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Review Article

The importance of building inventory update in urban regeneration of Turkey: A call for action and solution

Ali Tunc*

Civil Engineering Faculty, Department of Geomatics Engineering, Istanbul Technical University, 34469 Istanbul, Turkey

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***Corresponding author:** Ali Tunc, Civil Engineering Faculty, Department of Geomatics Engineering, Istanbul Technical University, 34469 Istanbul, Turkey,
E-mail: tuncali1@itu.edu.tr

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Abstract

The spatial building inventory of Turkey plays a central role in many challenges and development opportunities the country faces. Located in a seismic zone and confronting rapid population growth, Turkey continuously experiences change and development in urban infrastructure and settlement arrangements. This article comprehensively addresses the necessity of updating building inventories in Turkey, emphasizing its numerous benefits and examining its impact on urban development, disaster management, and economic, and social structures. Given factors like seismic activity, rapid urbanization, demographic changes, and urban regeneration in Turkey, the need for an up-to-date and accurate building inventory is underlined. The research highlights the critical importance of updating building inventory data in areas such as disaster preparedness, urban planning, and potential solutions in this process. Furthermore, updating building inventory information significantly enhances the effectiveness of urban regeneration policies and forms a crucial reference 19 point in decision-making processes for both public and private sectors.

Introduction

In contemporary urban development and disaster management, the significance of maintaining updated and comprehensive building inventories has emerged as a critical component, especially in regions prone to natural disasters. This aspect of urban planning gains even greater prominence in countries like Turkey, which are characterized by significant seismic activity and rapid urban growth. Among Turkish cities, Istanbul stands out due to its dense population, historical significance and susceptibility to earthquakes. This complex interplay of urbanization, historical preservation, and disaster risk management makes Istanbul a unique case for examining the practices and challenges in building inventory management. The need for robust and accurate building inventories is not only crucial for urban planning but also forms the backbone of disaster risk mitigation and response strategies.

Recent advancements in GIS and remote sensing have revolutionized urban planning, offering detailed insights into urban fabric and infrastructure vulnerabilities, particularly in seismic zones. Technologies such as LiDAR and UAV-based imaging provide high-resolution data crucial for updating building inventories [1]. Moreover, global case studies, such as the post-earthquake urban regeneration in Christchurch, New Zealand, offer valuable lessons for Turkey's urban resilience efforts [2]. Alongside technological advancements, there's a growing emphasis on sustainable urban design in seismic areas, focusing on green infrastructure and energy efficiency [3]. The comparative analysis of urban resilience strategies in cities like Tokyo and San Francisco reveal the influence of cultural and regulatory contexts on urban planning [4].

The study "Development of a Holistic and Inclusive Model for Disaster Priority Regeneration Area (DPRA): Case of Istanbul, Turkey" by Tunç, Sezgin and Yomralıoğlu [5] indirectly highlights the broader challenges faced in managing Istanbul's building inventory. While the study primarily addresses the formulation of a model for disaster priority areas, it also reflects on the necessity of having reliable and updated spatial data for effective urban management and

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disaster preparedness. This revelation aligns with the global discourse on the importance of updated building inventories as foundational elements in resilient urban planning [6,7].

The historical context of Turkey, especially in terms of seismic events, has shaped its approach to urban planning and disaster management. The devastating 1999 Marmara Earthquake, in particular, served as a catalyst for reevaluating and enhancing urban resilience strategies across the country [8,9]. This event underscored the vulnerability inherent in outdated and incomplete building data, leading to significant revisions in national building codes and urban planning regulations [10]. However, Istanbul's case presents unique challenges in updating and managing building inventories. Data fragmentation across various institutional repositories leads to issues of redundancy and inconsistency, hindering the development of cohesive risk profiles and structural vulnerability assessments for the city [11]. Furthermore, the rapid pace of urban development in Istanbul adds another layer of complexity, necessitating continuous updates to building inventory data to accurately reflect the ever-changing urban landscape. The challenges encountered in Istanbul's building inventory management, as indirectly suggested by Tunç, Sezgin and Yomralıoğlu [12], resonate with broader urban planning issues across Turkey. The deficiencies in existing building data can significantly impede disaster management efforts and compromise urban resilience initiatives. Addressing these challenges requires a multi-faceted approach, integrating technological advancements, policy reforms, and stakeholder collaboration.

