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A GROWING RISK IN FLAMES: A SOCIO-SPATIAL ANALYSIS OF THE FIRE INCIDENTS IN ISTANBUL

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ABSTRACT

This study offers a comprehensive assessment of the socio-spatial dimensions of the recent increase in fire incidents in Istanbul. The purpose of the research is to identify the underlying causes, spatial patterns, and socio-economic determinants of urban fire risks, and to develop evidence-based recommendations for effective fire management policies. The research analyzes the primary causes of fires, their spatial distribution patterns, response times, and frequency across districts. The findings reveal that fires caused by electrical faults constitute the most dominant type of fire incident in the city. This is particularly evident in areas where technical infrastructure is outdated and maintenance is inadequate, thereby heightening the risk of fire. Building fires account for a significant portion of total incidents, while vehicle and natural area fires represent other critical dimensions of urban fire risk. Spatial distribution analyses across districts indicate that fire frequency is significantly higher in densely populated and rapidly urbanizing areas such as Esenyurt, Bağcılar, and Pendik. Response times of firefighting services are shorter in central urban areas due to better-developed infrastructure and transportation networks; however, they are relatively longer in peripheral and forested regions. These data suggest that fire risk is not only associated with physical and technical infrastructure deficiencies but also shaped by socio-economic factors and spatial inequalities. In conclusion, enhancing the effectiveness of fire management in Istanbul requires the modernization of infrastructure, public awareness initiatives, strengthening firefighting capacity, and the integration of spatial risk maps with socio-economic parameters. This study underscores the importance of interdisciplinary and multidimensional approaches to fire prevention and offers a comprehensive perspective to guide policymakers and practitioners in the field.

Keywords: Fire, Socio-Spatial analysis, Urban safety, Firefighting, Istanbul

INTRODUCTION

Combustion is an exothermic chemical reaction that occurs when a combustible material interacts with oxygen and heat in specific proportions, releasing a significant amount of heat and light into the surrounding environment. For this reaction to take place, three essential elements—fuel, oxygen, and heat—must coexist simultaneously under suitable conditions. This trio is commonly referred to in the literature as the “fire triangle”. If any one of these elements is removed from the environment, the reaction ceases, and the combustion process comes to an end (Glassman et al., 2014; Pédrot & Tabareau, 2019). When this chemical process cannot be controlled, the phenomenon of fire emerges. Fire represents an uncontrolled combustion process that escalates into a hazardous event, posing threats to human life, the environment, infrastructure, and economic assets. Fire incidents are inherently multifaceted and cannot be attributed to a single cause. A range of factors—including accidents, human error, negligence, sabotage, technical malfunctions, lack of adequate training, insufficient or absent preventive measures, natural events (e.g., lightning strikes), and fire spread from external sources—can contribute to the outbreak of fires (Quintiere, 2006; Williams, 2020).

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Throughout history, fires have profoundly impacted not only individual living spaces but also societal structures, urban fabric, and natural ecosystems. In addition to causing loss of life and significant property damage, large-scale fires may also lead to secondary consequences such as psychological trauma, migration movements, and economic collapse. This chemical process, which begins with the combination of the fundamental components of fire—fuel, heat, and oxygen—in specific proportions, brings with it multidimensional risks when it gets out of control. Therefore, fires are not only associated with physical destruction but also fall within the scope of academic research due to their social, environmental, psychological, and economic impacts. The complex and multifaceted nature of fire necessitates interdisciplinary approaches, calling for the development of risk management strategies, disaster planning, educational policies, and technological solutions (Gill, 2005; Clark et al., 2015).

In order to effectively prevent fire incidents and to control them rapidly once they occur, it is of vital importance to collect accurate, reliable, and comprehensive data on past fire events. Such data should encompass a wide range of variables, including the causes of fires, their geographical distribution, response times, types of affected structures, as well as seasonal and climatic conditions. The systematic collection and analytical evaluation of these data contribute to the formulation of science-based policies aimed at reducing fire risks. Additionally, these data play a critical role in assessing the effectiveness of structural and non-structural preventive measures, evaluating response capacities, and developing long-term risk reduction strategies (Franklin & Agee, 2003; Kodur et al., 2020). The scientific analysis of fire causes and consequences through interdisciplinary approaches provides significant insights not only at the individual or institutional level but also at the societal level for enhancing fire safety. In this context, the importance of evidence-based decision-making processes in the development and improvement of fire safety policies is increasingly emphasized.

In the literature, studies on fires are generally categorized under three main headings. The first group focuses on the pre-fire period, examining the identification of risk factors, analyzing conditions that may lead to fires, and developing preventive strategies to minimize these risks. Within this scope, urban planning, construction materials, early warning systems, public education, and regulatory frameworks come to the forefront. The second group comprises studies related to intervention during and after the fire, including emergency management, the effectiveness of firefighting services, coordination mechanisms, and the impact of response time on fire outcomes. The third group involves forecasting and planning studies based on the analysis of fire statistics. These studies aim to develop more proactive and data-driven approaches to fire management through the modeling of fire trends, the use of spatial analysis techniques, and the application of artificial intelligence-supported prediction methods (Lin, 2004; Minciardi et al., 2007; Crawl et al., 2017).

Fire statistics play a pivotal role in the development of effective strategies aimed at preventing the recurrence of similar incidents by enabling the scientific analysis of the causes, frequency, and impacts of fires. These statistical data are critically important not only for the retrospective evaluation of incidents but also for forecasting and mitigating potential future risks. Such data serve as a crucial reference point in decision-making processes related to identifying high-risk areas, allocating resources (such as fire trucks, personnel, and early warning systems) efficiently and effectively, planning community education programs based on needs, and enhancing firefighting capacity. Furthermore, the continuous and up-to-date collection of fire statistics is essential for analyzing the impact of factors such as urbanization, construction, and climate change on fire occurrence (Peng et al., 2017).

However, the absence of a centralized, comprehensive, and up-to-date statistical database on fires in Turkey significantly limits research in this field. While the Turkish Statistical Institute (TÜİK) systematically produces accessible data in various domains such as agriculture, population, environment, and economy, it does not provide an integrated national dataset on fire incidents (TÜİK, 2024). This lack of data hampers macro-level assessments regarding the causes, geographical distribution, seasonal trends, and human and material losses related to fires. Consequently, it narrows the scope of academic research and poses a major obstacle to the design of effective and evidence-based public policies. The existing data on fires in Turkey largely rely on records maintained by local governments, particularly the fire departments and directorates of municipalities. These locally confined data, due to the use of non-standardized forms and reporting methods, hinder comparative analyses across different regions and compromise data integrity and reliability. Moreover, this situation

complicates the development of disaster management policies through a comprehensive, nationwide approach. The systematic collection of fire statistics in a complete, consistent, and accessible manner is a fundamental requirement across a broad spectrum—from pre-disaster risk assessments to post-disaster response planning (FSE, 2024). Therefore, the centralization, standardization, and public availability of fire data in Turkey should be considered a strategic priority not only for firefighting efforts but also for enhancing the overall disaster management capacity.

