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A Decade Analysis of Fire Incidents, Fatalities and Property Losses across Premise Types in Nigeria: Implications for Fire Safety and Risk Management

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Abstract

Fire outbreaks continue to cause significant loss of life, property damage, environmental degradation and economic disruption in Nigeria. This study presents a ten-year analysis of the occurrence, severity and distribution of fire incidents across 12 premise types in Nigeria using fire incident records obtained from the Federal Fire Service Headquarters for the period 2016–2025. Temporal trends in fire occurrence, fatalities and property losses, as well as variations across premise categories, were examined. A total of 16,528 fire incidents, 565 deaths and approximately ₦3,426.63 billion in property losses were recorded during the study period. The analysis shows that fire incidents increased from 2016 and reached a peak in 2020, followed by an overall decline with fluctuations through 2025. Private dwellings recorded the highest number of fire incidents (6,121), followed by public buildings/government quarters (3,106). Automobile fires recorded the highest number of fatalities (151), followed by private dwellings (138). Markets recorded the greatest property losses, estimated at approximately ₦3,076.2 billion. These findings demonstrate substantial variation in fire occurrence and severity across premise types and years, with residential, public and commercial premises representing important areas of concern. The study highlights the need for improved fire prevention, stronger safety compliance, effective emergency preparedness, public awareness and targeted allocation of fire fighting resources. Such measures can contribute to reducing fire-related fatalities, property losses and the socioeconomic impacts of fire incidents in Nigeria.

Keywords: Fire incidents, Fire safety, Fire severity; Premises, Fire frequency

Introduction

Fire is a rapid oxidation reaction that releases energy in the form of heat and light, accompanied by the production of various chemical by-products (Olufunke, 2023). When controlled, fire fuels human progress by serving numerous beneficial purposes and applications in domestic, commercial and industrial activities; but when uncontrolled, it leaves behind destruction, loss and tragedy, thereby transforming years of hard work and investment into ashes within a matter of minutes or less. Studies have shown that fire outbreaks constitute one of the most devastating disasters affecting human societies and continue to cause significant loss of life, extensive property damage, environmental degradation and economic disruption (Daramola and Ibrahim, 2021). The increasing complexity of modern urban

environment coupled with rapid population growth, industrial expansion, aging infrastructure, inadequate adherence to fire safety regulations and growing energy demands has further heightened the vulnerability of societies to fire-related disasters.

Globally, fire incidents account for thousands of fatalities and injuries annually, while associated economic losses amount to billions of dollars. In Nigeria, Odeniyi (2025) reported that the Federal Fire Service recorded 100 deaths and property losses of ₦67.1 billion from fire outbreaks in 2024. Similarly, Gbonegun (2026) reported Federal Fire Service figures of 1,866 fire incidents, 114 deaths and property losses of ₦74.75 billion in 2025. In the United States, U.S. fire departments handled about 1.38 million fires in 2024, resulting in nearly 3,920 civilian fatalities, 11,780 injuries and \$19 billion in property loss (Hall, 2025). These statistics underscore the persistent nature of fire-related hazards and the need for continuous evaluation of fire risk factors, safety measures and emergency response strategies.

Over the past decades, considerable efforts have been made globally to strengthen fire safety governance to mitigate the devastating impacts of fire incidents, through the establishment of specialized agencies and regulatory bodies responsible for fire prevention, preparedness and emergency response. Examples include the National Fire Protection Association (NFPA) and the United States Fire Administration (USFA) in the United States, the Fire and Rescue Services in the United Kingdom, the National Fire Agency (NFA) in South Korea, Canadian Association of Fire Chiefs (CAFC), Fire and Rescue New South Wales (FRNSW) and Country Fire Authority (CFA) in Australia. Others include Fire and Disaster Management Agency (FDMA) in Japan, German Fire Services Association (DFV) in Germany, and the Federal Fire Service (FFS) in Nigeria. Despite the existence of these institutions and the implementation of various fire safety regulations and awareness programs, fire outbreaks continue to occur worldwide, resulting in substantial losses of lives, property and economic resources.

Fire incident analysis has emerged as an indispensable approach for understanding the dynamics of fire incidents and assessing the effectiveness of existing safety measures. Through systematic examination of fire records, researchers and policy makers can identify temporal trends, spatial patterns, causal factors, and high-risk environments. These insights support evidence-based policymaking, resource allocation, emergency planning and the development of targeted prevention strategies.

Due to the increasing frequency and severity of fire incidents and their associated socio-economic consequences, fire safety and fire risk management have attracted considerable research attention. Existing studies have examined various aspects of fire occurrence, including causal factors, risk assessment, fire dynamics, emergency response mechanisms and the effectiveness of prevention and mitigation strategies. For example, Lawal et al. (2018) assessed the implementation of fire safety procedures and regulations in selected public buildings in Kano State, Nigeria using survey data collected from facility managers, workers and visitors. The study found that key fire safety provisions, including fire extinguishers, sprinklers, hose reels, emergency exits, fire alarms and safety signage were generally available and adequately implemented within the surveyed facilities. The authors identified electrical faults, inadequate fire safety awareness, insufficient staff training and poor emergency preparedness as significant contributors to fire risks in public buildings. The study further emphasized the importance of regular fire drills, safety training, and institutional fire safety committees in enhancing fire preparedness. However, the study was limited to a few public buildings and relied primarily on respondents' perceptions, with little attention given to long-term fire occurrence patterns and accident records.

In the same vein, Shokouhi et al. (2018) conducted a systematic review of residential building fires and associated injuries and identified unsafe human behaviours, including smoking, alcohol consumption, and poor emergency response, as major contributors to fire-related mortality and morbidity. The study further highlighted the influence of structural deficiencies such as unsafe electrical installations, absence of smoke detectors, inadequate fire suppression systems, and the use of combustible construction materials. In addition, socioeconomic disadvantages, limited access to firefighting services and inadequate fire safety awareness were found to increase fire vulnerability, particularly in low- and middle-income countries. The authors recommended a combination of legislative reforms, structural improvements, public education, and enhanced emergency response systems as critical measures for reducing fire-related losses. However, the review noted a scarcity of

evidence from developing countries and emphasized the need for further empirical studies examining fire occurrence patterns and risk factors in diverse socioeconomic contexts.

Daramola and Ibrahim (2021) examined fire safety measures in residential buildings within Yaba Local Council Development Area (LCDA), Lagos State, Nigeria, using administrative records, field surveys, questionnaires, interviews and GIS mapping techniques. The study identified 15 recorded fire incidents between 2008 and 2018 and found that the area was served by only one fire station and four centrally located hydrants, resulting in an average emergency response time of 9.36 minutes. Fire exits and portable extinguishers were the most common safety features in residential buildings; however, many extinguishers were non-functional, while critical systems such as smoke detectors, sprinkler systems and emergency lighting were largely absent. The study further revealed that high installation and maintenance costs, inadequate government monitoring, and residents' poor attitudes toward fire preparedness were the primary barriers to adopting fire safety measures. The authors recommended stricter enforcement of fire safety regulations, improved public awareness campaigns, increased provision of firefighting infrastructure, and greater promotion of fire insurance. A key limitation of the study is its relatively small sample size of 70 households within a single local government area, which limits the generalizability of the findings to other parts of Lagos or Nigeria.

Olufunke (2023) reviewed twenty-five fire outbreaks in Nigerian government buildings between 2019 and 2022 and identified electrical faults, political factors, inadequate safety awareness, poor enforcement of fire safety regulations, negligence, arson, and the absence of fire detection and suppression systems as the major causes of fire incidents. The study further emphasized the need for improved fire safety governance, routine inspections, occupant training and the incorporation of fire protection systems in building design and maintenance. However, the study was limited to government facilities and relied largely on secondary data sources, thereby highlighting the need for broader empirical investigations of fire occurrence patterns across different building categories and regions.

