EP-JOURNALS

GLOBAL JOURNAL OF EDUCATION, FINANCE & MANAGEMENT

Available on: https://gjefm.ep-journals.org/ E-ISSN: 3117-6771, P-ISSN: 3117-6763

Global Journal of Education, Finance and Management

Volume: 02 Issue: 09 September 2026

Analysis of Fire Trends and Losses in Vietnam During 2021–2025

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Published Date: September 14, 2026 **DOI: 10.65150/EP-gjefm/V2E9/2026-02**

ABSTRACT: Against the backdrop of rapid urbanization and economic development in Vietnam, fires continue to cause substantial human and property losses. This study analyzes trends and the magnitude of fire-related losses in Vietnam during 2021–2025 using annual secondary data on fire incidents, fatalities, injuries, and property damage. Descriptive statistics and a linear time-trend regression are employed. Over the five-year period, 14,689 fire incidents were recorded, resulting in 531 fatalities, 512 injuries, and estimated property damage of VND 3,330.727 billion. Fire incidence fluctuated markedly, rising from 1,741 incidents in 2022 to 4,112 in 2024 before declining to 3,151 in 2025. The estimated regression is $\hat{Y} = 1{,}682.9 + 418.3t$, with $R^2 = 0.488$, adjusted $R^2 = 0.317$, and $p = 0.190$ for the time coefficient. Although the estimated time coefficient is positive, the evidence is insufficient to establish a statistically significant linear trend over the study period. Given that the series contains only five annual observations, the regression is interpreted as exploratory rather than predictive. The findings support further standardization of fire statistics, stronger risk-prevention and infrastructure measures, and greater use of information technology in fire prevention, firefighting, and rescue management.

KEYWORDS: fire incidents, fatalities, injuries, property damage, statistics, regression, trend, Vietnam

1. INTRODUCTION

Fire is a major risk to human safety, property, and socioeconomic activity. In urban environments, residential fire risk is associated with socioeconomic conditions, building quality, and characteristics of the built environment [10]. In Vietnam, published data for 2021–2025 indicate a complex fire situation with substantial human and property losses. Fires have occurred in residential areas, dwellings, manufacturing facilities, and commercial establishments, underscoring the need to strengthen fire prevention, firefighting, and rescue (FPFR) and data-informed risk management [15–19].

Against this background, this study analyzes fire trends and losses in Vietnam during 2021–2025 using statistical methods. Specifically, it pursues three objectives: (i) to examine changes in the number of fire incidents over time; (ii) to assess human and property losses; and (iii) to apply a linear regression model as an exploratory assessment of the temporal trend in fire incidents. The results provide additional quantitative evidence to support improvements in FPFR and the reduction of fire risk.

2. THEORETICAL FOUNDATION AND INTERNATIONAL STANDARDS FRAMEWORK

2.1. Theoretical Foundation of Fire Prevention, Firefighting, and Fire Risk Management

Fire prevention and firefighting constitute a core component of risk management, with the objectives of reducing the likelihood of fire occurrence and limiting consequences when an incident occurs. In fire risk assessment, common objectives include protection of life, property, business continuity, and the environment [9]. From a management perspective, prevention focuses on controlling risk factors; early detection relies on warning and monitoring systems; and effective response depends on FPFR capability, infrastructure conditions, and coordination among relevant stakeholders. Accordingly, fire risk management requires the integration of technical, human, organizational, and data-related factors.

From a statistical perspective, fire incidents also vary over time and are influenced by multiple stochastic factors. Time-series analysis can characterize temporal variation, identify trends, and, where the data are adequate, support forecasting models [1, 7]. The application of time-series methods and statistical modeling should therefore be aligned with series length, data quality, and the research objective.

2.2. International Standards Framework

At the international level, research on fire patterns should distinguish among three components: (i) fire risk-assessment frameworks; (ii) systems of fire-incident indicators; and (iii) statistical methods for data analysis. This distinction avoids conflating technical standards with statistical models and helps ensure that analytical results are interpreted in relation to clearly defined data and management objectives [1, 9, 11].

With respect to risk assessment, ISO 16732-1:2012 provides a conceptual basis for the quantitative assessment and interpretation of fire risk, including objectives related to life safety, property protection, continuity of operations, and environmental protection [9]. The standard establishes principles for fire risk assessment but does not prescribe a specific statistical forecasting model.

In terms of indicators, international fire statistics commonly track the number of fire incidents, fatalities, injuries, and direct property losses. These four indicators are also used in the long-term analysis of Chinese fire statistics by Luo et al. [11]. Maintaining a consistent set of indicators over time is essential for comparing trends and the magnitude of losses.