Academic research on fire incidents, particularly within the context of Turkey, predominantly focuses on forest fires. This tendency is evident in searches conducted via the Google Scholar database using keywords such as "Fire" and "Turkey." However, more refined queries, such as "Fire" + "Turkey" + "Province," reveal the existence of studies addressing the spatial distribution of fires. These findings indicate that fire incidents are not confined to natural areas but also produce widespread and destructive consequences in residential and urban settings. One of the primary causes of fires in both urban centers and rural areas is electrical malfunction. In this regard, Kara (2018), in a study based on data from Artvin province, reports that electrical faults caused 46.7% of fires. Similarly, another study by Kara (2017) emphasizes that the vast majority of fire incidents occurred in residential areas and were primarily attributed to electrical failures. These findings suggest that fire risk is not limited to natural environments but also constitutes a significant threat in densely urbanized areas. The relationship between fire incidents and energy infrastructure becomes even more critical in industrial regions. Pekşen et al. (2022), in their study focusing on Kocaeli province, underline that a substantial portion of fires resulted from deficiencies in the electrical system. The impact of infrastructure inadequacies on fire risk is also evident in a study conducted in Istanbul, where Pekşen et al. (2020) report that 31% of fire incidents were caused by electrical sources, highlighting the pivotal role of urban energy infrastructure in fire emergence. Problems encountered in the collection and classification of fire-related data significantly hinder the development of effective fire management strategies. Bakırcı et al. (2019) point out that fire incident data in Turkey lack both quantitative and qualitative depth. This limitation also applies to fires originating from energy infrastructure, restricting the ability to formulate comprehensive preventive strategies.

When considering the spatial distribution of fire risk, patterns of urbanization emerge as a crucial determinant. Balcı and Altundağ (2023) demonstrate a direct correlation between fire risk, building density, and irregular urban development, thereby indicating that unplanned urbanization increases vulnerability to fire hazards. In line with this, energy-related negligence appears as a frequent cause of structural fires. Kara and Kara (2020) emphasize that most of these incidents result from careless or improper energy use, drawing attention to both individual and institutional-level failures that exacerbate fire risks. The use of Geographic Information Systems (GIS) in the local monitoring of fires and the formulation of preventive planning has been frequently highlighted in the literature. Üstündağ (2008) asserts that GIS technology offers substantial advantages in visualizing fire data and identifying high-risk zones. The adoption of such technologies enhances data-driven decision-making in fire management and strengthens the effectiveness of both responsive and preventive strategies. These findings suggest that there may be a significant and direct relationship between fire types and building usage patterns. For example, in residential buildings, factors such as commonly used electrical appliances, outdated or non-standard electrical installations, insufficient maintenance activities, and user errors increase fire risk; whereas in industrial facilities, technical malfunctions or chemical reactions tend to be more prominent causes. In this context, it is insufficient to consider the causes of fires solely as technical faults or human errors; rather, multidimensional analyses that take into account varying risk profiles according to building type, usage purpose, socioeconomic conditions, and urbanization dynamics are necessary.

Increasing the number of regional and national analyses on fires in Turkey holds strategic importance not only for disaster risk management but also for local governments' resource planning, public awareness activities, and the updating of legal regulations. Data-driven decision-making processes yield more effective outcomes in combating fires. Therefore, empirical data on the causes of fire incidents serve not only to enhance retrospective analysis but also act as a fundamental reference for the formulation of policies related to spatial planning, building safety, fire regulation reforms, and public education. Such findings obtained specifically in Turkey will contribute to the development of a

comprehensive fire prevention strategy that accounts for local conditions (Gültekin & Gültekin, 2024; Özcan et al., 2025).

Istanbul, as Turkey's most populous city and one of its key economic, social, and cultural centers, is a metropolis that requires special consideration regarding fire risk. Factors such as the city's high population density, the increase in multi-story buildings, complex transportation infrastructure, dense industrial zones, and irregular migration flows are among the primary elements that elevate both the frequency and potential impact of fires. The convergence of these factors suggests that fires occurring in Istanbul could generate multifaceted effects, not only physical but also social, economic, and environmental in nature. Particularly in areas with a high concentration of old and deteriorated building stock, factors such as the use of low fire-resistant materials, non-standard electrical installations, narrow streets, and building layouts that hinder access increase the speed of fire spread and reduce intervention capacity. Furthermore, unplanned urbanization, regulatory deficiencies, and inadequate building inspections impede the development of fire-resilient urban areas, perpetuating structural risks that lead to higher casualties and property losses. This situation is especially pronounced in some rapidly growing districts of Istanbul, such as Esenyurt, Sultangazi, and Bağcılar (Gencer, 2013; Aktaş et al., 2013; Aygün & Baycan, 2020).

In assessing fires specifically in Istanbul, it is necessary to consider variables such as population growth, socioeconomic disparities, industrial density, and infrastructure inequalities alongside urbanization dynamics. Within this context, the annual activity reports of the Istanbul Metropolitan Municipality Fire Department provide important quantitative data on the city's fire trends. These reports indicate that the districts with the highest incidence of fires are generally those with dense populations and extensive urban development. Additionally, a marked increase in fire incidents is observed during the summer months, particularly in July and August. This highlights the influence of seasonal factors and individual negligence (such as outdoor smoking and barbecue activities) on fire risk in Istanbul (Hacıoğlu, 2010; Gencer, 2013). However, academic and local studies on fire data specific to Istanbul are limited in number and fragmented in nature. Most existing studies focus on specific districts and do not provide comprehensive analyses that adequately consider long-term trends, spatial variations, and detailed cause-and-effect relationships. This situation complicates the evidence-based formulation of fire management policies in a high-risk metropolis like Istanbul. This deficiency not only restricts academic knowledge production but also negatively impacts data-driven decision-making processes in the long-term fire prevention and response strategies of municipalities and central authorities (Aktaş et al., 2013; Nyimbili & Erden, 2020). In conclusion, the multidimensional nature of fire risk in Istanbul necessitates examination through the contributions of various disciplines, including urban planning, disaster management, sociology, engineering, and public administration. Within this framework, the development of Istanbul-specific fire risk maps, neighborhood-level risk analyses, and the establishment of integrated centralized databases will contribute to the formulation of more effective and sustainable fire management policies.

In this context, the scientific analysis of fire incidents occurring in Istanbul—including their causes, frequency, response times, and outcomes—will enable the development of a comprehensive fire risk map for the city. This will enable local governments and public institutions to ground their fire prevention efforts on a more strategic, proactive, and effective basis. The primary aim of this study is to statistically examine fire incidents in Istanbul between 2021 and 2023, conducting a multidimensional analysis of their distribution, causes, response times, and consequences. Based on institutional datasets from the Istanbul Metropolitan Municipality Fire Department, this analysis seeks to enhance understanding of the current state of fire safety in Istanbul and to support the formulation of risk reduction policies founded on scientific evidence. Consequently, the study aims both to contribute to the improvement of fire safety policies and to produce important insights specific to Istanbul in terms of disaster management and emergency planning.

