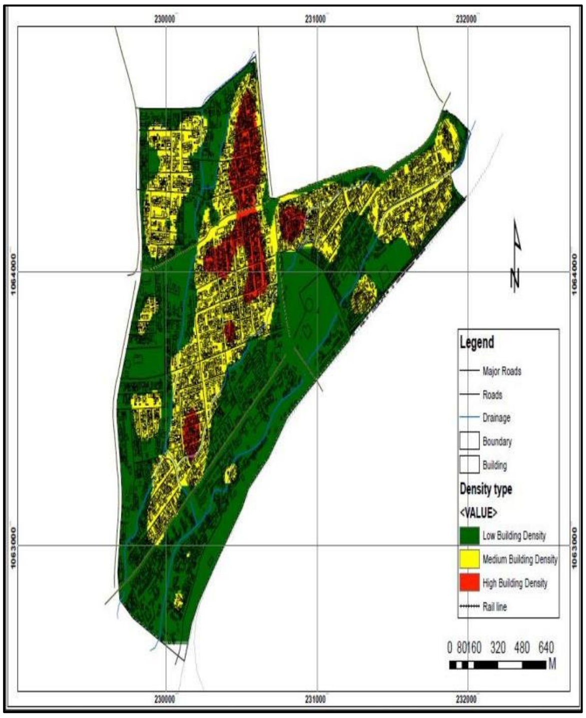


Figure 3: Land Use Pattern of Minna Traditional **Figure 4: Density Pattern of Minna**
Traditional
Core Area **Core Area**

Table 2: Land Use and Development Characteristics by Neighbourhood

Land Use / Building Attribute	Keteren Gwari (%)	Kwangila (%)	Limawa (%)	Makera (%)	Sabon Gari (%)
Residential land use	63.0	57.1	43.8	29.6	30.1
Commercial land use	21.0	9.5	25.0	35.2	41.0
Mixed use	16.0	33.3	31.1	35.2	28.9
Buildings with wood/zinc/cement (mixed combustible)	71.4	66.7	78.8	88.7	88.0
Buildings: cement blocks only	17.6	14.3	12.5	4.8	4.8
Buildings: very close spacing (≥80%)	34.5	47.6	33.8	81.7	81.9
Buildings: not accessible by road	3.4	9.5	12.4	1.4	14.5

Road accessibility analysis revealed significant spatial variations with important implications for emergency response capacity. Makera (49.3%) and Keteren Gwari (49.6%) showed the highest proportions of very accessible buildings, whilst Sabon Gari recorded 14.5% of buildings in non-accessible zones and Limawa 12.4%. The combination of poor accessibility in Sabon Gari with its extreme building congestion and high commercial activity creates particularly hazardous conditions where fire incidents would face delayed emergency response allowing fires to escalate before suppression can commence. These findings illustrate how multiple vulnerability dimensions interact multiplicatively rather than additively, with poor road access compounding risks already created by congestion and combustible materials (Mandalapu *et al*., 2024; Pelling *et al*., 2021).

Fire incidence patterns and causal analysis

Fire incidence analysis reveals pronounced spatial concentration patterns strongly correlated with urban structural characteristics (Table 3; see appendix). Sabon Gari exhibited the highest fire frequency, with 74.7% of respondents reporting more than three fire incidents, followed by Limawa at 43.8%. Keteren Gwari and Makera showed moderate recurrence (15.1% and 11.3% respectively with more than three incidents), whilst Kwangila demonstrated the lowest incidence with 52.4% of respondents reporting no fire experiences. These patterns directly correspond to observed variations in building density, material composition, and commercial intensity, suggesting that fire vulnerability is systematically embedded in urban form rather than randomly distributed.