A recent review by Zhang (2023) examined the global occurrence of structural fires and identified electrical faults, cooking activities, smoking materials, combustible construction materials and human negligence as the major causes of fire incidents. The study further emphasized that developing countries face greater fire risks due to inadequate fire protection infrastructure, poor urban planning and limited fire safety awareness. To reduce fire occurrence, the authors recommended the integration of fire safety considerations into building design, enhanced public education, development of fire-resistant materials, stricter regulatory enforcement and the adoption of artificial intelligence-based fire prediction systems. However, the study was largely descriptive and did not provide empirical analyses of long-term fire occurrence patterns, highlighting the need for data-driven investigations into fire trends and risk factors across different geographical contexts.

Ismaila et al. (2025) assessed the temporal trends and periodicity of fire disasters in Sokoto Metropolis, Nigeria, using monthly fire incident records from the Sokoto State Fire Service and meteorological data from the Nigerian Meteorological Agency covering 2000 - 2023. The study employed the Mann-Kendall trend test and multiple linear regression to examine fire occurrence patterns and the influence of climatic variables. The findings revealed a significant upward trend in fire incidents over the study period, with February, March, January, and December identified as the most fire-prone months. Fire outbreaks occurred most frequently during afternoon hours and were associated with the cold-dry and hot-dry seasons. Meteorological variables, particularly minimum and maximum temperatures, showed weak but measurable relationships with fire incidence. The authors recommended increased public awareness campaigns, strategic establishment of additional fire stations and recruitment of more firefighting personnel to improve emergency response and preparedness. This study relies on secondary fire incident records, which may be affected by underreporting and inconsistencies in data collection. Additionally, the regression analysis showed that meteorological factors explained only a small proportion of the variation in fire incidents, indicating that important human and socioeconomic factors such as population growth, electrical faults, urban expansion and safety practices were not directly incorporated into the analysis.

Overall, these studies have contributed significantly to understanding the complex interactions among human, technical, environmental and institutional factors that influence fire occurrence and severity. However, significant gaps still exist as most of the existing research has been geographically localized, focused on specific categories of premises, or relied predominantly on secondary data sources. Furthermore, many studies have been based on relatively short observation periods, limiting

their ability to capture long-term temporal trends, evolving risk patterns and the broader dynamics of fire incidents across diverse settings. This present study aims to analyse the occurrence, causes, impacts, and safety characteristics of fire incidents using long-term fire service records in Nigeria. Specifically, the study seeks to identify temporal and spatial trends, assess variations across different premises and evaluate the implications of observed patterns for fire safety management, disaster preparedness, and policy formulation.

Methodology

The study was conducted in Nigeria, the most populous country in Africa, with an estimated population exceeding 220 million people. The country is located in West Africa, along the Gulf of Guinea on the Atlantic coast. It lies approximately between latitudes 4°N and 14°N and longitudes 3°E and 15°E. Nigeria shares land borders with four countries; to the west, Benin; to the north, Niger; to the northeast, Chad; and the east and southeast, Cameroon. Nigeria covers a total land area of approximately 923,768 square kilometres, making it one of the largest countries in Africa. The map of Nigeria showing its neighbouring countries is in Figure 1. Nigeria comprises 36 states and the Federal Capital Territory (FCT) and experiences diverse climatic, socioeconomic, and infrastructural conditions that influence fire occurrence patterns.



Figure 1. Map of Nigeria and its bordering countries.

Source: Study authors.

The fire incident data used in this study were officially obtained in raw form from the National Fire Data Repository Centre (NFDRC) under the Policy, Planning, Research and Statistics (PPRS) Division of the Federal Fire Service Headquarters Abuja. The fire incident data received was for the entire country, Nigeria and spanned a period of 10 years from 2016 to 2025. The fire incidents for the period under review were categorised into two major parts namely, premise type and causes of the incident. However, the present study is limited to the first part which is the type of premise where the fire incident occurred. There were 12 various premises for analysis of the fire incident in this study. These premises include public building/government; private dwellings; educational establishments; markets as well as clubs, hotels, restaurant. Others include factories; banks; petrol/gas stations; automobile; timber sheds; transformer and others. For each type of premises, a number of variables were used to perform analysis of the fire incidents in the study. These variables include the number of fires, number of lives of lost, number of lives saved, number of injured and rescued persons for each year (January to December cycle). This is in addition to the estimated amount of property lost to the fire incidents and those saved by the FFS or other relevant stakeholders.

The collected raw data was arranged into a pivot for data management and to statistically analyse fire incidents both in descriptive and inferential form. The inferential statistics using RStudio

IDE software covered Trend Analysis of National Fire Incidence, Composite Fire Severity Index (CFSI), Hierarchical Clustering of Premises by Fire Risk Profile and Premise Risk-Tier Classification (K-Means Clustering). Consequently, data were presented using diagrams, graphs, tables, and charts to gain more insight on the menace. This served as the foundation for result discussion and findings which were presented in narrative form. Because these are administrative records, possible underreporting and changes in reporting coverage should be considered when interpreting temporal differences.

Results and Discussion

Frequency of Fires

The number of fire incidents recorded per year in Nigeria over a 10-year period from 2016 to 2025 is presented in the line chart in Figure 2. For the period under review, there were 16528 fire incidents in Nigeria. The least recorded cases of fire incidents of 391 occurred in 2016 constituting about 2.4 per cent of the entire fire incidents. Subsequently, the data show a steady increase from 2017, peaking in 2020 with 3555 cases. This is approximately 9 times the number of incidents recorded in 2016. Thereafter, a fluctuation in the number of incidents was observed between 2021 – 2022, before a steady decline till 2024 with number of cases dropping to 1697. From 2023 onward, the number of fires declined significantly to 147 cases and remained stable in 2024, indicating possible improvements in fire prevention, emergency response and traffic safety regulatory enforcement. However, the increase to 1860 incidents in 2025 suggests a slight resurgence in fire outbreaks, showing that although the situation improved compared to the peak years, fire risks remain present.

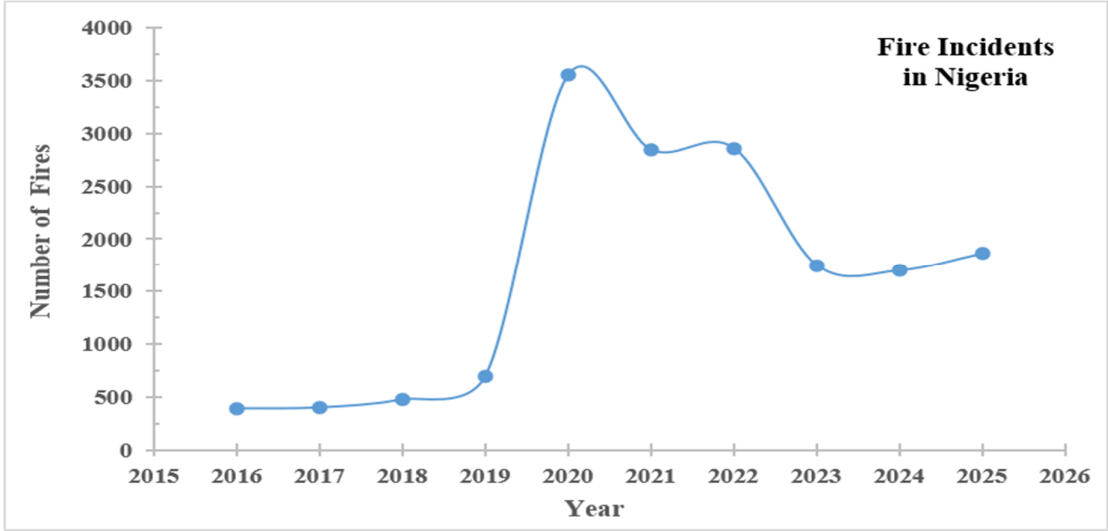


Figure 2. Number of fire incidents in Nigeria, 2016–2025.