2. OBJECTIVES AND SCOPE

In large metropolitan areas experiencing rapid urbanization, factors such as high population density, complex and congested built environments, and increased industrial activities substantially elevate fire risk in terms of both frequency and severity. This situation underscores the critical importance of fire

prevention, early detection, and effective intervention. Fires occurring in metropolises like Istanbul—which hold a central role in the country's historical, cultural, economic, and demographic landscape—are complex and multifaceted events that demand attention not only from local governments within disaster management frameworks but also from academic research. Therefore, the systematic and scientific investigation of fires in Istanbul is of paramount importance for risk management, policy development, and public safety.

Within the scope of the study, the causes of fires, their spatial and temporal distributions, response times, and the resulting human and property losses are evaluated. Accordingly, these analyses aim to provide a more accurate representation of fire risk in Istanbul and contribute to the development of preventive strategies aimed at risk reduction. The primary objective of this study is to conduct a multidimensional analysis of fire incidents that occurred in Istanbul during the years 2021, 2022, and 2023, based on statistical data. The objectives of the study can be summarized as follows:

- Quantitative assessment of fire incidents occurring in Istanbul during the years 2021, 2022, and 2023,
- Classification of fire incidents according to their causes and examination of changes in these causes over the years,
- Analysis of the spatial distribution of fires at the district level,
- Evaluation of fire response times and investigation of the relationship between rapid intervention and fire severity,
- Identification of the relationship between fire types and the types of locations where incidents occurred,
- Presentation of recommendations aimed at reducing fire risk specific to Istanbul based on the findings obtained.

Within this scope, the study was conducted using official data archived by the Istanbul Metropolitan Municipality Fire Department. Quantitative research methods were adopted for the analyses, and statistical data were evaluated using SPSS and Excel software, with visual support provided through graphs and tables. The study's scope is limited to fire incidents that occurred within Istanbul's boundaries between 2021 and 2023 and are recorded in the Istanbul Metropolitan Municipality Fire Department's database. In this context, the causes, frequencies, and outcomes of all fires in Istanbul were analyzed through a comprehensive approach. However, unreported or unattended fire incidents were excluded from this study. Additionally, rural fires such as forest fires fall outside the jurisdiction of the Istanbul Fire Department and were therefore not included in the analysis. Accordingly, this research aims to provide local governments, disaster and emergency units, and the academic community with up-to-date and systematic data regarding fire risk in Istanbul.

3. METHOD

The dataset used in this study comprises official records of fire incidents responded to by the Istanbul Metropolitan Municipality Fire Department during the years 2021, 2022, and 2023. Necessary permission was obtained from the Istanbul Metropolitan Municipality Fire Department Central Fire Branch Directorate through the official letter dated February 19, 2024, reference number E-94750735-622.01-2024.315173. The study employed a quantitative research method, specifically the descriptive survey model. Through these reports, up-to-date and detailed information was obtained regarding the number of fires, causes of fire outbreaks, types of fires, response times, districts where incidents occurred, and the number of vehicles involved in interventions. Within the scope of the research, existing data on fire incidents that occurred within a specified time period were collected, systematically classified, and analyzed using various statistical techniques. This approach allowed for the identification of the general profile of fire dynamics in Istanbul, providing scientifically grounded insights into related processes and risk factors. A total of 67,599 fire cases were analyzed.

The data used in this study were obtained from the annual activity reports in PDF format, downloaded from the official website of the Istanbul Metropolitan Municipality Fire Department. Information contained in these reports was transferred into Excel using both manual and automated data extraction techniques. During this process, missing or contradictory data were carefully checked, and an appropriate dataset was created for analysis. Additionally, the reliability and consistency of the dataset

were confirmed through cross-validation between intra-year reports and annual summary reports. These methods enhanced the data quality of the study and supported the accuracy of the results obtained.

Descriptive statistics (such as frequency, percentage, mean, etc.) and various graphical representation techniques were used in the analysis of the data. The data were classified based on fire counts, causes, types, and distribution by districts, and detailed trends of these variables over the years were examined. The analysis utilized both Microsoft Excel and SPSS 25.0 statistical software. Trends in fire incidents over the years were visualized using line graphs, while distributions by districts were supported by bar and pie charts. Additionally, average values of time-varying variables such as response times were calculated, and their changes over the years were presented with tables and graphs. This approach enabled effective quantitative and visual evaluation of the data, allowing for a comprehensive understanding of fire dynamics. During data cleaning, missing and contradictory records were excluded; records lacking neighborhood or coordinate information were specifically omitted for spatial analysis. The cleaned datasets were analyzed using both quantitative methods (descriptive statistics, cross-tabulations, correlation analysis) and geographic methods (heat maps, distribution maps).

The resulting cleaned datasets were evaluated through two main analytical methods aligned with the study objectives. First, quantitative analyses including descriptive statistics, cross-tabulations, and correlation analyses were conducted to numerically present the temporal distribution, causes, and outcomes of fires. Second, geographic analysis methods were applied to visualize the spatial distribution of fires and identify high-risk areas through heat maps and distribution maps. This multifaceted analytical approach facilitated a comprehensive understanding of fire dynamics in Istanbul and provided essential data foundations for the development of risk reduction strategies.

One of the main limitations of this study is that the analyzed data are restricted solely to the Istanbul province. Additionally, the study period being limited to the years 2021, 2022, and 2023 constrains the examination of longer-term trends in fire incidents. Moreover, the exclusive use of the annual activity reports published by the Istanbul Metropolitan Municipality Fire Department as the data source imposed certain limitations in terms of data granularity. For instance, detailed classifications and analyses of critical variables such as response times by district or fire type were not possible due to the lack of such data. This restricts a more in-depth spatial and categorical investigation of fire response performance. Given these limitations, the findings of the study specifically reflect the fire dynamics within Istanbul during the designated timeframe, and caution should be exercised when generalizing to other periods or regions.

4. FINDINGS AND DISCUSSION

The Marmara Region holds strategic importance as the area with the highest concentration of industry, population, infrastructure, and superstructure activities in Turkey. In this context, Istanbul, which houses approximately one-quarter of the country's population and is home to world heritage sites and cultural riches, occupies a critical position not only regionally but also nationally. With these characteristics, Istanbul hosts the most advanced fire department organization in Turkey and stands out as one of the few provinces where statistical records on fire incidents are maintained regularly and systematically. This section presents and thoroughly discusses the findings derived from the analysis of data obtained from the Istanbul Metropolitan Municipality Fire Department's annual activity reports for the years 2021, 2022, and 2023. The analysis comprehensively evaluates key variables such as the number of fires, causes, fire types, spatial distribution by district, response times, and the number of vehicles deployed for interventions.