An effective strategy for managing Istanbul's building inventory should include the standardization of data collection methods, the establishment of a centralized and dynamic database, and the regular updating of spatial data. Advances in Geographic Information Systems (GIS) and data analytics offer potential solutions for streamlining data collection and enhancing the accuracy of building inventories. These tools can facilitate the mapping of diverse building stocks, assess structural vulnerabilities, and inform targeted interventions for disaster risk reduction [13,14]. The effective management of Istanbul’s building inventory stands as a crucial element within the city’s extensive urban planning and disaster management framework. This aspect gains additional prominence when considering the intricate challenges posed by the city’s unique geographical and demographic dynamics. The significance of maintaining comprehensive, accurate, and consistently updated building inventories becomes evident in light of these challenges. These inventories play an indispensable role in facilitating efficient urban planning, shaping proactive disaster response strategies, and fostering the long-term resilience of a megacity like Istanbul. A city's capacity to respond to and recover from natural disasters is deeply intertwined with the quality and accessibility of its building data. Accurate inventories enable city planners and disaster management authorities to make informed decisions, identify high-risk zones, and implement timely interventions. Moreover, in the context of rapid urban development and changing landscapes, the necessity of keeping these inventories up-to-date cannot be overstated. They are not only tools for current assessment but also vital resources for future-proofing the city against potential seismic threats.

In Istanbul, the confluence of historical heritage, modern infrastructure, and seismic vulnerability underscores the need for a holistic approach to building inventory management. This approach should blend advanced technological methods with collaborative policy-making and stakeholder engagement. By doing so, it can provide a robust foundation for sustainable urban development and enhance the city's resilience against future disasters. As urban centers like Istanbul continue to expand and modernize, the insights gleaned from their building inventory management practices become increasingly valuable. These insights can guide other cities that are navigating similar growth and seismic challenges. This evolution underscores the importance of dynamic and comprehensive urban data management, which is crucial for developing sustainable urban strategies and enhancing resilience against future disasters.

General procedure and key concepts of the study

This study embarks on a comprehensive exploration of urban development and disaster management, with a particular emphasis on the vital role of maintaining updated and extensive building inventories, a crucial aspect of a city like Istanbul. The city's unique characteristics, such as its dense population, rich historical heritage, and high susceptibility to earthquakes, place it at a critical intersection of urbanization, historical conservation, and disaster risk management. This study seeks to delve into the multifaceted challenges and current practices in building inventory management within Istanbul, acknowledging the critical role these inventories play in both urban planning and disaster risk mitigation strategies. Positioning itself within the broader landscape of contemporary urban development and disaster management, especially in seismically active regions like Turkey, the study offers an in-depth analysis. It pays particular attention to the historical context of Turkey, especially the profound impact of seismic events such as the 1999 Marmara Earthquake. This event has been pivotal in shaping Turkey's approach to urban planning and disaster management, prompting significant enhancements in urban resilience strategies and leading to substantial revisions in national building codes and urban planning regulations [15] (Gündoğdu 2022). The study focuses on the unique challenges that Istanbul faces in updating and managing its building inventories, taking into account the complications arising from data fragmentation, redundancy, and the necessity for comprehensive risk profiles and structural vulnerability assessments.

A key component of this study is the development of an effective strategy for managing Istanbul's building inventory. Emphasizing the need for standardization in data collection methods, the establishment of a centralized and dynamic database, and the regular updating of spatial data, the study explores the potential and application of Geographic Information Systems (GIS) and data analytics. These technologies are deemed crucial for streamlining data collection processes and enhancing the accuracy of building inventories. They play a

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pivotal role in mapping diverse building stocks, evaluating structural vulnerabilities, and informing targeted interventions for disaster risk reduction [16] (Yeşilnacar and Cömert 2021). Advocating for a holistic approach to building inventory management in Istanbul, the study combines advanced technological methods with collaborative policymaking and stakeholder engagement. This approach is designed to provide a robust foundation for sustainable urban development and to enhance the city's resilience against future disasters. The study also considers the valuable insights gained from Istanbul's experiences in building inventory management, offering lessons that could be beneficial to other urban centers facing similar challenges. It acknowledges that the journey toward resilient urban development is ongoing and requires adaptive strategies and innovative solutions. The study emphasizes the necessity of comprehensive management of urban data as a cornerstone for these strategies, ensuring that cities like Istanbul can effectively respond to and recover from natural disasters.

By contributing to the discourse on urban resilience, this study provides a detailed analysis of the challenges and solutions in building inventory management, particularly relevant in the context of rapidly developing and changing urban landscapes.

In addition to these methodologies, the application of Geographic Information Systems (GIS) in urban regeneration in Turkey, especially in seismic risk assessment and urban planning, is a topic warranting further exploration. Recent developments in GIS technology have facilitated more accurate and efficient urban data management, crucial for seismic resilience. For instance, in the context of Istanbul, the integration of GIS has enabled better visualization and analysis of urban growth patterns, highlighting areas of high seismic risk and informing strategic urban planning decisions. This enhanced approach to urban data management exemplifies the evolving role of GIS in supporting sustainable urban development and disaster preparedness, aligning with global urban resilience initiatives.