Figure 3 shows the distribution of fire accident cases recorded across premise type from 2016 to 2025. This premise includes public building/government quarters, private dwellings, shops/markets, petrol station/transformers, automobile and others. For residential dwellings, the data steadily increase from 2016 till 2020 peaking 1382 cases, the largest share overall. This likely reflects the high number of households and common issues like faulty wiring, cooking gas explosion and unattended cooking. The annual fire incidence data for other premise/unknown locations revealed a fluctuating upward trend between 2016 and 2019. This was followed by a sharp increase in 2020 with 566 cases accounting for the second largest share after private dwellings. Although, fire occurrences remained relatively high through 2022 and afterwards, a progressive decline was observed from 2023 to 2025.

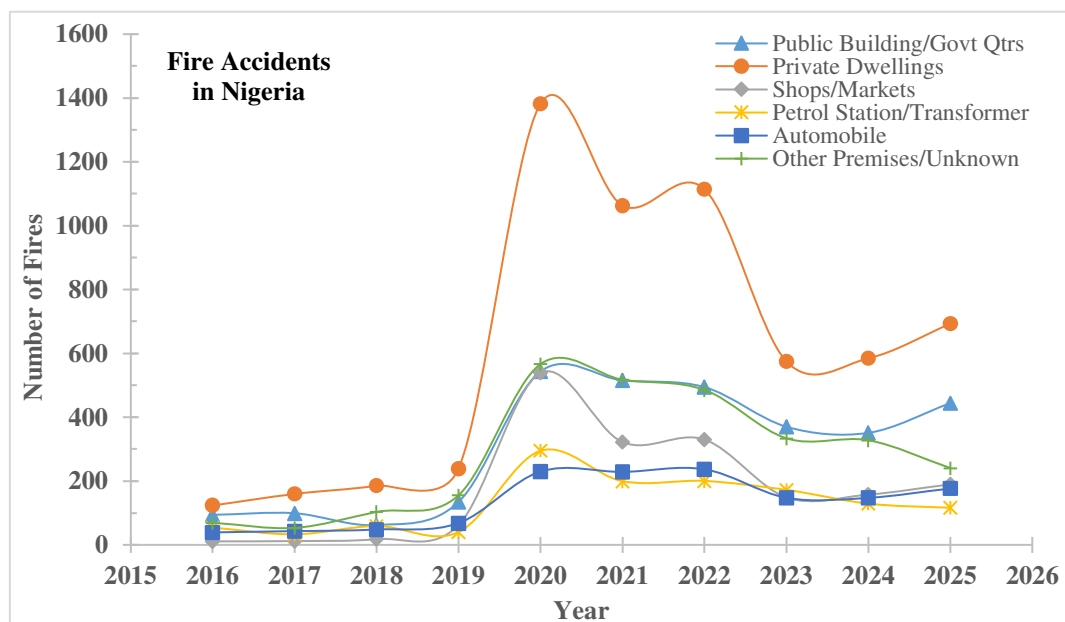


Figure 3. Number of fire incidents by premise type in Nigeria, 2016–2025.

Public buildings/government quarters exhibited near identical trajectories with other premise. In this premise, an irregular early trend was noticed between 2016 and 2019, followed by a sharp peak between 2020 and 2022 indicating about 543 and 494 cases respectively. A temporary decline was noticed, indicating a gradual decrease in fire outbreaks between 2021 to 2024, before it began to increase again 2025. The fire incidents in shops and markets remained relatively low between 2016 and 2018, indicating a stable period with limited commercial fire outbreaks. However, a noticeable increase occurred in 2019 rising to 62 cases, which may suggest growing commercial activities, overcrowding in markets, poor electrical installations or inadequate fire safety compliance. A dramatic increase was recorded in 2020 where fire accident cases increased sharply to 539, representing the peak period and indicating a major fire outbreak crisis in commercial areas. Possible contributing factors include electrical faults, poor market planning, storage of flammable materials and unsafe trading practices. Although the number of fire incidents declined after 2020, with a mean value of 326 cases between 2021 and 2022. A slight resurgence towards 2025 was observed. This indicates that commercial fire risks remain significant and require continuous monitoring and intervention.

Petrol stations and transformer fire incidents showed moderate fluctuations between 2016 and 2019 with no clear consistent upward or downward trend. These variations may have resulted from irregular electrical faults, fuel-related accidents or varying safety compliance levels. The fire outbreaks resulting from automobiles increased gradually from 39 to 68, indicating a steady rise in the occurrence of fire outbreaks during the pre-2020 period. This upward trend may reflect road traffic accident from increasing urban activities, human negligence, improper handling of flammable materials and vehicle related issues such as electrical faults, fuel system leakage, mechanical friction or brake failure, engine overheating. A major spike occurred in 2020 when fire incidents rose sharply to 230 cases. The number of fires then remained consistently high in 2021 and 2022 with 229 and 237 recorded cases respectively, suggesting a prolonged period of elevated fire risk rather than a temporary spike. This sustained peak may indicate persistent safety challenges, poor compliance with fire prevention measures and infrastructural problems.

Overall, across all premise types, cases increased from 2019 to 2020 before declining from 2020–2021. The 2020 spike likely reflects improved reporting and expanded fire service coverage, underlying growth which could include more buildings, more people and more activities across all the premise or specific events such as heat waves, dry seasons and economic activity spikes. The 2021

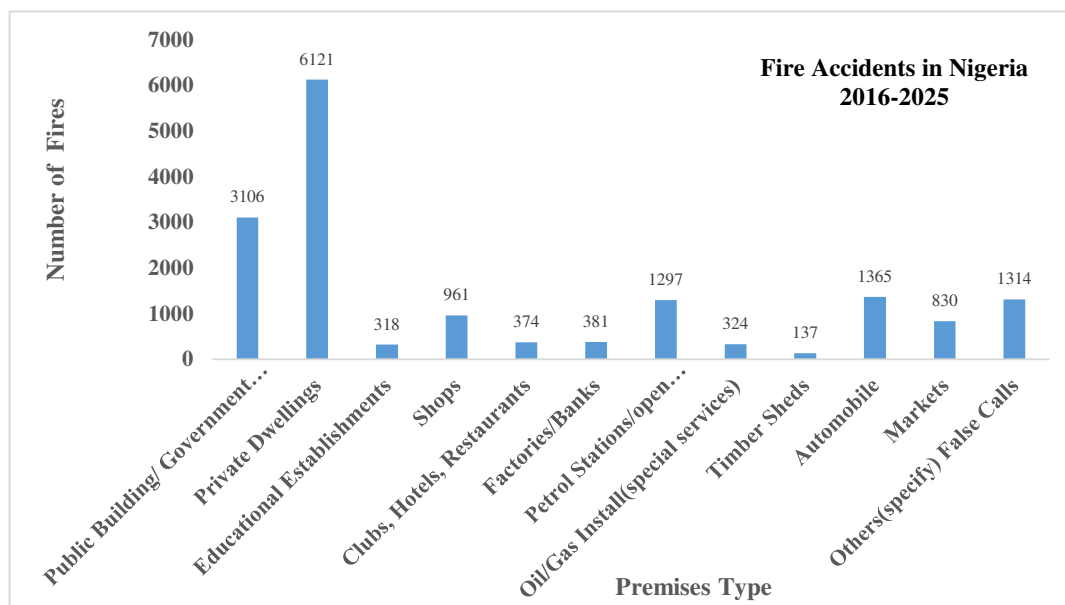


Figure 4. Number of fire incidents by premise type, 2016–2025.

decline coincides with reduced commercial and institutional activities during Nigeria’s Covid-19 lockdown and phased reopening periods.