4.1. Fire Department Personnel Status

In a metropolitan area like Istanbul, characterized by a high population density, intensive urbanization, and significant industrial activities, an effective and well-equipped fire department is essential for combating fire risks. As of the end of 2024, the Istanbul Metropolitan Municipality Fire Department employs a total of 4,583 professional firefighters. These personnel carry out a wide range of duties, including firefighting, rescue operations, first aid, and disaster response, providing services from stations distributed across the city's 39 districts. In addition to the professional force, a volunteer-based structure has been developed to enhance community participation and strengthen local resilience against

disasters. Within this framework, a total of 485 volunteer firefighters are actively serving in 32 Volunteer Fire Stations operating throughout Istanbul. These volunteers not only support professional teams but also play crucial roles in fire prevention awareness and initial response activities within their neighborhoods.

Based on an assessment referencing Turkish Statistical Institute (TÜİK) data, the number of professional firefighters per 100,000 inhabitants in Istanbul was calculated to be approximately 29.18 as of 2024. This ratio indicates that the fire department possesses a relatively comprehensive personnel structure considering Istanbul's size and risk profile. However, given factors such as urban growth, population increase, and the rising frequency of climate change-related disasters, it is crucial to continuously evaluate this figure and adjust staffing levels according to emerging needs. The fire department's personnel composition should be assessed not only by quantitative metrics but also by qualitative criteria such as education level, equipment adequacy, and task distribution. In this context, recent in-service training programs, procurement of modern equipment, and disaster scenario-based drills represent significant steps taken to enhance the Istanbul Fire Department's capacity to respond effectively to emergencies.

4.2. Fire Department Vehicle Fleet

Effective response to disasters and emergencies requires not only adequate human resources but also a strong, modern, and functional vehicle fleet. In a city like Istanbul, with a population exceeding 16 million, intensive high-rise buildings, and a substantial share of the country's industrial and transportation infrastructure, the number, types, and distribution of firefighting vehicles play a critical role. The number of vehicles within the Istanbul Metropolitan Municipality Fire Department has been continuously updated over the years to meet increasing demands and technological advancements, as shown in Table 1. As of 2024, the fleet comprises vehicles serving various operational areas, including firefighting, rescue, water supply, ladder interventions, initial response, hazardous materials incidents, search and rescue, and support services. The equipment within the vehicle fleet is specialized to address fires of varying sizes and characteristics, traffic accidents, natural disasters (such as earthquakes, floods, storms), and incidents requiring technical rescue. In particular, compact vehicles capable of accessing narrow streets, hydraulic ladder trucks designed to reach high-rise buildings, and chemical-biological intervention units have been specifically procured to meet the complex urban structure of Istanbul.

In modern cities, the operational success of fire departments is closely linked to the adequacy of the vehicles and equipment they use. As exemplified by Istanbul, a technologically advanced and diversified vehicle fleet provides a significant advantage not only in firefighting but also in managing all types of disasters and emergencies. The periodic maintenance and renewal of fire department vehicles are also of great importance for ensuring service continuity. In this regard, the Istanbul Metropolitan Municipality Fire Department continues to strengthen its vehicle fleet both quantitatively and qualitatively. Additionally, through the strategic distribution of vehicles across geographic regions, response times are reduced, aiming to reach incidents as quickly as possible.

Table 1: Fire Department Vehicle Fleet in Istanbul

Years	Fire Trucks	Ambulance	Total
2021	840	49	889
2022	849	61	910
2023	854	71	925
2024	890	27	917

4.3. Number of Fire Department Stations

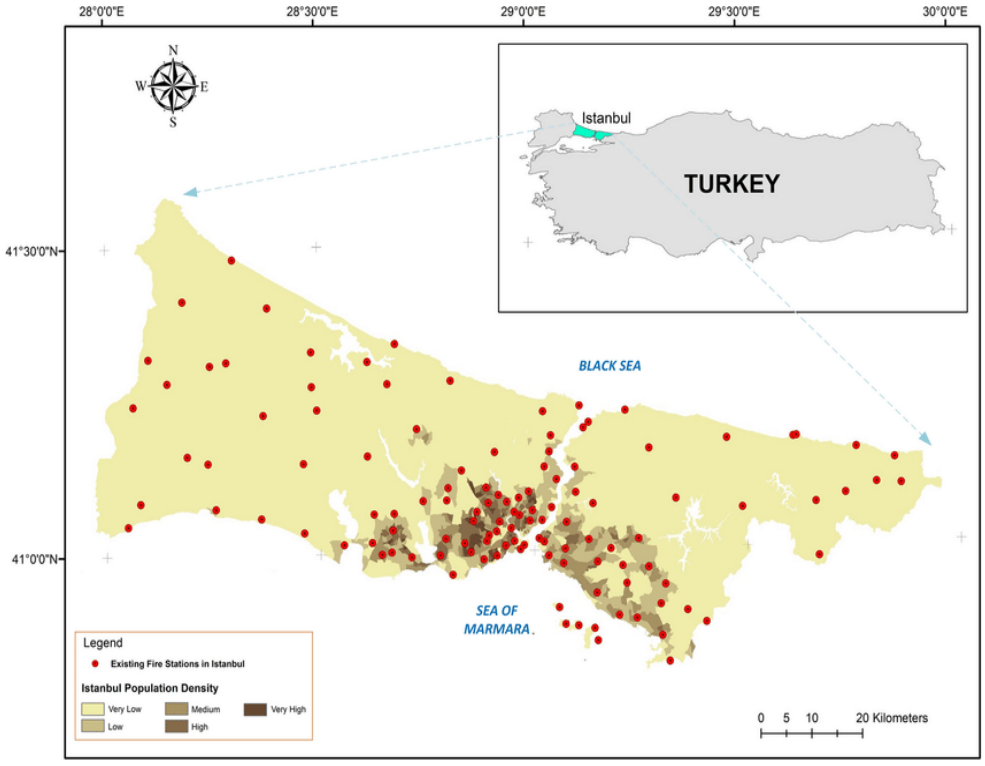
The effectiveness of fire services depends not only on personnel and vehicle capacity but also on the geographical accessibility of these services throughout the city. In this context, the number and strategic placement of fire stations are critically important for reducing response times to fires and other emergencies. In large and densely populated cities, the strategic planning of station locations plays a direct role in minimizing loss of life and property.

In line with this approach, the Istanbul Fire Department continuously expands and restructures its stations by taking into account the city's topographic and demographic characteristics. As of the end of 2024, a total of 123 professional fire stations are actively serving across Istanbul. This number has been planned to ensure a balanced distribution between the European and Anatolian sides, with priority given to industrial zones, densely populated residential areas, and regions with high disaster risk. Additionally, within the Istanbul Metropolitan Municipality Fire Department, 32 Volunteer Fire Stations operate based on principles of community solidarity and local participation. Approximately 485 volunteer firefighters serving at these stations work in coordination with the professional force, contributing particularly to initial response efforts and leading initiatives to raise fire safety awareness at the neighborhood level.

Another key factor in determining the number of fire stations is the "response time" target. In an ideal urban fire response, arriving at the incident site within the first five minutes is crucial for controlling the fire before it spreads. To achieve this target, planning takes into account variables such as distances between stations, traffic density, road infrastructure, and population density. The strategic placement of fire stations in Istanbul in alignment with this goal indicates a highly advanced organizational structure compared to other global metropolises.