A notable observation in Table 3 concerns the apparent tension between self-reported electricity conditions and electrical fault as the dominant cause of fire. Across several neighbourhoods, a significant proportion of respondents rated their electrical condition as 'fair' or 'good', yet electrical faults emerged overwhelmingly as the most commonly reported cause of fire incidents. This divergence is not necessarily contradictory. It is well established that subjective assessments of infrastructure condition tend to normalise deterioration that has occurred gradually over time residents' benchmarks for 'fair' or 'good' electrical infrastructure may themselves reflect low baseline expectations shaped by longstanding neglect. Beyond subjective perception, electrical faults are frequently attributable to conditions that are not always visible to occupants, including overloaded distribution circuits at the grid level, inadequate earthing, ageing wiring within walls, and illegal connections that feed multiple premises from a single supply line. These systemic conditions are consistent with the wider documented state of electrical infrastructure in Nigerian secondary cities (Joseph, 2025; Agbola & Falola, 2021).

Causal analysis identified electrical faults as the dominant fire trigger across all neighbourhoods, accounting for 94.4% of incidents in Makera, 75.0% in Limawa, 64.7% in Keteren Gwari, 59.0% in Sabon Gari, and 56.5% in Kwangila. Sabon Gari showed notable diversification of fire causes including refuse burning (21.7%) and open flames (19.2%), reflecting the additional risks associated with high commercial activity and inadequate waste management. Secondary data from Niger State Fire Service corroborated these patterns, with 17 documented incidents during 2021–2024 predominantly attributed to electrical faults, supplemented by cooking accidents, welding sparks, and child-related incidents.

Community preparedness and awareness assessment

Preparedness analysis exposed severe deficiencies in community fire safety capacity (Table 4). Fire safety awareness levels were critically low, particularly in high-risk zones, with 68.7% of Sabon Gari residents unaware of fire risks, 58.8% in Limawa, and 40.8% in Makera. Knowledge of the fire service emergency number (199) remained abysmally low across all areas, with only 18.1% of Sabon Gari residents, 14.3% of Kwangila residents, and 26.8% of Makera residents able to correctly identify how to contact emergency services. This knowledge gap fundamentally undermines rapid response capacity, as delayed notification allows fires to escalate beyond containment potential before professional services arrive.

Availability of firefighting equipment was virtually non-existent at the household level. Sabon Gari recorded 91.6% of households with no equipment, Keteren Gwari 93.3%, Makera 91.5%, and Kwangila 100.0%. Even basic tools such as sand buckets and fire blankets were absent in most areas, whilst sophisticated equipment including smoke detectors, fire alarms, and sprinkler systems were completely absent across all surveyed buildings. This equipment deficit means that household-level suppression capacity is entirely absent—with residents unable to control even small fires in their initial stages, necessitating external intervention regardless of fire size. The combination of low awareness, poor knowledge of the emergency number, and absence of equipment create a multi-layered vulnerability condition in which several protective mechanisms that should provide defence-in-depth are simultaneously missing.

What makes this pattern particularly instructive—and somewhat counterintuitive—is its persistence even in the more educationally privileged neighbourhoods. Kwangila, where 81.0% of respondents hold tertiary qualifications, recorded the worst equipment availability of all five neighbourhoods (100% with no equipment). Makera, with 77.5% tertiary educated, showed only 8.5% equipment ownership. This appears to confirm what Protection Motivation Theory predicts: that the decision to invest in fire safety equipment is driven not by knowledge or intent, but by access, affordability, and the presence or absence of institutional facilitation (Rogers, 1975; Nwankwo & Eze, 2020).

Table 4: Fire Safety Awareness and Preparedness by Neighbourhood

		Keteren Gwari	**Kwangila**	**Limawa**	**Makera**	**Sabon Gari**					
		(*f*)	(%)	(*f*)	(%)	(*f*)	(%)	(*f*)	(%)	(*f*)	(%)
Fire safety awareness	Aware	70	58.8	16	76.2	33	41.3	42	59.2	26	31.3
	Not aware	49	41.2	5	23.8	47	58.8	29	40.8	57	68.7
Knowledge of fire emergency number (199)	Know	52	43.7	3	14.3	26	32.5	19	26.8	15	18.1
	Do not know	67	56.3	18	85.7	54	67.5	52	73.2	68	81.9
Firefighting equipment available	Yes	8	6.7	0	0.0	11	13.8	6	8.5	7	8.4
	No	111	93.3	21	100.0	69	86.3	65	91.5	76	91.6
Total		119	100	21	100	80	100	71	100	83	100