Figure 4 presents the number of fire incidents in Nigeria per premise between 2016–2025. Private dwellings recorded the highest number of fire incidents with number of fires incidents peaking 6,121 cases, accounting for a about 37 per cent of all reported fires. Public buildings/government quarters recorded the second highest number of incidents with 3,106 fires, indicating that fires in public facilities also constitute a significant concern. The high frequency in these premises may be associated with the extensive use of electrical equipment, aging infrastructures and high occupancy levels.

Among the remaining premises, automobile fires, others/false calls and petrol stations/transformers recorded relatively high numbers of incidents with numbers of fires ranging from 1365 - 1297, suggesting that transportation or fuel related, and electrical fire hazards contribute significantly to overall fire occurrence. Other categories of fire incidents in premises such as timber sheds, educational establishments, banks/factories, oil and gas installations recorded comparatively fewer incidents. These findings suggest that residential buildings and public premises represent the primary hotspots for fire outbreaks and should therefore be prioritized in fire prevention, public awareness and safety intervention programs.

Number of Deaths

The trend in Figure 5 shows the number of deaths caused by fire incidents between 2016–2025 in Nigeria. The trend in lives lost for the selected study period shows considerable variation. No fatality was recorded in 2016 despite the considerable number of fire incidents recorded (see Fig 2). This indicates either the absence of fatal fire incidents or effective emergency interventions during that year. The number of deaths increased to 10 in 2017 and then decreased slightly to 5 in 2018. Thereafter, a progressive increase in the trend was observed indicating the increasing number of lives lost between 2018 – 2020 with the number of deaths peaking 147 in 2020. This dramatic increase indicates that 2020 was the most severe in terms of human impacts of fire disasters. The number of fatalities slightly decreased to 137 in 2021 and a more pronounced reduction was observed in 2022 when the number of lives lost decreased to 81, followed by a further reduction to 39 and 18 in 2023 and 2024 respectively. In 2025, a substantial increase was recorded with number of deaths increasing to 114.

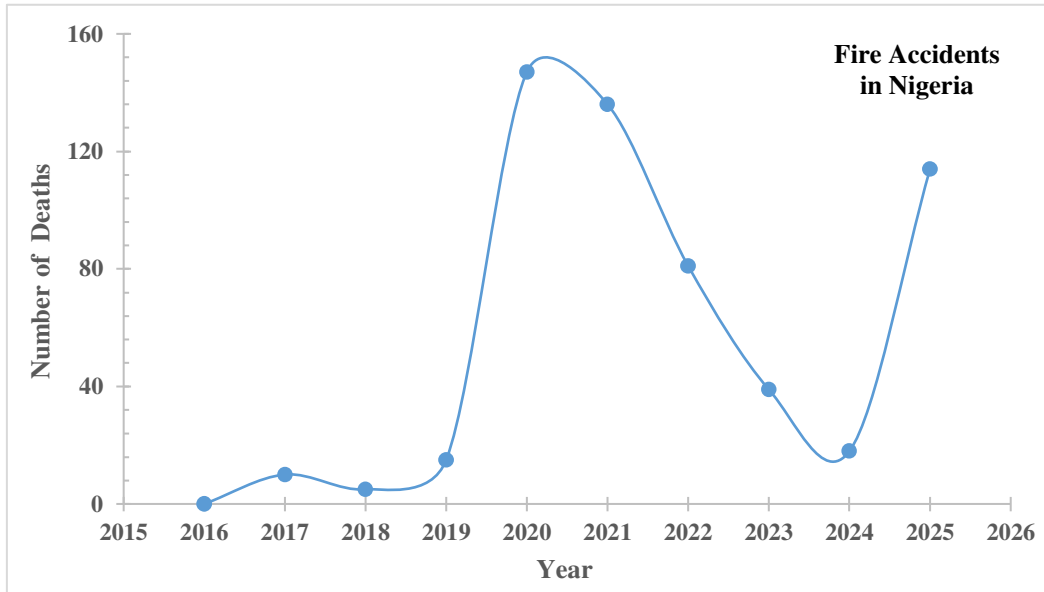


Figure 5. Number of deaths caused by fire incidents per year, 2016–2025.

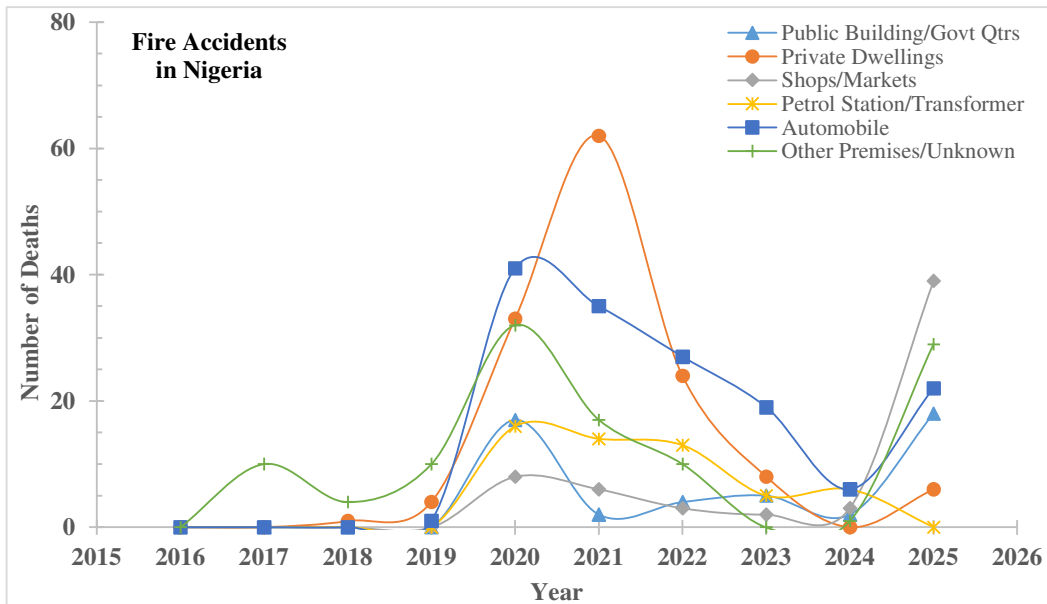


Figure 6. Number of deaths caused by fire incidents by premise type, 2016–2025.