In conclusion, the extensive network in Figure 1 of professional and volunteer fire stations (Nyimbili & Erden, 2021) operating in Istanbul not only enhances operational capacity for fire and disaster response but also enables faster and more effective service delivery to all segments of society. This structure constitutes a fundamental pillar of the Istanbul Fire Department's comprehensive and inclusive service approach.

Figure 1: Professional and Volunteer Fire Stations in Istanbul



4.4. Number of Fires by Year

An examination of fire incidents across Istanbul reveals that the total number of recorded cases increased from 20,760 in 2021 to 24,285 in 2023. These data indicate a relative upward trend in fire occurrences over the years. This pattern, frequently observed in large metropolitan areas, is associated with complex and multidimensional dynamics that cannot be attributed to singular causes. The rising number of fires in Istanbul is considered to be influenced by factors such as population growth, dense urbanization, inadequate infrastructure, unplanned urban development, and the widespread use of electrical devices

and systems. Fire risk is particularly elevated in informal settlements (gecekondu areas) and mixed-use zones where industrial and residential areas overlap. This situation underscores once again the critical importance of spatial planning deficiencies for fire safety.

Furthermore, environmental factors, including climate change, seasonal droughts, and increasing temperatures, play a significant role in elevating fire risk. The frequency of grass fires during dry summer months is directly linked to these environmental hazards. Additionally, economic crises, fluctuations in energy prices, and declining social welfare levels drive individuals towards unsafe heating methods, thereby indirectly increasing fire hazards.

When all these factors are considered together, the increase in fire incidents in Istanbul is closely related not only to the capacity of the fire department but also to urban governance, public awareness levels, construction standards, and emergency preparedness policies. Consequently, enhancing fire response capabilities is as crucial as developing effective fire prevention strategies.

4.5. Distribution by Types of Fire

According to data from the Istanbul Metropolitan Municipality Fire Department, analyzing fire incidents by type enables a better assessment of risks for urban safety and facilitates the development of preventive strategies. Based on the Istanbul Fire Department records, fires are generally classified into two main categories: structural fires (occurring in fixed buildings such as residences, workplaces, and public buildings) and non-structural fires (including outdoor fires such as forest, waste, vehicle, and grass fires). Fires that occurred between 2021 and 2023 were examined under these two primary categories. Structural fires encompass enclosed building units used for office, storage, residential, and healthcare purposes, whereas non-structural fires mainly refer to grass, waste, and forest fires occurring in open areas.

In 2021, a total of 20,760 fire incidents were recorded across Istanbul, with approximately 45% classified as structural fires and 55% as non-structural fires. By 2023, the total number of fires increased to 24,285, accompanied by a rising trend in the proportion of structural fires. When examining the total fire counts annually, a notable increase in incidents during the summer months is observed. Specifically, 25,249 fires were recorded in 2021, 26,411 in 2022, and 28,129 in 2023, indicating an approximate 11% increase over the three years. Monthly distributions show that the highest number of fires occurred in July (4,524 incidents) and September (3,843 incidents). Notably, in July 2023, 1,799 non-structural fires were recorded, indicating a significant rise in open-area fires during this period. This increase is likely associated with seasonal factors and drought conditions. These findings reveal that fire risk in Istanbul varies throughout the year, with non-structural fires particularly concentrated during the summer months. Additionally, the increasing total number of fires over the years highlights the need for stronger preventive policies and enhanced resource allocation in fire management efforts.

Figure 2: Types of Fire in Istanbul

Months	January		February		March		April		May		June		July		August		September		October		November		December	
Years	Structural	Non-Structural	Structural	Non-Structural	Structural	Non-Structural	Structural	Non-Structural	Structural	Non-Structural	Structural	Non-Structural	Structural	Non-Structural	Structural	Non-Structural	Structural	Non-Structural	Structural	Non-Structural	Structural	Non-Structural	Structural	Non-Structural
2021	1.206	430	1.012	470	1.082	558	941	533	826	587	905	679	944	1.242	954	1.328	834	1.248	890	769	921	728	948	725
2022	1.119	646	1.007	580	1.160	657	908	645	1.021	872	947	1.085	999	1.483	935	954	948	950	937	1.027	878	1.003	1.034	759
2023	1.087	903	1.047	800	1.025	803	913	619	875	727	899	1.021	1.140	1.799	1.015	1.597	978	1.645	910	996	963	651	1.025	847
TOTAL	**3.412**	**1.979**	**3.066**	**1.850**	**3.267**	**2.018**	**2.762**	**1.797**	**2.722**	**2.186**	**2.751**	**2.785**	**3.083**	**4.524**	**2.904**	**3.879**	**2.760**	**3.843**	**2.737**	**2.792**	**2.762**	**2.382**	**3.007**	**2.331**

Structural fires are observed to predominantly result from internal factors such as electrical short circuits, negligence, and malfunctions in heating systems, whereas non-structural fires tend to increase during the summer months due to environmental causes like dry grass, stubble burning, waste disposal sites, and vehicle fires following traffic accidents. These data highlight the significant influence of variables such as urbanization patterns, population density, infrastructure adequacy, and public

awareness levels on the types of fires. Additionally, seasonal changes and heat waves are particularly noted to affect non-structural fires. The changes in the distribution of fire types over the years reflect not only a numerical increase but also a transformation in the risk profile. This situation underscores the necessity to diversify Istanbul's fire management strategies with policies tailored to specific fire types, directing educational campaigns, inspections, and technological investments accordingly.

4.6. Distribution by Causes of Fire

The classification of fire causes is of critical importance in the analysis of fire incidents occurring in Istanbul, particularly for risk management and the development of preventive strategies. This section examines the distribution of recorded fire cases in Istanbul according to their causes, focusing on the socio-spatial variations of these causes and their relationship with fire frequency. Fire causes are generally divided into two main categories: structural and non-structural causes. Structural fire causes are typically associated with technical issues such as building infrastructure, electrical installations, heating, and gas system failures. In contrast, non-structural causes encompass factors such as negligence, intentional damage (arson), the use of open flames, accidental fires, or natural causes.

The examination of Istanbul's fire records reveals that, as shown in Figure 3, the highest proportion of fires—42%—are caused by faults in electrical installations. The dense and aging electrical systems, particularly in the city's historic and informal settlement areas, significantly increase the fire risk. Additionally, fires attributed to negligence account for 25% of cases, reflecting the impact of socioeconomic and educational disparities on fire risk. Negligence-related fires include incidents such as improper disposal of cigarette butts, fires started accidentally by children while playing, and uncontrolled use of open flames.

Arson cases account for approximately 10% of the fires, with a notable concentration in low-income neighbourhoods and areas experiencing significant social problems. The increase in intentional fires such as arson in socio-spatially disadvantaged areas highlights underlying social tensions and security challenges within these communities. Fires caused by natural factors are relatively rare in densely urbanized areas like Istanbul, but constitute about 8% of incidents, particularly those occurring near forested zones during the summer months. Climatic changes, including drought and high temperature conditions, mostly trigger these fires. Lastly, gas leaks and kitchen-related fires make up approximately 15% of fire causes. The acceleration of urbanization and increased domestic energy use have contributed to a rise in such incidents.