Composite fire vulnerability index and spatial mapping

Integration of structural, incidence, and preparedness data through the Composite Fire Vulnerability Index yielded clear differentiation of risk zones (Figure 5). Sabon Gari emerged as the most vulnerable neighbourhood with a CFVI score of 4.38, driven by extreme scores (5.0) across building spacing, road accessibility, electrical condition, fire incidence frequency, safety awareness, and equipment availability. Limawa followed with a CFVI of 3.92, reflecting high scores in multiple dimensions. Keteren Gwari scored 3.61, placing it in the high vulnerability category despite relatively better performance in certain indicators. These three neighbourhoods require immediate prioritised intervention given their documented high-risk status.

Makera achieved moderate vulnerability classification with a CFVI of 3.24, benefiting from relatively better road accessibility despite high commercial intensity and poor building spacing. Kwangila ranked lowest with a CFVI of 2.87, reflecting its transit zone character with lower commercial intensity, reduced fire incidence history, and somewhat better community awareness despite persistent equipment deficits. The spatial patterns revealed by the CFVI map align closely with independently documented fire incident records from the Niger State Fire Service for the period 2021–2024. Of the 17 formally recorded incidents, 11 occurred in Sabon Gari and Limawa the two highest-scoring neighbourhoods on the CFVI. This degree of correspondence offers some reassurance regarding the index's validity as a planning tool, since the vulnerability classifications generated from structural and behavioural survey data appear to correspond to observed fire incident concentrations. However, it is important to note that formal fire service records represent only a fraction of total fire events in the study area; many incidents, particularly smaller ones in residential compounds, go unreported. The survey data, which captures community-reported incidents, provides a more complete though necessarily retrospective picture of fire experience across the five neighbourhoods. The CFVI thus draws on triangulated evidence rather than any single data source, enhancing confidence in the classifications whilst acknowledging that residual uncertainty is inherent in all composite index methodologies (Baquedano-Juliá *et al*., 2025).

The vulnerability map visualised clearly delineates these risk zones, providing spatial decision support for targeted intervention planning by urban planning authorities, fire services, and community organisations. Its value lies not merely in depicting what is already known anecdotally, but in providing an empirically grounded and replicable framework through which risk can be systematically monitored and reassessed over time as urban conditions evolve. The methodology offers a replicable framework that may be applicable to other Nigerian secondary cities facing comparable urban fire risk challenges, though indicator selection and weighting would need to be adapted to local conditions and available data.