The trend in Figure 6 shows the number of deaths per premise resulting from fire incidents between 2016–2025. Overall, the number of deaths caused by fire incidents from automobiles, public buildings/government quarters, shops/markets and transformers remained relatively low or absent between 2016 and 2019. However, a sharp increase in fatalities occurred from 2020 onward with some premises contributing more heavily than others. Private dwellings recorded the highest fatalities between this study period, with the number of lives lost peaking 62 in 2021. This was followed by automobiles with the total number of 41 deaths in 2020 making it the second largest premise with high

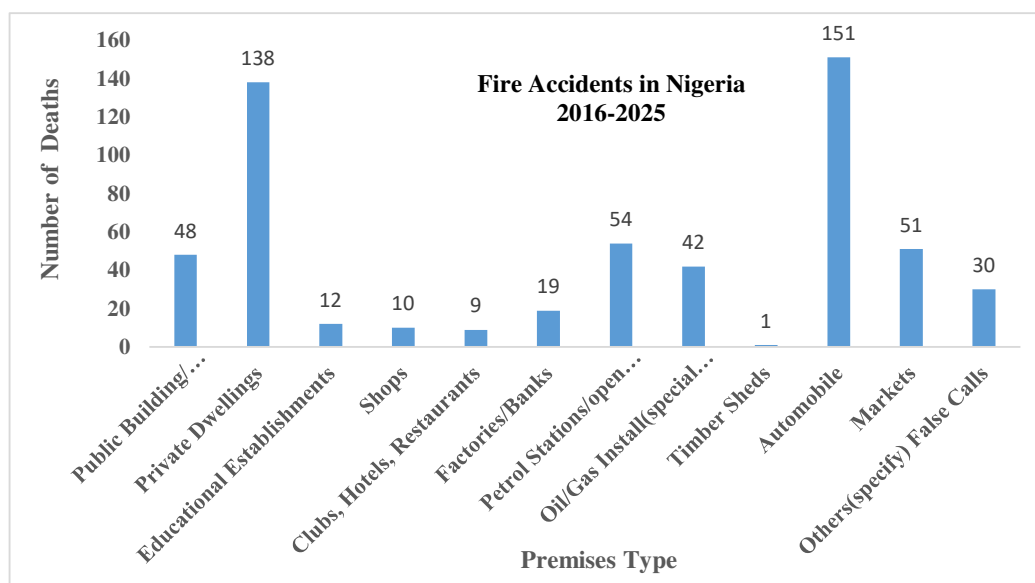


Figure 7. Number of deaths by premise type caused by fire incidents, 2016–2025.

mortality rate, highlighting the need for strengthened fire safety measures. Shops/markets, petrol stations/transformers and public buildings/government quarters contributed relatively fewer deaths.

Figure 7 shows the number of fatalities resulting from fire incidents across various premises between 2016–2025. Automobiles recorded the highest number of fatalities with 151 cases of death within the study period. This was followed by private dwellings with 138 cases. This is an indication that private dwellings and automobiles are more vulnerable to fire outbreaks, possibly due to faults from electrical connections, kitchen accidents, collisions, fuel leakage and inadequate fire safety practices at homes and on roads. While Petrol stations, markets and public buildings recorded 54, 51 and 48 cases of deaths respectively, other premises such as educational establishments, timber sheds and clubs recorded relatively low cases of fatalities, with number of casualties averaging to approximately 10 cases. A possible explanation to the low mortality cases recorded in these premises could be attributed to faster detection and evacuation, presence of fire safety infrastructure such as emergency exits and firefighting equipment, occupancy level during fire incidents especially in the case of timber sheds. Additionally, the structural characteristics of these premises such as educational establishments, clubs or restaurants may facilitate rapid escape, thereby reducing the likelihood of casualties.

Amount Lost to Fires

The trend in Figure 8 shows the total amount of properties lost to fire incidents taken across all the study premises between 2016–2025. For the ten-year period, Nigeria lost about N3426.63 billion to fire incidents. The fluctuations in the trend over the study period indicates variation in the severity and economic impact of the fire outbreaks. The property losses between 2016–2018 increased remarkably from ₦1.7 billion to ₦26.7 billion. This represents an increase of approximately 14.7 times, which suggests the growing economic burden of fire incidents. However, a sharp decline was observed in 2019 when the loss amount decreased to N16.5billion indicating a temporary reduction in the scale of damage and property destruction. In 2020, the amount of property losses increased again to ₦32.1 billion before increasing to ₦3,045.3 billion in 2021, making it the most remarkable surge within the study period, reflecting a worsening impact of fire incidents. Following this unprecedented peak, the amount of property loss dropped to ₦69.4 billion in 2022. Although fluctuations in the property loss were observed between 2022 – 2025. However, they remained considerably lower than the 2021 losses, indicating that the extreme losses recorded in 2021 were likely exceptional rather than part of a sustained trend.

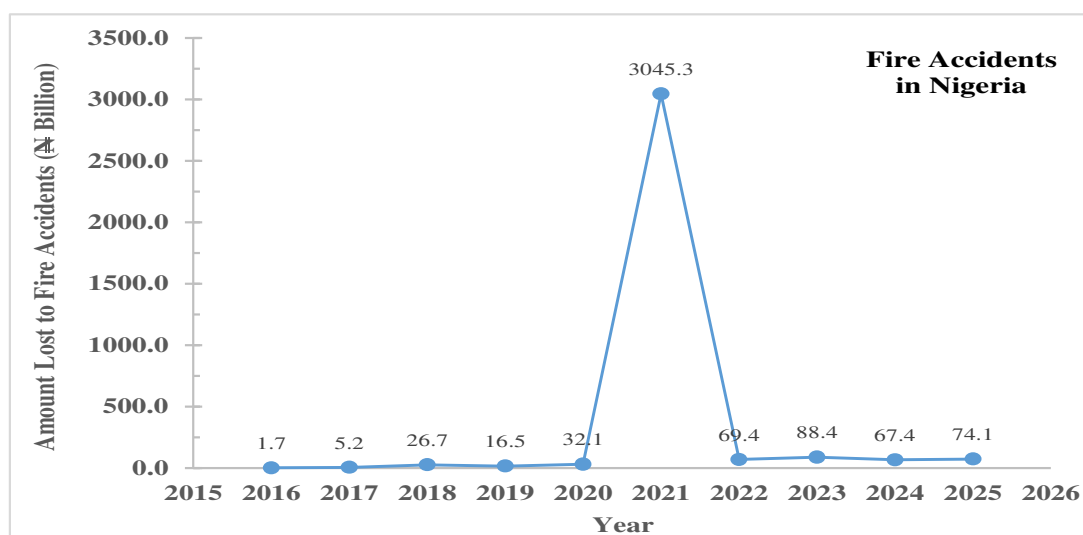


Figure 8. Amount lost to fire incidents across all premises, 2016–2025.

Figure 9 shows the amount of value of properties lost to fire incidents between 2016–2025. Markets recorded by far the highest property loss, amounting to approximately ₦3,076.2 billion resulting to severe economic impact. The high amount of property loss in markets is likely due to goods and business assets within this premise. Private dwellings and public buildings recorded about 86.7 and 83.6 billion Naira respectively resulting to substantial losses, while educational establishments and other premises recorded comparatively lower levels of damage.

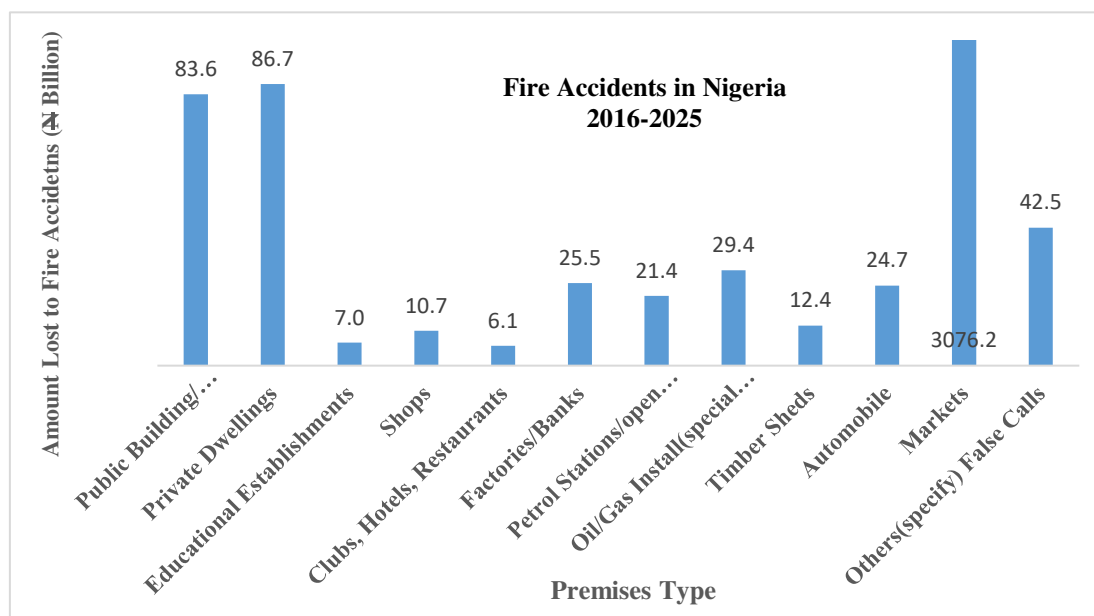


Figure 9. Amount lost to fire incidents by premise type, 2016–2025.