When analyzing the spatial distribution of these causes, electrical faults predominantly lead to fires in older residential areas in the city center. Negligence-related fires are widespread both in central and peripheral neighbourhoods. Arson incidents tend to concentrate in informal settlements and low-income districts characterized by social challenges, while naturally caused fires are mostly recorded near forested and rural-adjacent residential areas. In light of these data, intervention and preventive policies addressing the causes of fires in Istanbul need to be strengthened through the renewal of technical infrastructure, public awareness campaigns, and the integration of social support programs. Moreover, an in-depth analysis of how socio-spatial inequalities influence fire risk will enable the development of more targeted and effective fire management strategies.

Figure 4: Fire Numbers by Causes in Districts

Districts	Electric			Fire & Heat			Mechanical Heating			Flammable Explosive			Chemical Heating			Natural Heat Sources			Other Reasons			Not Detected			TOTAL		
	2021	2022	2023	2021	2022	2023	2021	2022	2023	2021	2022	2023	2021	2022	2023	2021	2022	2023	2021	2022	2023	2021	2022	2023	2021	2022	2023
ADALAR	15	16	13	32	27	24	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	7	6	4	55	51	41
ARNAVUTKÖY	130	155	164	484	631	670	22	31	25	3	10	5	0	1	2	5	2	3	3	5	4	81	82	146	728	917	1.019
ATAŞEHİR	120	125	119	216	290	322	7	8	6	3	7	2	1	0	1	1	4	0	2	6	3	64	69	72	414	509	525
AVCILAR	139	136	146	481	444	605	11	18	14	5	6	3	0	0	0	7	5	5	6	3	8	80	77	69	729	689	850
BAĞCILAR	215	219	201	488	467	564	19	15	25	7	6	6	0	0	2	0	1	1	8	1	2	60	42	71	797	751	872
BAHÇELİEVLER	171	180	144	328	327	368	11	13	5	6	6	8	0	0	1	0	0	0	3	1	1	75	57	34	594	584	561
BAKIRKÖY	71	91	77	133	140	164	7	5	4	1	1	4	0	0	1	0	0	0	4	8	11	12	11	13	228	256	274
BAŞAKŞEHİR	160	143	161	534	464	534	41	31	39	6	4	6	5	1	1	4	4	1	6	0	4	58	61	64	814	708	810
BAYRAMPAŞA	133	103	120	175	236	249	2	9	8	5	5	2	1	3	0	1	0	0	2	2	1	36	27	22	355	385	402
BEŞİKTAŞ	98	101	85	234	135	123	8	10	4	1	2	2	0	1	1	1	1	2	4	2	1	16	30	28	362	282	246
BEYKOZ	89	93	106	200	171	155	10	8	10	4	1	1	0	0	0	2	7	2	10	3	9	85	116	149	400	399	432
BEYLİKDÜZÜ	89	101	112	233	299	267	13	12	5	4	2	2	1	1	0	3	3	4	2	3	3	122	110	77	467	531	470
BEYOĞLU	113	133	128	181	225	237	11	8	9	9	4	7	0	0	1	2	1	1	7	2	1	64	70	62	387	443	446
BÜYÜKÇEKMECE	115	98	106	384	473	476	8	18	19	4	2	5	1	1	0	5	6	2	4	3	2	86	66	97	607	667	707
ÇATALCA	75	50	76	216	239	259	16	15	12	0	4	1	0	1	0	1	2	4	2	1	0	18	24	59	328	336	411
ÇEKMEKÖY	75	82	77	86	145	194	3	8	11	1	0	4	0	0	0	0	0	1	4	2	0	58	52	22	227	289	309
ESENLER	157	140	140	256	322	400	9	7	6	5	4	3	0	1	0	1	0	1	8	1	2	42	24	77	478	499	629
ESENYURT	268	296	267	837	991	1.212	27	44	38	12	10	8	0	0	5	5	9	6	12	4	2	176	160	123	1.337	1.514	1.661
EYÜPSULTAN	139	145	153	312	385	393	19	28	15	6	5	4	1	2	1	2	2	2	2	4	3	49	44	52	530	615	623
FATİH	253	247	261	682	705	783	26	27	17	3	8	3	0	2	3	11	4	3	9	16	7	54	76	90	1.038	1.085	1.167
GAZİOSMANPAŞA	151	144	157	381	408	438	7	8	10	5	7	4	0	2	2	1	1	3	6	4	2	64	30	26	615	604	642
GÜNGÖREN	105	111	113	176	149	166	4	5	7	0	0	1	0	0	1	0	0	0	4	1	3	28	14	13	317	280	304
KADIKÖY	119	141	152	235	229	273	13	15	14	7	2	2	0	1	1	1	2	2	4	2	1	136	115	86	515	507	531
KAĞITHANE	141	136	113	251	270	259	11	12	11	3	5	4	1	2	1	2	2	0	10	2	3	41	27	41	460	456	432
KARTAL	124	117	111	265	402	387	12	8	13	1	4	2	0	0	0	0	0	0	5	5	3	27	59	49	434	595	565
KÜÇÜKÇEKMECE	176	215	198	525	541	673	29	23	24	3	5	11	0	0	1	3	1	2	8	4	7	101	38	64	845	827	980
MALTEPE	146	128	123	226	351	401	5	1	16	9	1	1	0	1	1	0	0	6	4	2	5	55	33	44	445	517	597
PENDİK	187	204	205	556	737	758	24	16	19	12	10	10	0	1	1	1	1	1	6	6	6	113	154	187	899	1.129	1.187
SANCAKTEPE	99	121	122	265	438	483	11	11	6	7	5	1	1	0	3	3	2	2	2	1	1	110	76	30	498	654	648
SARIYER	114	155	176	162	195	197	27	13	22	3	2	4	1	0	0	1	1	2	11	2	2	58	43	40	377	411	443
SİLİVRİ	112	106	116	673	658	556	35	39	49	7	7	2	9	2	3	7	3	9	6	7	5	103	175	244	952	997	984
SULTANBEYLİ	85	113	115	341	414	542	8	8	15	6	4	4	0	0	0	1	1	1	4	4	3	25	15	24	470	559	704
SULTANGAZİ	183	183	157	420	506	538	9	14	19	5	8	7	3	1	2	0	2	3	6	2	2	45	21	21	671	737	749
ŞİLE	36	31	43	65	98	107	6	3	2	1	2	0	0	0	0	6	2	4	7	2	0	40	30	28	161	168	184
ŞİŞLİ	128	152	161	172	240	288	5	6	13	10	1	5	0	0	1	3	0	1	4	2	1	57	105	69	379	506	539
TUZLA	97	126	136	252	373	395	15	27	28	6	6	4	2	2	2	0	0	2	9	5	2	53	52	53	434	591	622
ÜMRANİYE	199	190	231	325	408	539	8	12	12	8	7	5	1	0	1	0	2	0	6	2	2	63	53	47	610	674	837
ÜSKÜDAR	116	139	116	222	234	241	6	11	10	6	4	4	2	1	0	0	0	2	6	3	4	60	57	73	418	449	450
ZEYTİNBURNU	114	136	118	215	203	261	9	3	8	5	4	4	0	0	2	0	1	1	4	16	12	30	14	17	377	377	423
İL DIŞI / DİĞER	3	1	1	3	3	4	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	4	8	6	9
TOTAL	5.060	5.303	5.320	12.222	13.973	15.505	515	551	570	189	172	151	30	28	41	81	72	79	210	140	128	2.453	2.315	2.491	20.760	22.554	24.285
Grand Total	15.683			41.700			1.636			512			99			232			478			7.259			67.599		