Methodologically, linear regression and time-series models such as ARIMA are statistical and forecasting tools rather than mandatory requirements of fire-safety standards. Model selection should be based on series length, data structure, model assumptions, and the analytical objective [1, 2, 7]. When the available series is short, results should primarily be interpreted as exploratory and should not be generalized beyond what the data support.

Beyond temporal analysis, research on urban fire risk has increasingly incorporated spatial analysis and geographic information systems (GIS) to examine relationships between fire risk, socioeconomic characteristics, and the built environment [10]. Big-data and artificial-intelligence approaches represent potential future directions, but they should be applied only when the underlying data are sufficiently detailed, stable, and verifiable.

Accordingly, the most appropriate international reference framework for this study is not a single analytical model but three principles: standardized indicators, data quality and comparability, and analytical methods proportionate to the characteristics of the sample. These principles provide the basis for using descriptive statistics and linear regression to assess fire trends during 2021–2025 [1, 7, 9].

2.3. Implications for Research in Vietnam

Based on the above framework, improvements in the analysis of fire patterns in Vietnam should focus on the following directions:

- Standardization of the statistical indicator system [12, 14]
- Application of time-series and regression models [1, 7]
- Integration of data from multiple sources
- Development of technology-enabled fire forecasting systems

These directions can improve data consistency, strengthen the interpretability of analytical results, and support evidence-based FPFR policymaking [7, 9].

3. RESEARCH METHODOLOGY AND INSTITUTIONAL ANALYSIS

This study uses secondary data on fires in Vietnam during 2021–2025, covering four main indicators: the number of fire incidents, fatalities, injuries, and property damage. The data were compiled and cross-checked from annual official publications of the Police Department for Fire Prevention, Firefighting and Rescue and the University of Fire Prevention and Fighting [15–19]. Statistical reporting within the People's Public Security Force is governed by Circular No. 14/2019/TT-BCA and C07 guidance on reporting and statistical activities [12, 14]. Annual published figures were used for each year. Because definitions, aggregation practices, and comparison baselines may differ across some annual releases, the five-year series is treated as a descriptive series based on published annual data; this limitation is explicitly considered when interpreting the regression results.

Two principal analytical approaches are employed. First, descriptive analysis is used to examine trends and year-to-year variation in the fire indicators. Second, linear regression is used to estimate the temporal trend in the annual number of fire incidents [6, 20]. Because the dataset contains only five annual observations, the regression results are interpreted as exploratory and are not considered a sufficiently robust basis for long-term forecasting.

The analytical procedure comprises data standardization and cleaning, calculation of descriptive statistics, graphical presentation, and estimation of the linear regression model. This approach enables the overall temporal pattern to be described while also highlighting the degree of variation in fire incidence during 2021–2025 [6, 20].

In addition to the quantitative analysis, the study considers the institutional context of fire prevention and firefighting in Vietnam during the study period. For most of the period, Decree No. 136/2020/ND-CP was a key instrument detailing provisions and implementation measures under the legislation on fire prevention and firefighting [3]. This regulatory framework directly addressed state management, fire-safety conditions, responsibilities of agencies and organizations, and the operation of specialized forces.

Vietnam's FPFR legal framework continued to evolve during 2021–2025. Decree No. 50/2024/ND-CP amended and supplemented several provisions of Decree No. 136/2020/ND-CP [4]. The Law on Fire Prevention, Firefighting and Rescue No. 55/2024/QH15 took effect on 1 July 2025 [13]. From the same date, Decree No. 136/2020/ND-CP ceased to be effective, and the new implementation framework was established under Decree No. 105/2025/ND-CP, dated 15 May 2025, which details a number of provisions and measures for implementing the new Law [3, 5, 13]. This transition highlights the need for regular updates to management standards, data systems, and implementation arrangements. Accordingly, the study combines statistical analysis with consideration of the institutional context to support evidence-based assessment and policy recommendations.