Summary of Results

The summary of results for the fire incidents from 2016-2025 in terms of fire severity and premises is shown in Table 1 and 2 respectively.

Table 1. Overview of fire severity in Nigeria from 2016-2025.

Year	No. of fires	%	Lives lost	%	Property lost (₦ billion)	%
2016	391	2.37	0	0.00	1.65	0.05
2017	400	2.42	10	1.77	5.18	0.15
2018	476	2.88	5	0.88	26.71	0.78
2019	698	4.22	15	2.65	16.46	0.48
2020	3555	21.51	147	26.02	32.12	0.94
2021	2845	17.21	136	24.07	3045.26	88.87
2022	2860	17.30	81	14.34	69.40	2.03
2023	1746	10.56	39	6.90	88.40	2.58
2024	1697	10.27	18	3.19	67.43	1.97
2025	1860	11.25	114	3.19	74.06	2.16
Total	16528	100.00	565	20.18	3426.63	100.00

Source: Compiled by author's, 2026

Table 2. Overview of fire severity in Nigeria from 2016-2025 based on premises.

Premises	No. of fires	%	Lives lost	%	Property lost (₦ billion)	%
Public Building/ Government Quarters	3106	18.79	48	8.50	83.6	2.44
Private Dwellings	6121	37.03	138	24.42	86.7	2.53
Educational Establishments	318	1.92	12	2.12	7.0	0.20
Shops	961	5.81	10	1.77	10.7	0.31
Clubs, Hotels, Restaurants	374	2.26	9	1.59	6.1	0.18
Factories/Banks	381	2.31	19	3.36	25.5	0.74
Petrol Stations/open ground/Transformer	1297	7.85	54	9.56	21.4	0.62
Oil/Gas Install (special services)	324	1.96	42	7.43	29.4	0.86
Timber Sheds	137	0.83	1	0.18	12.4	0.36
Automobile	1365	8.26	151	26.73	24.7	0.72
Markets	830	5.02	51	9.03	3076.2	88.79
Others	1314	7.95	30	5.31	42.5	1.24
Total	16528	100	565	100	3426.63	100

Source: Compiled by author's, 2026

Trend Analysis of National Fire Incidence

To complement the descriptive trend presented in Figure 3, a non-parametric Mann-Kendall Trend Test and Sen's Slope Estimator were applied to the national fire-count series (all premises summed per year) for the period 2016–2025, in order to statistically evaluate the direction and magnitude of the trend independent of the year-to-year fluctuations observed in the raw data.

The Mann-Kendall test returned a test statistic of $S = 21.00$ ($\text{var}S = 125.00$), a normalized statistic of $z = 1.79$ and Kendall's tau = 0.467, with an associated p-value of 0.074. Since the p-value exceeds the conventional 0.05 significance threshold, the null hypothesis of no trend cannot be rejected at the 5% level, although the result is significant at the 10% level. This suggests that, over the ten-year study period, national fire incidence exhibited a positive, but only marginally significant, monotonic upward trend. The Sen's slope estimator, which provides a robust, outlier-resistant estimate of the trend magnitude, indicated a median increase of approximately 182.5 fire incidents per year, with a 95% confidence interval of -49.0 to 411.5 . Because this interval spans zero, it further supports the conclusion of a positive but statistically inconclusive trend, consistent with the sharp 2020 spike and subsequent decline described in “Frequency of Fire Section” masking a weaker underlying long-term signal.

Figure 10 reproduces the premise-level trends shown earlier alongside linear reference lines. The trend lines confirm that private dwellings, automobile and public building/government quarters fires increased more steeply over the study period compared with shops/markets and petrol stations/transformers, whose reference lines are comparatively flatter, indicating that the modest but positive national trend identified by the Mann-Kendall test is driven disproportionately by a subset of premise types rather than a uniform increase across all categories.

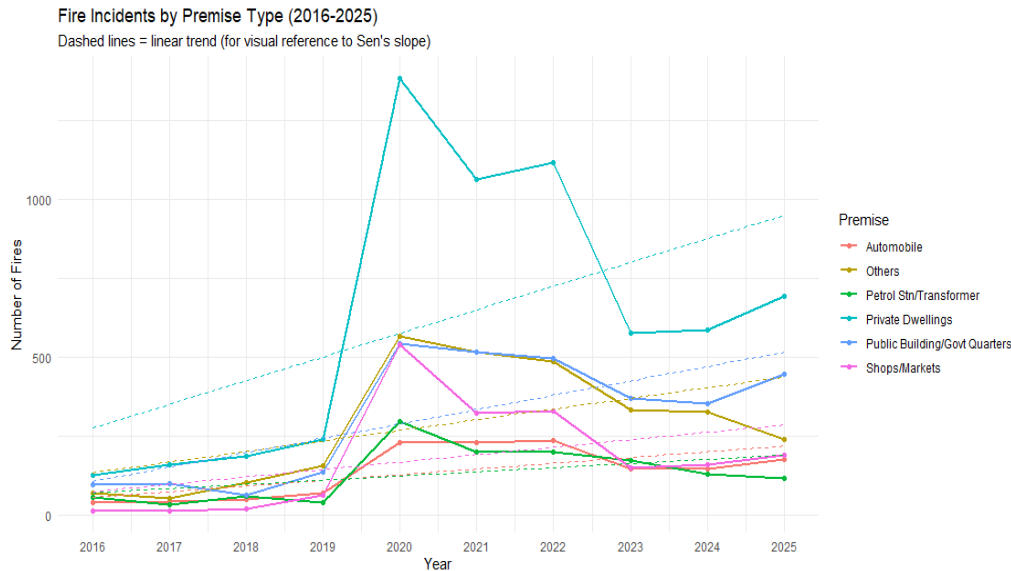


Figure 10. Number of fire incidents by premise type, 2016–2025, with linear trend lines.

Composite Fire Severity Index (CFSI)

Because fire incidents, fatalities and property losses are measured on different scales and do not necessarily convey the same information about risk, a Composite Fire Severity Index (CFSI) was constructed to obtain a single, unified measure of the relative severity of fire outbreaks across premises. Each of the three indicators, number of fires, number of deaths and property loss was first min-max normalized to a common 0–1 scale, after which Principal Component Analysis (PCA) was applied to the normalized indicator panel to derive a composite score.

The first principal component (PC1) accounted for 64.43% of the total variance in the normalized indicator panel, with the second and third components explaining a further 19.77% and 15.79% respectively (cumulative variance = 100%). Because PC1 captured the majority of the variation among the three indicators, it was retained and used as the Composite Fire Severity Index for each premise-year observation.