4.7. Fire Incidents by Districts

The spatial distribution of fire incidents recorded across various districts of Istanbul serves as a crucial indicator for understanding the city's fire risk and response capacity. This section analyzes the numerical distribution of fire events by district in recent years and examines the relationship between this distribution and the urban, demographic, and socio-economic characteristics of the districts.

Data analysis indicates that the districts with the highest incidence of fires include Esenler, Bağcılar, Sultanbeyli, Gaziosmanpaşa, and Küçükçekmece—areas characterized by high population density and socio-economically disadvantaged neighborhoods. The proportion of fires recorded in these districts accounts for over 40% of the total fires in Istanbul, with particularly elevated fire risks in informal settlements and densely built environments. Notably, in Esenler and Bağcılar, the aging and insufficient electrical infrastructure contribute to a high frequency of electrical faults as a leading cause of fires. Meanwhile, Sultanbeyli and Gaziosmanpaşa experience a comparatively higher occurrence of negligence-related and intentional arson cases. This situation highlights the direct impact of the socio-spatial characteristics of these districts on their fire risk profiles.

On the other hand, although fire incidents are relatively lower in central districts such as Şişli, Beşiktaş, and Kadıköy, the characteristics of these fires and the intervention processes differ notably. In these districts, fires predominantly occur in high-rise buildings, and the availability of rapid response capabilities plays a crucial role in limiting fire damage. In districts close to forested areas, such as Beykoz, Çekmeköy, and Sarıyer, forest and naturally caused fires are more frequent compared to other districts. The increase in these fires, especially during the summer months, and the resulting damage to ecosystems highlight the necessity of managing not only urban fire risks but also the risks posed to the natural environment.

This distribution necessitates the diversification of fire intervention strategies and the prioritization of resources according to the specific risks in Istanbul's various districts. A detailed analysis of fire causes and building types unique to each district will enable local governments and fire departments to develop targeted preventive measures that enhance their effectiveness. Consequently, examining the numerical distribution of fires by district across Istanbul contributes to the creation of an urban fire risk map and promotes spatial equity in fire management. In this context, integrating fire data analyses with socio-economic and spatial parameters will serve as a guiding framework for strengthening Istanbul's future fire response capacities.

Figure 4: Number of Fires by District

Districts / Years	2021	2022	2023
ADALAR	55	51	41
ARNAVUTKÖY	728	917	1.019
ATAŞEHİR	414	509	525
AVCILAR	729	689	850
BAĞCILAR	797	751	872
BAHÇELİEVLER	594	584	561
BAKIRKÖY	228	256	274
BAŞAKŞEHİR	814	708	810
BAYRAMPAŞA	355	385	402
BEŞİKTAŞ	362	282	246
BEYKOZ	400	399	432
BEYLİKDÜZÜ	467	531	470
BEYOĞLU	387	443	446
BÜYÜKÇEKMECE	607	667	707
ÇATALCA	328	336	411
ÇEKMEKÖY	227	289	309
ESENLER	478	499	629
ESENYURT	1.337	1.514	1.661
EYÜPSULTAN	530	615	623
FATİH	1.038	1.085	1.167
GAZİOSMANPAŞA	615	604	642
GÜNGÖREN	317	280	304
KADIKÖY	515	507	531
KAĞITHANE	460	456	432
KARTAL	434	595	565
KÜÇÜKÇEKMECE	845	827	980
MALTEPE	445	517	597
PENDİK	899	1.129	1.187
SANCAKTEPE	498	654	648
SARIYER	377	411	443
SİLİVRİ	952	997	984
SULTANBEYLİ	470	559	704
SULTANGAZİ	671	737	749
ŞİLE	161	168	184
ŞİŞLİ	379	506	539
TUZLA	434	591	622
ÜMRANİYE	610	674	837
ÜSKÜDAR	418	449	450
ZEYTİNBURNU	377	377	423
İL DIŞI / DİĞER	8	6	9
TOTAL	***20.760***	***22.554***	***24.285***

4.8. Fire Response Times

Response times are a critical factor in controlling the growth and spread of fires. In Istanbul, the fire response time is defined as the duration from the onset of the fire until the arrival of firefighting teams at the scene. This timeframe is vital for minimizing the harmful effects of the fire and preventing loss of life.

Analyses indicate that the average fire response time in Istanbul ranges between approximately 4 and 10 minutes. However, this duration is influenced by numerous spatial and logistical factors such as district accessibility, traffic density, infrastructure conditions, and the distribution of fire stations. In central districts like Şişli, Beşiktaş, and Kadıköy, response times typically hover around 5 minutes, reflecting rapid and efficient intervention capabilities. The high density of fire stations and well-developed transportation infrastructure in these areas positively impact response times. Conversely, in densely populated but infrastructure-challenged districts such as Esenler, Bağcılar, and Sultanbeyli, average response times can reach around 7 minutes. These delays increase the risk of fire escalation and compound the difficulties faced by firefighting teams during intervention. Furthermore, in forest-adjacent districts such as Beykoz, Sarıyer, and Çekmeköy, response times to natural fires tend to exceed the average, often surpassing 9 minutes due to challenging terrain. This prolongation hampers early fire containment efforts and results in significant damage to local ecosystems.

To reduce response times, Istanbul Metropolitan Municipality is taking steps such as increasing the number of fire stations, investing in modern vehicles and equipment, and enhancing priority passage rights in traffic management. Additionally, improvements in fire detection and alarm systems enable rapid notification of first-response teams, thereby shortening intervention times. Consequently, a detailed spatial analysis of response times forms the foundation for strategic planning aimed at enhancing fire management effectiveness in Istanbul. Increasing response speed in both urban and natural areas is indispensable for reducing fire-related risks and preventing loss of life.