The field of disaster risk reduction has seen significant innovations, particularly in the integration of machine learning algorithms with GIS for predictive modeling of urban vulnerabilities [17]. Additionally, recent technological advancements in building inventory management, such as the use of blockchain for secure and transparent data sharing, are promising for enhancing urban planning processes [18]. Advanced simulation models now incorporate real-time data and AI to predict urban disaster scenarios with greater accuracy [19]. Moreover, community engagement has emerged as a critical component in urban planning, ensuring that regeneration projects align with local needs and aspirations [20].

Problem statement and methodology

Urban regeneration projects are crucial in creating resilient and sustainable urban structures, especially in areas prone to natural disasters. The Turkish Building Earthquake Regulation (TBYY), highlighted by Özyıldırım [21], is a key regulation designed to ensure the earthquake safety of buildings in Turkey. Projects focusing on disaster mitigation aim to restructure the existing building stock in accordance with earthquake risk, making TBYY an essential reference in the disaster-focused urban regeneration process. The integration of heterogeneous data sources remains a significant challenge in urban planning. Recent studies have proposed novel frameworks for the semantic integration of urban data, facilitating a more coherent understanding of urban dynamics [22]. Methodologies leveraging big data analytics for urban regeneration projects have shown the potential to improve disaster resilience while ensuring sustainable urban development [23].

A significant challenge identified in this study is the discrepancy in the total number of buildings in Istanbul as reported by different data sources. This research specifically examines the differences in building counts between the Spatial Address Registration System (MAKS) and the spatial building data created by the Directorate of Earthquake and Ground Research (DEZIM). All the works carried out within the Istanbul Metropolitan Municipality are conducted using these two structural data. In the conducted studies, the presence of different attribute information in these two different structural inventories, especially the building age grouping in the DEZIM structural data, leads to different results in the studies. Primarily, the inconsistency issues encountered in the studies conducted for the integration of the mentioned different attributes are causing increasing spatial data differences due to different building stocks and the purpose of a current and dynamic database in the MAKS structural data. The continuity of disaster-focused urban regeneration and ongoing area-based and structure-based projects has necessitated urgent re-identification studies in the field due to differences in databases and lack of attribute data in the studies conducted in this regard, leading to compatibility issues between the data collected in the field and the data within the database.

Firstly; comparison, even at a broader level, reveals notable inconsistencies in the total building numbers. According to MAKS, the total number of buildings, including auxiliary buildings, is 1,389,930. When auxiliary buildings are excluded, this figure decreases to 1,160,691. In contrast, DEZIM reports a total of 1,038,737 buildings, not including auxiliary buildings (Table 1).

These discrepancies between MAKS and DEZIM's figures raise significant concerns about the reliability and consistency of data used in urban planning and regeneration projects. The variability in reported numbers can lead to substantial challenges in accurately assessing urban regeneration needs and priorities, particularly in disaster risk reduction initiatives.

Table 1: Table of Total Number of Buildings in Istanbul According to MAKS and DEZIM.

Data Source	Total Number of Buildings
MAKS (Spatial Address Registration System)	1,160,691
DEZIM (Directorate of Earthquake and Ground Research)	1,038,737

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The methodology for this study involves a systematic comparison of data from these two sources to understand the discrepancies' extent and potential causes. Analyzing these differences is crucial for highlighting the importance of data accuracy and standardization in urban regeneration projects. Inaccurate or inconsistent data can result in misinformed decision-making, inefficient resource allocation, and potential delays in project execution. Moreover, it can impact the effectiveness of disaster mitigation strategies, as precise and reliable building data is essential for accurate risk assessment and planning. Through this analysis, the study aims to provide insights and recommendations for improving data collection and management processes. These improvements are vital to ensuring that urban regeneration projects in Istanbul and similar urban environments are based on reliable and accurate data, thereby enhancing their effectiveness and contributing to more resilient urban development.

In current projects, the absence of construction year data within the dynamic database MAKS, and the fact that license information has been recorded only after 2007, result in the DEZIM structural data being the sole source for construction year data grouping. In the integration studies conducted within this scope, it has been determined that the number of structures in the current and polygonal maintained MAKS data that exactly match spatially is 1,088,860. In the construction year grouping of these matching structures, the district with the highest license rate after 2007 has been designated as the pilot area. While Esenyurt has the highest number of buildings licensed after 2007, it is followed by Sancaktepe and Büyükçekmece. The total number of buildings in these districts, the number of licenses issued after 2007, and the total ratio of licensed buildings in the district are provided in Table 2. As a result of the integration study mentioned in the two structural data used, as seen in Figure 1, in the MAKS data, new licensed buildings can correspond to two or more DEZIM structural data, and differences in the license data and construction year data in the relevant buildings can be easily observed.