An examination of the PC1 loadings showed that the number of fires (loading = 0.672) and number of deaths (loading = 0.741) contributed strongly and positively to the composite index, whereas property loss contributed negligibly (loading = -0.002). This indicates that the CFSI, as derived,

predominantly reflects the frequency and lethality of fire incidents rather than their financial cost, implying that premises with frequent and fatal fire occurrences are ranked as more severe by the index even where the associated property loss is comparatively modest.

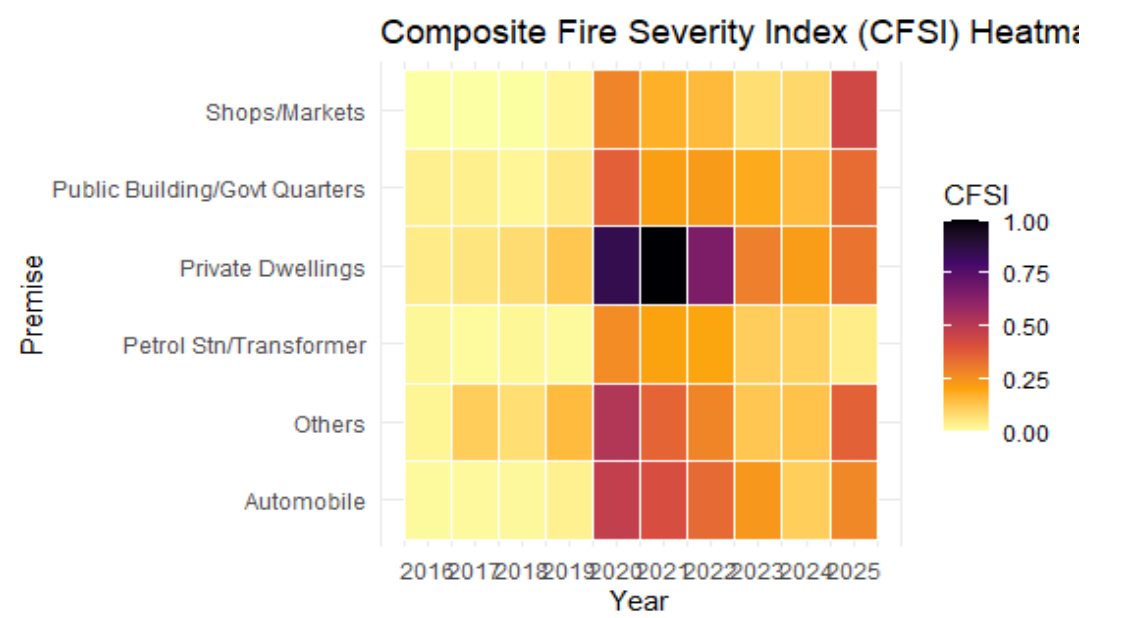


Figure 11. Mean Composite Fire Severity Index (CFSI) by premise type, 2016–2025.

Premises ranked by their mean CFSI (Fig 11) showed that private dwellings recorded the highest average severity score (0.366), reflecting the combined effect of the very high fire frequency and elevated fatalities associated with this premise. This was followed by the “Others” category (0.214) and automobiles (0.193). Public buildings/government quarters (0.163), shops/markets (0.123) and petrol stations/transformers (0.098) recorded comparatively lower composite severity scores, despite petrol stations and markets being associated with substantial property losses in absolute terms (*Amount Lost to Fires Section*), reinforcing the earlier observation that the CFSI is driven primarily by fire frequency and mortality rather than economic loss.

Hierarchical Clustering of Premises by Fire Risk Profile

To examine the extent to which premises with similar fire risk profiles naturally group together, agglomerative hierarchical clustering was performed on the standardized (scaled) premise-level averages of fire count, deaths and property loss. Prior to clustering, the optimal number of clusters was assessed using the average silhouette width method across candidate solutions of k = 2 to k = 5.

The silhouette analysis (Figure12) showed the average silhouette width fluctuating across the candidate values of k, with a local maximum at k = 3 before rising further at k = 4 and dropping sharply at k = 5. A three-cluster solution (k = 3) was adopted for the final classification, as it offered a good balance between within-cluster cohesion and a parsimonious, practically interpretable grouping of the six premise categories.

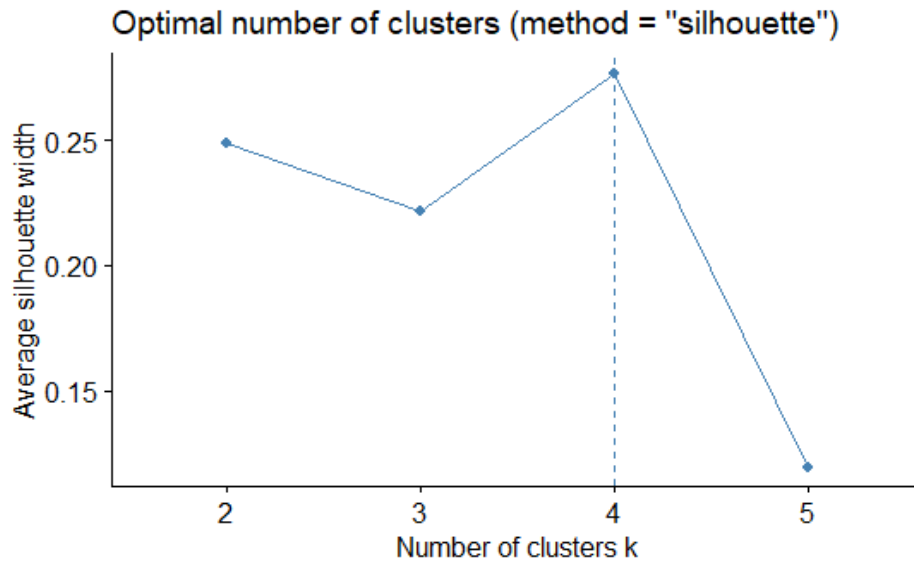


Figure 12. Optimal number of clusters for premise risk grouping using average silhouette width.

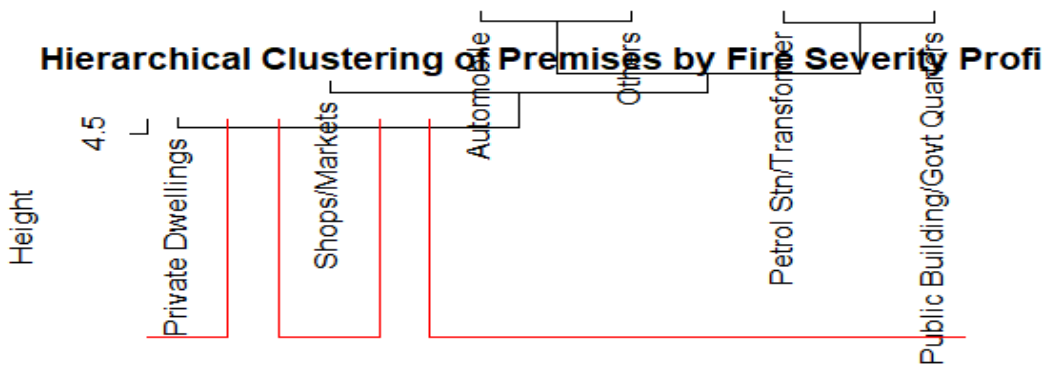


Figure 13. Dendrogram of hierarchical clustering of premises.

The resulting dendrogram (Figures 13 and 14) show that shops/markets separated from all other premises at the greatest linkage distance, reflecting its markedly distinct profile driven by the extraordinary property loss recorded in 2021. Private dwellings likewise formed a relatively distinct branch, consistent with its outstanding fire frequency and fatality profile. The remaining four premises which includes automobile, others, petrol stations/transformers and public buildings/government quarters merged at shorter linkage distances, indicating broadly similar, moderate risk profiles across these categories.