Figure 5: Average Arrival Time to Fires Based on District

Districts / Years	2021	2022	2023
ADALAR	04:15	03:27	03:38
ARNAVUTKÖY	07:17	07:31	07:15
ATAŞEHİR	05:43	05:48	05:55
AVCILAR	07:39	07:37	07:27
BAĞCILAR	07:23	07:37	07:04
BAHÇELİEVLER	05:09	05:47	06:02
BAKIRKÖY	05:45	07:06	06:45
BAŞAKŞEHİR	06:22	06:22	06:45
BAYRAMPAŞA	05:02	05:28	05:56
BEŞİKTAŞ	04:42	05:48	06:27
BEYKOZ	08:10	08:22	08:49
BEYLİKDÜZÜ	06:22	06:53	06:17
BEYOĞLU	06:33	07:28	07:26
BÜYÜKÇEKMECE	06:48	07:12	06:48
ÇATALCA	07:57	09:26	10:03
ÇEKMEKÖY	09:10	09:13	08:59
ESENLER	05:37	06:37	06:15
ESENYURT	06:13	06:20	06:33
EYÜPSULTAN	05:44	05:49	06:13
FATİH	04:29	04:36	04:24
GAZİOSMANPAŞA	04:55	05:45	05:56
GÜNGÖREN	05:14	05:47	05:55
KADIKÖY	06:11	06:02	06:24
KAĞITHANE	06:23	06:16	06:52
KARTAL	04:52	04:55	05:11
KÜÇÜKÇEKMECE	05:54	06:43	06:46
MALTEPE	05:49	05:24	05:11
PENDİK	05:38	06:05	06:16
SANCAKTEPE	06:10	06:15	06:45
SARIYER	05:41	05:58	06:52
SİLİVRİ	08:17	08:25	08:36
SULTANBEYLİ	05:15	05:51	06:05
SULTANGAZİ	05:14	05:24	05:30
ŞİLE	09:11	09:05	10:03
ŞİŞLİ	05:12	06:28	06:51
TUZLA	06:24	06:15	07:17
ÜMRANİYE	06:43	07:01	07:40
ÜSKÜDAR	05:39	06:13	06:18
ZEYTİNBURNU	05:18	05:55	05:56

5. CONCLUSION AND RECOMMENDATIONS

This study, based on the analysis of fire incidents in Istanbul, reveals that the number of fire cases in the city is steadily increasing and that this rise is closely linked to multifaceted socio-spatial dynamics. Rapid population growth, dense and unplanned urbanization, industrialization processes, and environmental factors have been identified as the primary elements elevating fire risk in the city. Urban transformation and infrastructure deficiencies directly contribute to the frequency and severity of fires, necessitating a fundamental reassessment of preventive policies within this context.

The distribution of fire types reveals that building fires constitute the majority of fire incidents in Istanbul. Following building fires, vehicle fires, and fires occurring in natural areas such as shrubs and

forests represent the next most common categories. This heterogeneous fire profile highlights the city's combination of densely populated urban settlements alongside environmentally sensitive ecosystems, necessitating multifaceted fire management strategies.

Findings related to fire causes indicate that electrical faults are the most prevalent source of fires. It has been observed that electrical-related fires occur more frequently in districts with older and poorly maintained technical infrastructure. This underscores the critical role of urban infrastructure renewal and regular maintenance in reducing fire risk. There are significant spatial differences in fire incidents across districts. It has been found that districts such as Esenyurt, Bağcılar, and Pendik, characterized by high population density and intense urbanization, experience markedly higher numbers of fires compared to other districts. These findings demonstrate a strong relationship between socio-spatial structures and fire risk, underscoring the importance of targeted preventive measures at the local level.

On the other hand, the Istanbul Fire Department has recorded notable improvements in response times in recent years. Technological upgrades have supported the shortening of intervention durations, strengthened organizational structures, and improved traffic management. These advancements significantly contribute to controlling fires before they escalate, thereby reducing loss of life and property.

In light of these findings, multidimensional strategies should be developed to reduce Istanbul's fire risk and enhance fire management effectiveness. Priorities within these strategies should include infrastructure modernization, public awareness campaigns, addressing socio-economic challenges, increasing firefighting capacity, and protecting natural areas. Furthermore, integrating fire risk analysis with spatial and socio-economic data will ensure efficient allocation of resources and effective prioritization of response efforts.

Based on these findings, the following recommendations were developed:

1. Renewing the Electrical Infrastructure and Increasing Inspections: Electrical installations should be updated, and periodic inspections should be increased, especially in older residential areas where fires are frequently observed.

2. Community-Based Awareness and Education Programs: To prevent fire negligence, it is important to raise awareness of fire risks among residents and educate children about the dangers of fire, including smoking, open fires, and other factors.

3. Reducing Socio-Spatial Problems: To prevent socially motivated fires such as deliberate arson, social support programs, security measures, and urban transformation projects should be accelerated.

4. Increasing Fire Department Capacity and Reducing Response Times: Placing new fire stations at strategic locations, activating priority right-of-way practices in traffic management, and strengthening technological infrastructure will increase response speed.

5. Protection and Early Warning Systems in Natural Areas: To reduce fire risk in forested areas, early detection systems should be established, the capacity of forest firefighting teams should be increased, and ecosystem-based preventive measures should be taken.

6. Integration of Spatial Data Analyses: Fire risk maps need to be updated, analyzed with socio-economic data, and decision support systems need to be developed and integrated into disaster management plans.

Consequently, integrated policies encompassing technical, social, and spatial dimensions should be developed to reduce fire risks in Istanbul. Understanding the socio-spatial causes of fires and designing preventive strategies within this framework is critical to maintaining the quality of life and ensuring life safety in the city. In this context, comprehensive and sustainable fire management models should be implemented in collaboration with relevant public institutions, local governments, civil society organizations, and academia.

Based on the findings of this study, the following strategic recommendations have been developed for local governments and public institutions responsible for disaster management:

1. Risk-Based Response Planning:
   - Considering that fires are concentrated in certain areas in Istanbul, the locations of fire stations should be re-evaluated, and new stations should be established where needed.
   - Dynamic risk maps should be created, and continuously updated data-based planning should be implemented in high-fire risk areas.

2. Logistics Optimization to Reduce Response Times:
   - Vehicle guidance systems and artificial intelligence-based route optimization software can be used to reduce fire department travel time to the scene.
   - Traffic management and priority routes should be planned during peak hours.

3. Education and Community-Based Awareness Programs:
   - Since a significant portion of fires are caused by negligence, fire awareness campaigns aimed at the public should be increased.
   - Regular fire drills and training seminars should be conducted in schools, apartment buildings, and industrial zones.

4. Establishing Data-Based Decision Support Systems:
   - An integrated decision support system should be developed to collect and analyze fire incident data on a single digital platform.
   - This system should also be able to analyze data from various institutions (e.g., AFAD, Meteorology, municipalities, TOKİ, etc.).

5. Seasonal Measures and Early Warning Systems:
   - Early warning systems should be established for open-air fires, which increase during the summer months, and field teams should be strengthened during these periods.
   - Forecast systems that integrate meteorological data, including drought, wind, and temperature should be established.

6. Increased Structural Safety Inspections:
   - Inspections of fire-resistant building materials and electrical installations should be increased, especially in older buildings.
   - Penalties should be imposed on buildings without fire escapes and evacuation plans.

7. Strengthening Personnel and Vehicle Capacity:
   - Fire department capacity needs to be increased in line with the types and frequency of fires.
   - The number of specially trained firefighting teams should be increased, and equipment technology should be updated.
   -

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