In the context of urban regeneration, particularly regarding disaster mitigation, the construction year of a building emerges as a critical factor influencing its earthquake performance and structural durability. Yaman, et al. [10] emphasize the significance of the construction year in determining a building's resilience to seismic activity. An examination of Turkey's construction history reveals that a substantial portion of the buildings constructed before 1998 do not comply with the Turkish Building Earthquake Regulation (TBYY), as noted by AFAD [9]. This non-compliance indicates that a significant segment of the building stock is vulnerable to earthquake risks, a concern also highlighted by Erdik [8]. Further evaluations, considering the construction year, show that buildings constructed before 1998 manifest deficiencies when measured against the current regulatory criteria. Therefore, these buildings should be given priority in the regeneration process aimed at disaster-focused urban renewal [10]. The construction year, thus, becomes a pivotal factor in strategizing and planning urban regeneration, aligning with the overarching goal of mitigating disaster risks.

Adding another layer to this analysis, the study examines the distribution of building construction years as integrated into

Table 2: Districts with the Highest Number of Licenses Issued After 2007.

District Name	Number of Buildings Licensed After 2007	Total Number of Buildings	License Ratio
Esenyurt	17,202	44,385	0.38
Sancaktepe	11,117	34,371	0.32
Küçükçekmece	7994	43,766	0.18

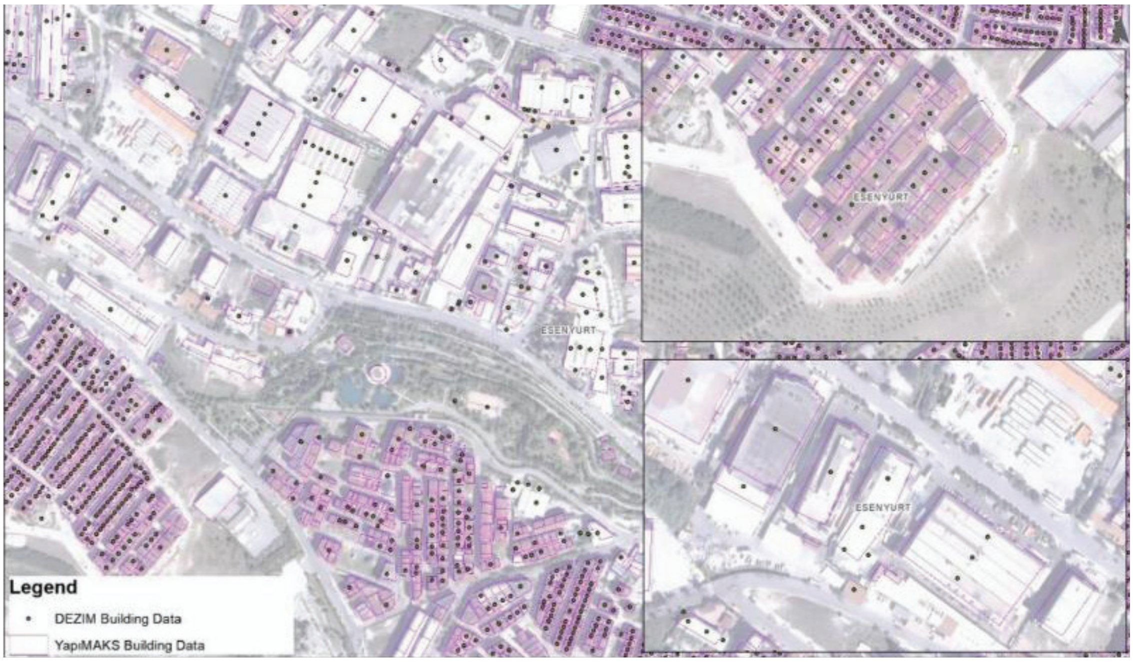

Figure 1: Examples of Differences Between DEZIM and YapıMAKS Spatial Structural Data in the Esenyurt District of Istanbul Province.

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the MAKS data. However, this integration reveals a significant gap: a total of 334,212 buildings lack recorded construction year information (Table 3). This gap in data presents a substantial challenge in accurately assessing the overall condition and risk profile of the building stock in Istanbul. The inability to determine the construction year of such a large number of buildings impedes the process of prioritizing and strategizing urban regeneration efforts effectively.

This revelation about the missing construction year data is significant as it points to potential shortcomings in data collection and management practices. It raises questions about the reliability of existing data sets and the implications for urban planning, particularly in the context of disaster preparedness and response. The study, therefore, will present a detailed tabulation of building numbers according to their construction year classes as per MAKS data, highlighting the portion of the building stock with unknown construction years. This analysis will provide a clearer picture of the challenges faced in planning and implementing urban regeneration projects and will form the basis for recommendations to improve data accuracy and completeness in future urban planning initiatives.