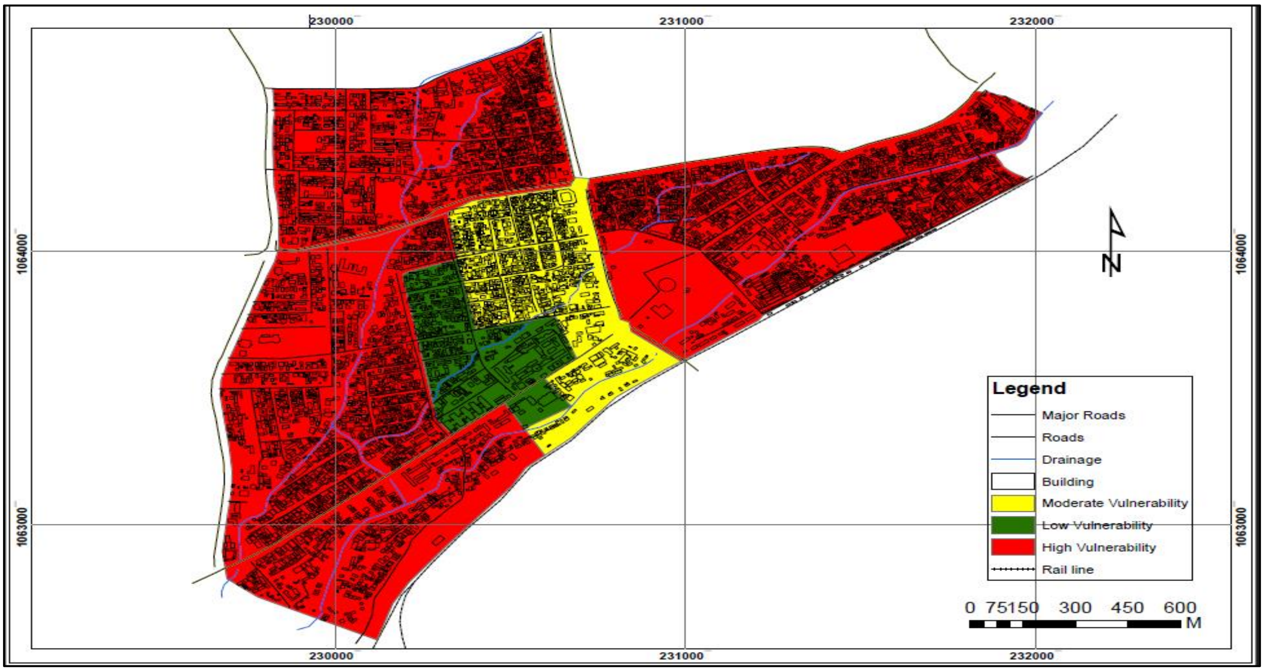


Figure 5: Vulnerability Map of Fire Hazard in Traditional Core Area of Minna

Planning Implications

The findings of this study carry substantial implications for urban planning practice, disaster risk management policy, and community development strategies in Minna and comparable Nigerian secondary cities. The demonstrated spatial concentration of fire vulnerability in specific neighbourhoods challenges the efficacy of generic, city-wide fire safety interventions, revealing the necessity for geographically targeted approaches that acknowledge and address neighbourhood-specific risk profiles. Planning authorities must recognise that Sabon Gari, Limawa, and Keteren Gwari require fundamentally different intervention intensities and strategies compared to lower-risk zones, with resource allocation reflecting these empirically documented risk differentials.

The dominance of electrical faults as a fire causation factor demands immediate electrical infrastructure auditing and upgrading programmes in high-risk zones. Current reactive responses following incidents must transition toward proactive systematic inspection regimes that identify and remediate electrical hazards before ignition occurs. This requires institutional capacity building within relevant agencies, development of inspection protocols adapted to local contexts, and enforcement mechanisms ensuring compliance with electrical safety standards.

The extreme building congestion documented in Sabon Gari and Makera presents complex planning challenges, given the well-established nature of these settlements. Wholesale clearance and redevelopment approaches are neither politically feasible nor socially justified. Instead, incremental strategies should focus on creating strategic firebreaks through selective intervention on vacant or dilapidated structures, widening critical access routes to enable emergency vehicle passage, and implementing fire-resistant construction standards for new development and major renovations. Zoning regulations must be strengthened and enforced to prevent further encroachment that exacerbates congestion in already dense areas.

The severe preparedness deficits identified across all neighbourhoods particularly acute in Sabon Gari and Limawa necessitate comprehensive community-based fire safety education programmes. These programmes must extend beyond simple awareness-raising to include practical training in equipment use, evacuation procedures, and initial fire suppression techniques. Partnerships with community organisations, religious institutions, and market associations can facilitate programme delivery and ensure cultural appropriateness and sustained engagement. Given the economic constraints evident in low equipment ownership rates, subsidy programmes or community-level equipment provision may be necessary to overcome financial barriers preventing household investment in basic safety tools.

The vulnerability map developed through this research should be formally integrated into Minna's urban development planning processes, serving as a foundational layer for land use decisions, infrastructure investment prioritisation, and disaster preparedness planning. Development applications in high-vulnerability zones should face enhanced scrutiny regarding fire safety provisions, with approval conditional on demonstration of adequate safety measures. Regular updating of the vulnerability assessment, ideally at two-to-three-year intervals, would enable tracking of risk trajectory and evaluation of intervention effectiveness.