4. RESULTS

4.1. Trends in Fire Incidents

Based on annual official publications of the Police Department for Fire Prevention, Firefighting and Rescue and the University of Fire Prevention and Fighting [15–19], the results are presented and discussed as follows:

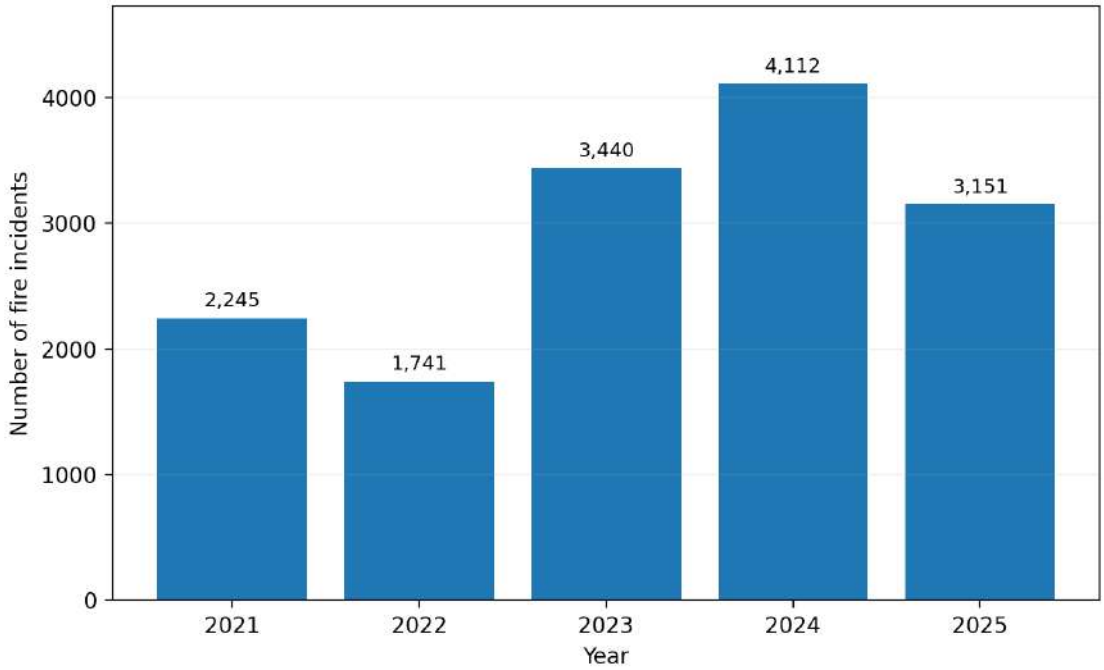

Figure 1. Number of fire incidents in Vietnam, 2021–2025
(Source: Compiled from official publications for 2021–2025 [15–19])

The annual number of fire incidents fluctuated markedly during 2021–2025. Specifically, the number declined from 2,245 incidents in 2021 to 1,741 in 2022, then increased to 3,440 in 2023 and 4,112 in 2024 before falling to 3,151 in 2025 [15–19]. Across the five-year period, 14,689 fire incidents were recorded, averaging approximately 2,938 per year, or about eight incidents per day. Because published annual figures may be affected by differences in recording, aggregation, and statistical comparison practices, this pattern should be interpreted cautiously. Nevertheless, the magnitude and variability of fire incidence indicate that fire risk remains a significant concern and reinforce the need for stronger prevention, risk management, and data use in FPFR.

4.2. Fire-Related Losses

Human and property losses due to fire during 2021–2025 were substantial. Based on the published annual figures, fires resulted in a total of 531 fatalities and 512 injuries, with estimated property damage of VND 3,330.727 billion [15–19]. This corresponds to annual averages of approximately 106 fatalities, 102 injuries, and VND 666.15 billion in property damage. These variations indicate that the severity of losses depends not only on the number of incidents but also on the scale, location, and characteristics of individual fires, highlighting the need for more effective prevention and risk-control measures.