In the evaluation of Turkey's seismic regulations, it's observed that many calculation principles used in the 2007 Earthquake Regulation, effective before the 2018 update, were originally introduced in the 1998 version. While both sets of regulations share similarities, there were minor yet crucial changes over time. These include the detailed elaboration of earthquake-resistant designs for steel structures, additions concerning the evaluation and strengthening of existing buildings, and the removal of sections related to earthquake-resistant designs for wooden and adobe buildings [24]. This evolution in regulations reflects an ongoing effort to enhance seismic resilience in building design and construction. An analysis focused on the selection of areas deemed risky under Law No. 6306 reveals significant inconsistencies in the data used. The criteria for selecting these areas, such as ground and plan functions, appear not to have been comprehensively considered. This study found that a staggering 83% of the current building stock, according to the Earthquake Ground Directorate, was constructed before 2000. Moreover, when examining the license data integrated with YapıMAKS data based on the 2007 regulation, only 2% of the buildings were found to have licenses issued after 2007. These findings suggest that the selection of risky areas has predominantly been based on TBYY compliance and the proportion of buildings constructed before the 1999 earthquake.

However, this approach reveals underlying issues in the building data. For instance, discrepancies become apparent when comparing the total number of buildings in risky areas as reported by different sources. The Earthquake Ground Directorate reports 29,638 buildings, while YapıMAKS data shows 28,532, and field studies report 27,370. Such discrepancies in the data, highlighted by Özmen, et al. [11], indicate significant deficiencies in the numerical building data of Istanbul. These inconsistencies arise from various issues, including incompatible data sets, data repetition, and lack of integration across different sources (Tables 4,5).

Table 3: Table of Number of Buildings in Istanbul According to Construction Year Classification Integrated into MAKS Data.

Construction Year Classification	Number of Buildings
Pre-1980 Constructions	205,919
1980 – 2000 Constructions	435,580
Post-2000 Constructions	213,130
Unknown Construction Year	334,212

These inconsistencies are particularly evident when examining license data in the context of TBYY regulations. The analysis of license data, especially in the 69 risky areas designated by the Ministry of Environment, Urbanization, and Climate Change, shows varying numbers depending on the source. Such discrepancies revealed through research conducted in these areas, raise serious concerns about the reliability of data used in determining and planning risky areas. The implications of this issue are profound, as 308 they can affect the accuracy of risk assessments, the effectiveness of planned projects, and the overall success of urban regeneration initiatives focused on disaster mitigation.

This situation underscores the need for more rigorous data management practices and the integration of reliable data sources to ensure accurate and effective planning. The challenges posed by these data discrepancies necessitate a comprehensive approach to urban planning, one that prioritizes data integrity and consistency to inform better decision-making processes. As urban regeneration projects continue to evolve, addressing these data challenges will be crucial in building more resilient and sustainable urban environments, particularly in areas prone to seismic risks. The problems that this situation can lead to can be expressed as follows.

Mistakes in Planning and Decision-Making Processes: Deficiencies and repetitions in structural data can lead to incorrect analyses and, consequently, erroneous decisions [25]. This situation can lead to mismanagement of crucial issues such as urban regeneration, infrastructure investments, and earthquake risk assessments [11].

Productivity loss: The lack of integration of different datasets and the absence of a holistic structure can result in productivity losses in data analysis and management processes [26]. This situation can lead to a waste of time and resources, slowing down urban development processes and increasing costs.

Legal and financial issues: Deficiencies and errors in structural data can also cause problems in legal and financial matters such as property and taxation [25]. This situation can lead to unfair and incorrect applications, resulting in societal dissatisfaction.

In this context, a model proposal has been presented within the scope of the study, aiming to eliminate the deficiencies in the numerical building data in Istanbul and the missing attributes of the structures.

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Table 4: YapıMAKS Building Data in Risky Areas Announced Under Law No. 6306 for the Province of Istanbul (Tunc 2023).

	License Status (YapıMAKS)		Total Number of Buildings	
Risky Areas Declared Under Law No. 6306 (69)	Number of Licensed Buildings Between 2000-2007	Number of Licensed Buildings After 2007	YAPIMAKS Building Data	Current Number of Buildings Based on Field Survey
	185	629	28,532	27,370

Table 5: DEZIM Building Data in Risky Areas Announced Under Law No. 6306 for the Province of Istanbul (Tunc 2023)

	Construction Year (DEZIM)		Total Number of Buildings	
Risky Areas Declared Under Law No. 6306 (69)	Number of Buildings Constructed Before 2000	Number of Buildings Constructed After 2000	DEZIM Building Data	Current Number of Buildings Based on Field Survey
	24,823	4,795	29,638	27,370

Results and model proposal

The development of centralized dynamic database systems, as evidenced in Singapore's Smart Nation initiative, underscores the potential for real-time urban data management [27]. Furthermore, the adoption of advanced standardization protocols, akin to those developed by the ISO for smart cities, ensures uniformity and interoperability of urban data across different platforms and stakeholders [28]. Recent case studies highlight the positive impact of urban green spaces on resilience, improving community well-being and ecological stability [29]. Furthermore, innovations in urban infrastructure emphasize adaptability and flexibility, incorporating modular and movable elements to accommodate future changes [30].