Beyond Minna-specific applications, this study demonstrates a methodological approach to fire vulnerability assessment that may be applicable across Nigerian secondary cities confronting similar urban development trajectories. The Composite Fire Vulnerability Index framework offers a replicable tool for systematic risk assessment, whilst the integration of multiple data sources community surveys, fire service records, and spatial analysis illustrates a practical methodology achievable within typical resource constraints facing local governments.

Conclusion

This study has comprehensively assessed the development pattern and fire vulnerability of Minna traditional core area, generating empirical evidence demonstrating that fire risk is systematically embedded in the physical structure, behavioural patterns, and institutional characteristics of the urban system. Fire vulnerability is not randomly distributed; it is concentrated in specific neighbourhoods where multiple risk factors converge. Sabon Gari emerged as the most vulnerable area, characterised by extreme building congestion with 81.9% of structures closely spaced, pervasive use of combustible construction materials, poor road accessibility affecting 14.5% of buildings, deteriorating electrical infrastructure, high fire incidence with 74.7% of residents experiencing multiple incidents, critically low safety awareness with 68.7% unaware of risks, and near-complete absence of household firefighting equipment at 91.6%.

The development of a spatially explicit Composite Fire Vulnerability Index integrating structural variables, fire incidence patterns, and preparedness indicators provided a robust analytical framework for risk assessment and intervention prioritisation. Classification of neighbourhoods into high, moderate, and low vulnerability zones enables targeted resource allocation and differentiated intervention strategies tailored to specific local conditions. The methodology demonstrates practical feasibility within typical data availability and technical capacity constraints characteristic of Nigerian local governments, offering a replicable approach for comparable urban centres confronting fire risk challenges.

Effective fire risk reduction requires multi-dimensional interventions addressing structural vulnerabilities through building code enforcement and infrastructure upgrading, behavioural dimensions through community education and equipment provision, and institutional capacity through enhanced fire service resources and regulatory enforcement. Single-dimension interventions focusing solely on awareness-raising or equipment distribution are likely to prove insufficient given the complex, interactive nature of vulnerability factors documented in this research. Sustained risk reduction necessitates coordinated efforts spanning urban planning, building regulation, emergency services, community development, and public education sectors.

Whilst Minna has not yet experienced a single catastrophic fire event comparable to those documented in Lagos or Kano, the cumulative effect of repeated smaller-scale incidents imposes substantial social and economic costs on affected communities. Without deliberate intervention, the risk trajectory is likely to continue escalating as urban expansion proceeds, population density increases, and infrastructure ages. The window for proactive risk reduction remains open but it will narrow if current development patterns persist unchecked. This study provides the empirical foundation and spatial intelligence necessary to guide evidence-based fire risk management strategies, offering planning authorities, emergency services, and community organisations the analytical tools needed to transition from reactive incident response toward proactive vulnerability reduction.

Planning authorities should prioritise Sabon Gari, Limawa, and Keteren Gwari for intensive fire risk reduction programmes given their documented high-vulnerability status. Niger State Government and the electricity distribution company should conduct comprehensive electrical infrastructure audits in high-risk zones, with particular focus on identifying overloaded circuits, illegal connections, and sub-standard wiring, followed by systematic remediation. Local government authorities should establish a community-based fire preparedness programme addressing the documented severe deficits in awareness, emergency procedure knowledge, and equipment availability. This should include subsidised provision of basic firefighting equipment. The fire vulnerability map developed through this research should be formally integrated into Minna's urban development planning framework as a foundational spatial data layer informing land use decisions, infrastructure investment priorities, and disaster preparedness strategies. Niger State Government should invest in fire service capacity enhancement, recognising that current single-station coverage for the entire metropolitan area is inadequate. Investment in additional stations, modern equipment, and trained personnel is essential for effective emergency response.