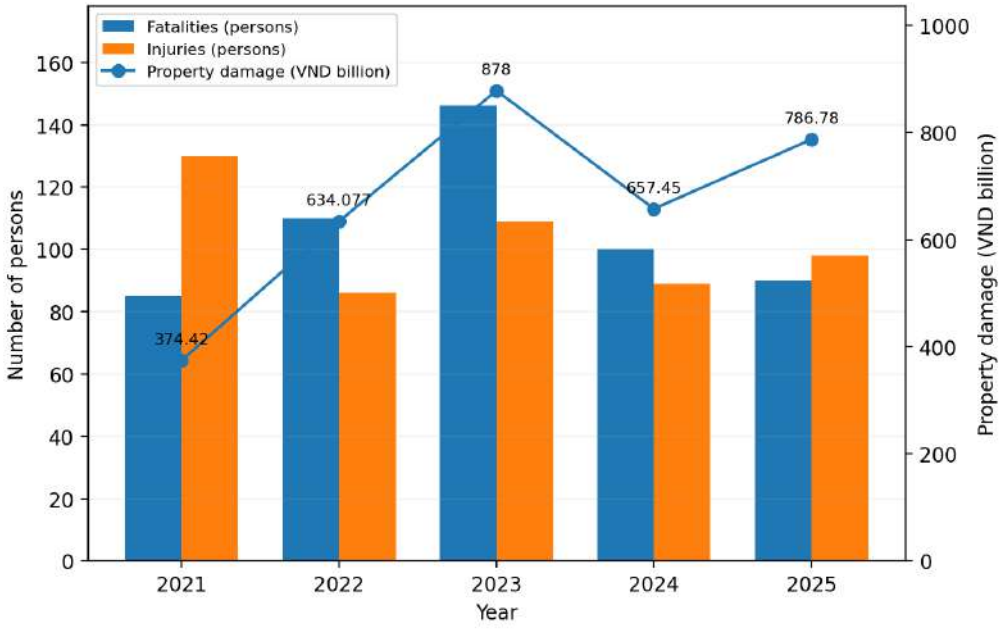

Figure 2. Fire-related human and property losses in Vietnam, 2021–2025
(Source: Compiled from official publications for 2021–2025 [15–19])

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4.3. Linear Regression Results

Using the published annual fire-incident series for 2021–2025, a linear regression model was estimated with the time variable coded as t = 1, 2, 3, 4, 5. The estimated model is $\hat{Y} = 1{,}682.9 + 418.3t$. The regression coefficients, standard errors, t statistics, p values, and goodness-of-fit measures are interpreted according to standard linear-regression conventions [6, 20]. Because the series contains only five observations and the annual releases may not be fully comparable, the regression is used solely for exploratory trend assessment and not as a basis for long-term forecasting.

Table 1. Linear regression results

Variable	Estimate (β)	Std. error	t statistic	p value
Intercept (β0)	1,682.9	821.1	2.05	0.133
Time (β1)	418.3	247.6	1.69	0.190

Model statistics:

- $R^2 = 0.488$
- Adjusted $R^2 = 0.317$
- Number of observations = 5

Interpretation

- The estimated time coefficient ($\beta 1 = 418.3$) indicates an average increase of approximately 418 fire incidents per year within the fitted model. This is an estimated linear tendency based on five annual observations and should not be interpreted as a fixed year-on-year increase.
- The p value for the time coefficient is 0.190, which exceeds the 0.05 significance level. Therefore, there is insufficient statistical evidence to conclude that the linear upward trend is statistically significant during the study period. This result is consistent with the very small sample and substantial year-to-year variation [6, 20].
- The model explains approximately 48.8% of the variation in annual fire incidents ($R^2 = 0.488$), while the adjusted R^2 is 0.317. The model therefore has limited explanatory power, with a substantial share of variation remaining unexplained. The regression should be regarded as an exploratory analysis rather than a forecasting model.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Key Factors Contributing to Severe Fire Losses

Based on official publications for 2021–2025, many fires with severe human consequences occurred in households and mixed residential–production or residential–business premises, where fire-safety and evacuation conditions may be inadequate [15–19]. The following factors may contribute to the severity of losses:

- Limited public awareness of and responsibility for fire safety: some residents do not consistently comply with fire-safety requirements, particularly those governing the safe use of electrical equipment; fail to provide basic firefighting equipment; store or use combustible goods in production and business activities without adequate preventive measures; or renovate and extend buildings or use combustible materials without ensuring appropriate fire-safety conditions [15–19].

- Regulatory requirements for households and mixed residential–production or residential–business premises require continued updating in response to changing practice. During the study period, Vietnam's FPFR regulations were amended and transitioned to a new legal framework through Decree No. 50/2024/ND-CP, the Law No. 55/2024/QH15, and Decree No. 105/2025/ND-CP [4, 5, 13]. This transition creates a continuing need for appropriate guidance, implementation, and inspection across different types of premises.

- Characteristics of the urban residential structure may not adequately satisfy fire-safety requirements:

+ Closely spaced tube houses may lack adequate fire separation, secondary escape routes, or measures to prevent fire spread. Multiple security doors, metal cages, or advertising structures that cover balconies and façades may also obstruct evacuation and access for firefighting and rescue operations [15–19].

+ Fire-service access: in many urban residential areas, narrow and winding streets and alleys, together with high building density, may restrict access by fire engines and constrain the deployment of firefighting and rescue operations. These constraints should be incorporated into firefighting plans and urban infrastructure design [15–19].