In this context, a model proposal has been presented within the scope of the study, aiming to eliminate the deficiencies in the numerical building data in Istanbul and the missing attributes of the structures (Table 5).

Centralized dynamic database system: A central database is fundamental for consolidating Istanbul’s building data [26]. This system should be dynamic, allowing for real-time updates and modifications. Regular synchronization with various data sources will ensure the database reflects the current state of the urban environment, thereby minimizing data redundancy and enhancing accuracy [11].

Advanced standardization protocol: The development of a sophisticated standardization protocol is crucial. This involves creating a comprehensive building data dictionary, aligned not only with national standards but also with international best practices [25]. Such a dictionary should include definitions and classifications that cover a wide range of building characteristics, from structural details to historical significance.

GIS integration for enhanced spatial analysis: The integration of the building database with Geographic Information Systems (GIS) is key to providing a spatial dimension to the data [26]. This integration should support advanced spatial analytics, enabling urban planners and decision-makers to visualize patterns and trends, conduct risk assessments, and plan urban development initiatives more effectively.

Robust quality control and continuous auditing: Establishing stringent quality control protocols and continuous auditing mechanisms is essential for maintaining data integrity [11]. This includes regular verification of data accuracy, periodic reviews of data sources, and continuous updates to ensure the database remains relevant and reliable.

Multi-stakeholder collaboration and data sharing: Encouraging active collaboration among multiple stakeholders is vital for the success of the Building Data Model [25]. This includes local governments, urban planners, emergency services, and community organizations. An efficient data-sharing platform should be established to facilitate the exchange of information and insights, which will enrich the database and support informed decision-making.

Training and capacity building: To effectively implement this model, training and capacity building are essential. Stakeholders should be trained in the latest data management and GIS technologies. This will ensure the proper utilization of the database and promote a culture of data-driven decision-making in urban development and disaster management.

Feedback mechanism for continuous improvement: A feedback mechanism should be incorporated to continuously refine the Building Data Model. This involves gathering input from users, analyzing performance metrics, and making iterative improvements based on real-world applications and evolving urban needs (Table 6).

This enhanced Building Data Model is designed to be a living, evolving system that adapts to the changing dynamics of urban environments. By addressing the challenges identified in the earlier sections of this study, the model sets a new standard

Table 6: Building Data Model.

Building Data Model	
Building Identity Information	Building Attribute Information
Building Coordinates	Building Materials and Structural Features
Building Usage	Building Permit and Licensing Information
Disaster Risk Factors	Energy Efficiency and Environmental Factors
Socio-Economic Factors	Transportation and Infrastructure Information
GIS Integration for Enhanced Spatial Analysis	
Centralized Dynamic Database System	
Robust Quality Control and Continuous Auditing	
Multi-Stakeholder Collaboration and Data Sharing	
Training and Capacity Building	
Feedback Mechanism for Continuous Improvement	

for urban data management, paving the way for more resilient and efficient urban planning and development in Istanbul and other similar urban settings.

This displays the fundamental components and relationships of a model aiming to eliminate deficiencies in the numerical building data and the attributes of structures. For the successful implementation of the model, continuous improvement and updating processes should be focused on, and the cooperation and participation of all stakeholders should be ensured. This Table schematically displays the essential components and relationships of the building data model. The building data model includes data in various categories such as building identity information, building attribute information, building coordinates, building materials and structural features, building usage, and building permit and licensing information. All these data categories are spatially associated through GIS integration, enabling geographical analysis and evaluations. The data, which are collected and managed in the central database, undergo quality control and auditing processes to ensure their accuracy and timeliness. The deficiencies in the numerical building data and attributes of structures in Istanbul, along with data repetition and integration issues, lead to significant planning, management, and legal challenges. A centralized and integrated building data model is proposed to solve these problems. This model includes elements of standardization, GIS integration, quality control, auditing mechanisms, and stakeholder collaboration. This approach ensures the accurate and up-to-date maintenance of building data in Istanbul, enabling more effective and efficient decision-making in urban development processes.

To implement the proposed Building Data Model for approximately 1.5 million buildings across Istanbul, a collaborative effort involving a wide range of public and private sector institutions is crucial. Considering the integration schema outlined in the previous study (Figure 2), the primary institutional actors essential for the model design are identified as follows.