Premise Risk-Tier Classification (K-Means Clustering)

Building on the hierarchical clustering result, a k-means clustering algorithm ($k = 3$, $nstart = 25$) was fitted to the same scaled indicator matrix to assign each premise to a discrete fire risk tier. The resulting classification is presented in Table 3 and visualized in Figure 15.

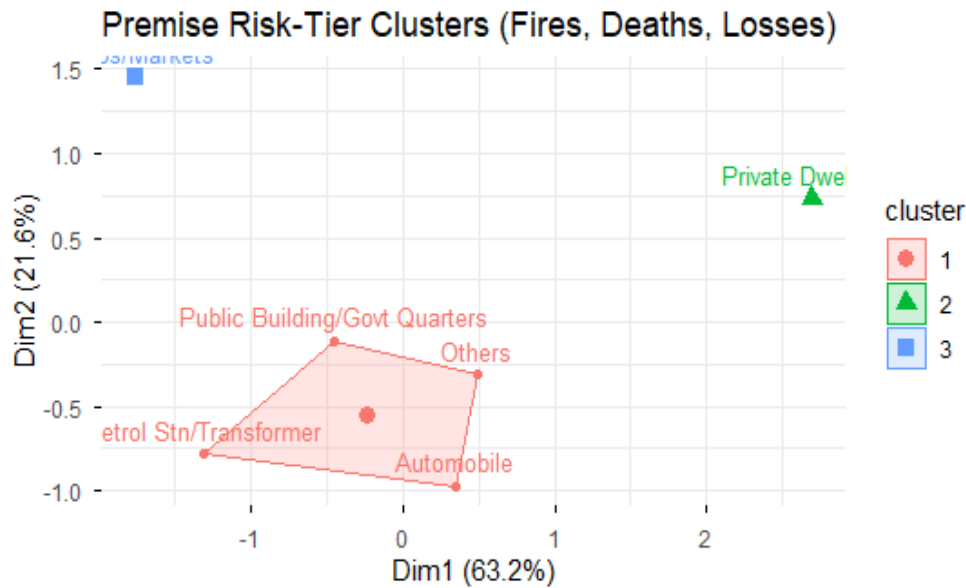


Figure 14. Premise risk-tier clusters derived from k-means classification ($k = 3$).

Table 3. Risk Tier Rating of Fire Incidents based on Premises in Nigeria

Premise type	Mean Fires	Mean Deaths	Mean Loss	Mean CFSI	Risk Tier
Private Dwellings	0.438	0.223	0.0029	0.366	2
Others	0.200	0.182	0.0041	0.214	1
Automobile	0.092	0.244	0.0008	0.193	1
Public Building/Govt Quarters	0.219	0.077	0.0028	0.163	1
Shops/Markets	0.123	0.098	0.103	0.123	3
Petrol Stn/Transformer	0.087	0.087	0.0007	0.098	1

The k-means solution grouped Others, Automobile, Public Building/Government Quarters and Petrol Station/Transformer into a single cluster (Risk Tier 1), characterized by generally low-to-moderate normalized fire counts, deaths and property losses. Private Dwellings formed its own cluster (Risk Tier 2), distinguished by the highest normalized fire frequency and a high mean CFSI, confirming its status as the leading contributor to fire incidence nationally. Shops/Markets formed a separate, singleton cluster (Risk Tier 3), driven almost entirely by its exceptionally high normalized property loss (0.103), which is more than an order of magnitude greater than any other premise, and is attributable to the extraordinary market fire losses recorded in 2021 (*Amount Lost to Fire Section*). This three-tier classification is broadly consistent with the hierarchical clustering result in *Hierarchical Clustering of*

Premises by Fire Risk Profile Section and provides a practical basis for prioritizing fire safety interventions: Risk Tier 2 and 3 premises (private dwellings and shops/markets) warrant the most urgent attention, the former on the basis of frequency and mortality, and the latter on the basis of economic exposure while Risk Tier 1 premises can be addressed through routine, standardized fire safety measures.

Negative Binomial Regression Analysis of Fire Incidence

Given the over dispersed count nature of the annual fire-incident data, a negative binomial generalized linear model (Fires ~ Year + Premise) was fitted to formally test whether fire incidence varied significantly over time and across premise types, using private dwellings as the reference category.

Table 4. Incidence rate ratio of fire incidents across premises

Predictor	Estimate	IRR (exp(coef))	95% CI	p-value
Year	0.209	1.232	1.147 – 1.324	< 0.001
Automobile	–1.500	0.223	0.127 – 0.392	< 0.001
Others	–0.759	0.468	0.267 – 0.821	0.008
Petrol Stn/Transformer	–1.502	0.223	0.127 – 0.391	< 0.001
Public Building/Govt Quarters	–0.701	0.496	0.283 – 0.870	0.014
Shops/Markets	–1.271	0.281	0.160 – 0.493	< 0.001

The model showed a highly significant positive effect of Year ($\beta = 0.209$, $z = 7.27$, $p < 0.001$), corresponding to an incidence rate ratio (IRR) of 1.232 (95% CI: 1.147 – 1.324). This indicates that, after adjusting for premise type, the expected number of fire incidents increased by approximately 23.2% per year over the study period, corroborating the marginally positive Sen's slope trend reported in Figure 10, but with far greater statistical precision once the premise-level structure of the data is accounted for.

All premise categories showed significantly lower fire incidence than private dwellings, the reference category. Automobile and petrol station/transformer premises recorded the largest reductions, with IRRs of 0.223 in both cases ($p < 0.001$), indicating that fire incidence in these premises was approximately 78% lower than in private dwellings. Shops/markets (IRR = 0.281, $p < 0.001$), public buildings/government quarters (IRR = 0.496, $p = 0.014$) and the “Others” category (IRR = 0.468, $p = 0.008$) similarly recorded significantly lower incidence rates, ranging from roughly 50% to 53% lower than private dwellings. These results confirm, in a multivariate framework, the descriptive finding from Section 3.1 that private dwellings are the dominant driver of fire incidence in Nigeria, while also demonstrating a statistically robust year-on-year escalation in fire occurrence nationally.

The model achieved an estimated dispersion parameter (theta) of 2.485 (SE = 0.436), and the reduction in deviance from the null model (142.114 on 59 degrees of freedom) to the fitted model (63.887 on 53 degrees of freedom) indicates that Year and Premise jointly explain a substantial proportion of the variation in fire counts. The model recorded an AIC of 757.1, providing a well-fitting basis for the incidence-rate conclusions reported above.

Conclusion

This study presents an analysis of fire incidents in Nigeria from 2016–2025. A total of 16,528 fire incidents, 565 fatalities and about ₦3,426.63 billion in property losses were recorded during the study period. Findings have shown that fire incidents did not occur at a steady rate. The highest number of fire incidents was recorded in 2020. Fluctuations were also observed in fatalities and property losses

within this study period. Results have also revealed the variation in the severity of fire incidents across different premise types. Private dwellings recorded the highest number of fire incidents, while automobiles recorded the highest number of fatalities. Markets recorded worrisome property losses, indicating the devastating effects of fire incidents on the nation's economy. These patterns suggest that fire prevention strategies should not be uniformly applied across all premise type, but should instead, consider the specific risks and characteristics of different premise types.

The study further highlights the need for strengthened fire prevention and fire safety regulatory strategies such as improved safety compliance, regular inspection of high-risk premises (like markets and automobiles), improved fire detection and suppression systems. This study has also demonstrated the importance of maintaining accurate and comprehensive fire incident records to support evidence-based planning and resource allocation thereby, significantly reducing future fire incidents.

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