+ Firefighting water supply: the availability of water depends on hydrant density, pressure, flow rate, and accessibility at the incident location. In densely populated areas or deep alleys, limited access to suitable water sources may reduce firefighting effectiveness; regular review and improvement of hydrants, water tanks, and designated firefighting water points are therefore necessary [15–19].

+ Electrical systems: deteriorated wiring, technically inadequate connections, overloaded equipment, and insufficient protective devices may increase the likelihood of short circuits and overheating. For dwellings and small businesses, periodic inspection and upgrading of electrical systems and appropriate protective devices are important preventive measures [15–19].

- Electrical-system failures are a frequently reported category of fire cause. Relevant scenarios include short circuits, overloaded wiring, deteriorated electrical equipment, ad hoc connections, and simultaneous use of multiple high-power appliances. In mixed residential–business premises, electrical systems may be modified repeatedly without coordinated engineering design, increasing the risk of overheating and fire spread to nearby combustible materials [15–19].

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- Public education and dissemination of fire-safety knowledge and skills should be sustained and tailored to different target groups. Limited knowledge of legal requirements, evacuation procedures, and the use of first-response firefighting equipment among part of the population means that community awareness remains a central component of fire prevention [15–19].

- Weather and environmental conditions may increase fire risk, particularly wildfire risk. Heat, drought, and other fire-conducive weather conditions are increasingly relevant in the context of climate change, while strong winds may accelerate fire spread. International climate assessments indicate that climate change is associated with increases in fire-weather conditions in many regions [8].

5.2. Recommendations

Fire patterns in Vietnam during 2021–2025 remained complex, with marked fluctuations in incident frequency and substantial human and property losses [15–19]. A coordinated set of measures is therefore required to reduce fire occurrence and mitigate consequences when incidents occur. The study proposes the following recommendations:

- Conduct systematic baseline assessments of fire safety, including the number and distribution of households and businesses; available firefighting equipment; evacuation, smoke-control, and fire-separation conditions; building design and construction materials; and relevant transport access, water supply, and electrical infrastructure [15–19].

- Review the legal and regulatory framework governing FPFR and propose amendments where necessary to reflect current conditions; continue improving technical standards and regulations for different building types, particularly high-rise and super-high-rise buildings, chemical plants, and petroleum-related facilities [3–5, 13].

- Strengthen communication, public education, and legal awareness relating to FPFR, while promoting broad community participation. Priority should be given to household heads, business operators, and high-risk groups. Communication should be diversified and combined with practical training in evacuation and the use of first-response firefighting equipment [15–19].

- Strengthen training and professional development for FPFR personnel to ensure adequate legal knowledge, technical competence, professional responsibility, and the capacity to meet evolving operational requirements.

- Improve firefighting and rescue effectiveness for households and mixed residential–production or residential–business premises with elevated fire and explosion risks. Local authorities should be involved in developing realistic firefighting plans and organizing drills, while relevant agencies should coordinate to ensure suitable access routes and firefighting water supplies [3, 4, 15–19].

- Expand the use of information technology in FPFR by developing an integrated national digital database on fire incidents, causes, losses, types of premises, population density, and relevant risk factors. This direction is consistent with the need to improve the consistency of reporting and statistical work within the People's Public Security Force [12, 14]. Digitalization would facilitate statistical analysis, trend assessment, and the selection of preventive measures. In parallel, software and applications should be developed to support public education, evacuation guidance, fire reporting, and rapid communication with firefighting services. A coordinated digital approach can contribute to modernizing FPFR and improving both prevention and emergency response.

The observations of this study are broadly consistent with international research showing that urban fire risk is related to socioeconomic characteristics and the built environment [10], while consistent tracking of fire incidents, fatalities, injuries, and direct property losses provides an important basis for evaluating temporal patterns [11]. For wildfires, climatic factors and extreme weather conditions should also be considered in risk assessment [8].

5.3. Conclusion

Overall, fire patterns in Vietnam during 2021–2025 exhibited substantial year-to-year variation and continued to generate considerable human and property losses. The regression analysis produced a positive time coefficient, but the coefficient was not statistically significant at the 5% level; consequently, the available evidence does not support the conclusion that a stable linear upward trend existed throughout the study period. The principal contribution of the study is the systematic organization of key indicators, the quantitative description of the scale and variability of fire incidents and losses, and the identification of a need for more data-driven fire risk management. The main limitations are the very short annual series of five observations and the possibility of differences in statistical aggregation across annual publications. Future research should use monthly or quarterly data, extend the observation period, and incorporate explanatory variables such as population density, type of premises, infrastructure characteristics, weather conditions, and fire causes to improve analytical and forecasting capacity.

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