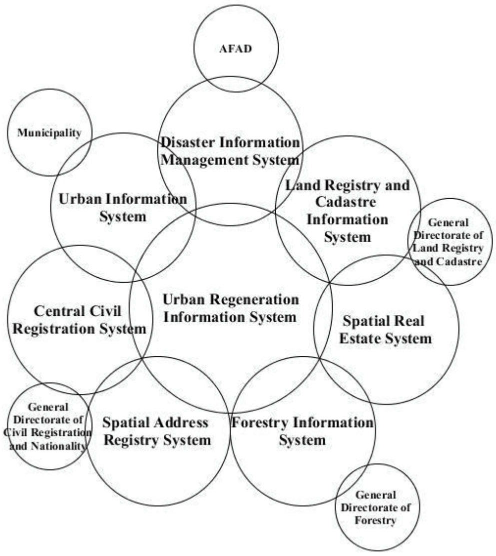

Figure 2: Urban Regeneration Database Integrated Components [5].

Primary institutions involved

Istanbul Metropolitan Municipality (IMM): IMM plays a pivotal role as a local government entity. It is instrumental in providing geographic information systems, building permits, and licenses, as well as data concerning infrastructure and transportation. IMM's involvement ensures that local governance perspectives are incorporated into the model, facilitating alignment with urban planning and development goals [13].

Disaster and Emergency Management Presidency of Turkey (AFAD): Collaboration with AFAD is vital for comprehensive disaster risk assessments and the formulation of mitigation strategies. AFAD's expertise and data resources are critical for integrating disaster risk factors into the building data model, enhancing the model's capacity for risk-informed decision-making [7].

General directorate of land registry and cadastre: This institution will provide essential building identity information, coordinates, and land registry data. Their contribution ensures that the model includes legally verifiable and accurate property information, a key component for any urban regeneration initiative [8].

Turkish Statistical Institute (TURKSTAT): Collaboration with TURKSTAT is essential for integrating socio-economic and demographic data into the model. This information will enrich the model by providing a broader understanding of the urban environment and its social dynamics [25].

Ministry of energy and natural resources: Partnering with this ministry is crucial for incorporating data and policies related to energy efficiency and environmental impacts. This integration aligns the model with sustainable development goals and environmental conservation efforts [26].

Ministry of environment and urbanization: Collaboration with this ministry is key for aligning the model with national building regulations, urban regeneration policies, and support mechanisms. This ensures that the model adheres to regulatory standards and contributes to policy-driven urban development [11].

Private sector and non-governmental organizations: Engaging with private sector entities and NGOs offers access to diverse information and experiences in areas such as building materials, energy efficiency technologies, and environmental impacts. Their involvement fosters innovation and brings cutting-edge practices into the model [14].

In addition to these local and national institutions, the model's development should also consider international best practices and standards. For instance, integration with global GIS databases and adherence to international standards for data quality and security can significantly enhance the model's effectiveness. Collaboration with international urban planning and disaster management organizations can also provide valuable insights and methodologies, contributing to a more robust and globally aligned model [6].

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The inclusion of these diverse institutions and adherence to international standards ensures that the proposed Building Data Model for Istanbul is not only comprehensive but also versatile, capable of addressing the multifaceted challenges of urban regeneration in a dynamic cityscape. This model, by pushing the boundaries of current urban data management practices, aims to set a new benchmark in resilient urban development.

Project planning

Preparation phase (0 - 6 months): Cooperation agreements should be made with institutions, the goals and scope of the project should be determined, and data collection and integration processes should be planned.

Data collection and integration phase (6 - 18 months): Required data should be collected from all institutions and stakeholders, standardized, and integrated into the central database.

Quality control and auditing phase (18 - 24 months): The accuracy and up-to-dateness of the collected data should be checked, missing or incorrect data should be corrected, and necessary arrangements should be made for continuous update processes.

GIS integration and analysis phase (24 - 30 months): The collected and organized data should be integrated with Geographic Information Systems (GIS) and spatial analyses should be conducted to develop suggestions for disaster-focused urban regeneration processes.

Implementation and monitoring phase (30 - 36 months): Urban regeneration projects should be initiated based on the analysis results and suggestions. The success and effectiveness of these projects should be monitored, and arrangements should be made for continuous improvement processes.

Evaluation and reporting phase (36 - 42 months): All processes and outcomes of the project should be evaluated, achievements and deficiencies should be identified, and suggestions should be developed for similar projects in the future.

In total, a process of approximately 3.5 years is planned for this project. Throughout this timeframe, in collaboration with all stakeholders, processes of data collection, integration, analysis, implementation, and evaluation can be successfully executed. By focusing on continuous improvement and updating processes, a sustainable and integrated disaster-focused urban regeneration process will be supported in Istanbul.