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Table 1: Socio-Demography of Respondents

		Keteren Gwari		Kwangila		Limawa		Makera		Sabon Gari	
		(*f*)	(%)	(*f*)	(%)	(*f*)	(%)	(*f*)	(%)	(*f*)	(%)
Gender	Female	58	48.7	9	42.9	34	42.5	36	50.7	35	42.2
	Male	61	51.3	12	57.1	46	57.5	35	49.3	48	57.8
Age	18-25	19	15.9	4	19	9	11.3	7	9.8	12	14.5
	26-35	47	39.5	7	33.3	32	40	20	28.2	24	28.9
	36–45	40	33.6	3	14.3	31	38.8	18	25.4	32	38.6
	Above 46	13	10.9	7	33.3	8	10	26	36.6	15	18.1
Level of Education	Primary education	–	–	–	–	–	–	–	–	2	2.4
	Secondary education	66	52.9	4	19	32	40	16	22.5	27	32.5
	Tertiary education	48	34.5	17	81	43	53.8	55	77.5	54	65.1
	No education	4	3.4	–	–	5	6.3	–	–	–	–
Occupation	Student	17	21.3	2	9.5	5	6.3	4	5.6	9	10.8
	Civil servant	24	30	1	4.8	12	15	2	2.8	4	4.8
	Trader/Artisan	50	62.5	16	76.1	43	53.8	59	83.1	46	55.4
	Self-employed	19	23.8	2	9.5	17	21.3	6	8.5	16	19.3
	Unemployed	9	11.3	–	–	3	3.8	–	–	8	9.6
Length of Residence	1-3 years	2	1.7	–	–	2	2.5	2	2.7	–	–
	4–6 years	32	26.9	1	4.8	5	6.3	8	11.3	3	3.6
	7 years and above	85	71.4	20	95.2	73	91.3	61	86	80	96.4
Occupancy size	1-4 persons	45	37.8	4	19	58	72.5	28	39.4	24	28.9
	5-8 persons	52	43.7	13	61.9	13	16.3	3	4.2	47	56.6
	9-12 persons	16	13.3	4	19	9	11.3	32	45.1	9	10.8
	13 persons and above	5	4.2	–	–	–	–	8	11.3	3	3.6
Total		**119**	**100**	**21**	**100**	**80**	**100**	**71**	**100**	**83**	**100**

Table 3: Fire Incidence and Causal Analysis by Neighbourhood

		Keteren Gwari		Kwangila		Limawa		Makera		Sabon Gari	
		(*f*)	(%)	(*f*)	(%)	(*f*)	(%)	(*f*)	(%)	(*f*)	(%)
Condition of electricity	Excellent	10	8.4	5	23.8	5	6.3	6	8.5	6	7.2
	Fair	33	27.7	8	38.1	33	41.3	44	62	11	13.3
	Good	43	36.1	1	4.8	19	23.8	3	4.2	24	28.9
	Poor	28	23.5	3	14.3	20	25	10	14.1	32	38.6
	Very poor	5	4.2	4	19	3	3.8	8	11.3	10	12
Fire incidence experience	No incidents	26	21.9	11	52.4	9	11.3	15	21.1	2	2.5
	Yes, once or twice	75	63	7	33.3	36	45	48	67.6	19	22.8
	Yes, more than 3 times	18	15.1	3	14.3	35	43.8	8	11.3	62	74.7
Common Cause of Fire	Electrical Fault	77	64.7	13	56.5	60	75	67	94.4	49	59
	Open Flame	10	8.4	3	13	13	16.3	3	4.2	16	19.2
	Refuse/Bush Burning	5	4.2	_	_	7	8.8	1	1.4	18	21.7
	Welding	27	22.7	6	26	_	_	_	_	_	_
	Generator	_	_	1	4.4	_	_	_	_	_	_
Storage of flammable materials	No flammable materials	28	23.5	4	19	10	12.5	5	7	6	7.2
	Stored in separate sheds	10	8.4	6	28.6	28	35	26	36.6	22	26.5
	Stored indoors in main structure	81	68.1	11	52.4	42	52.5	40	56.3	55	66.3
Total		**119**	**100**	**21**	**100**	**80**	**100**	**71**	**100**	**83**	**100**