Discussion

While the aforementioned suggestions offer a roadmap for enhancing urban regeneration through an integrated building data model, it is crucial to consider the potential consequences of inaction on rectifying the deficiencies in the building data inventory, particularly in disaster-focused initiatives.

Increased risk in disaster management: Inadequate or outdated building data can significantly compromise disaster preparedness and response efforts. Without accurate building information, emergency services may be hindered in their ability to effectively allocate resources, conduct rescue operations, and provide relief in the aftermath of a disaster [8].

Flawed urban planning and development: The absence of a reliable building data inventory can lead to erroneous urban planning decisions, potentially exacerbating vulnerabilities in the urban fabric. This could result in infrastructural developments in high-risk areas, increasing the likelihood of catastrophic outcomes during seismic events or other natural disasters [10].

Economic losses and inefficient resource allocation: Lack of precise and updated building data can lead to significant economic losses due to inefficient resource allocation and misguided investments in urban development projects. The financial impact can be particularly severe in the aftermath of a disaster, where accurate data is essential for effective recovery and reconstruction [26].

Legal and ethical challenges: Inaccurate or incomplete building data can also pose legal and ethical challenges, particularly in terms of property rights, insurance claims, and accountability in the event of a disaster. The absence of reliable data can lead to disputes and delays in compensation, further exacerbating the plight of affected communities [11].

Public safety and health concerns: The health and safety of residents can be directly impacted by the lack of a robust building data inventory. Inaccurate data can lead to inadequate structural assessments, potentially overlooking buildings that are unfit for habitation or pose significant risks in the event of an earthquake or other hazards [25].

Delayed response in emergency situations: In the event of a disaster, the absence of a comprehensive building inventory can result in delayed emergency response and rescue operations, potentially leading to higher casualty rates and increased severity of the disaster's impact [9].

Long-term resilience and sustainability issues: The long-term resilience and sustainability of urban areas can be severely undermined by the failure to address data deficiencies. This can leave cities ill-prepared to cope with future challenges, including climate change impacts and increasing urbanization pressures [7]. The failure to address the deficiencies in the building data inventory can have far-reaching and severe consequences, particularly in the context of disaster-focused urban initiatives. These implications underscore the urgency and necessity of implementing the proposed enhancements to the building data model, to ensure the resilience, safety, and sustainability of urban environments like Istanbul.

In conclusion, this study has extensively examined the critical role of an integrated and comprehensive building data model in enhancing urban regeneration, with a special focus on Istanbul's unique urban landscape. The discussions underscore the importance of accurate, timely, and detailed building inventories as fundamental tools for effective urban planning, disaster risk mitigation, and sustainable development. The consequences of inadequate building data are far-reaching, impacting not only disaster management but also the broader spectrum of urban planning and development. As highlighted by recent events, the absence of accurate and up-to-date building inventories can severely hamper emergency response and recovery efforts [31]. Looking forward, the integration of AI and IoT in building data models presents a promising avenue for enhancing urban resilience and sustainability [32]. The policy implications of urban planning research are vast, influencing governmental decision-making on levels ranging from local to international [33]. Additionally, international cooperation, as seen in global urban resilience networks, plays a pivotal role in sharing best practices and resources [34].

The proposed model, encompassing advanced technologies like GIS and remote sensing, and supported by robust inter-institutional collaboration, presents a strategic approach to addressing current deficiencies in Istanbul's building data inventory. This approach is essential not only for immediate urban regeneration needs but also for building long-term resilience against natural disasters and urban challenges. However, the potential repercussions of inaction or delay in addressing these data gaps are profound. Inadequate building data can significantly hinder disaster response, lead to flawed urban planning, incur economic losses, and raise legal and ethical concerns, directly impacting public safety and health. Furthermore, the absence of an updated and accurate building inventory can delay emergency responses in disaster situations, compromising the overall resilience and sustainability of the city. Therefore, the implementation of the recommendations outlined in this study is imperative. By enhancing data integration and management, fostering cross-sectoral collaboration, and aligning with international best practices and standards, Istanbul can mitigate the risks associated with outdated and incomplete building data. In doing so, the city can safeguard its residents, preserve its rich cultural heritage, and secure its developmental achievements.

Conclusion

This study contributes to the broader discourse on urban resilience by providing a detailed analysis of the challenges and solutions in building inventory management, particularly in rapidly developing urban landscapes like Istanbul. The insights and recommendations derived from this study have implications far beyond Istanbul, offering valuable lessons for other global cities facing similar urban regeneration challenges. The journey toward resilient urban development is an ongoing process, requiring continuous adaptation, innovation, and commitment to data-driven decision-making.

In sum, the success of urban regeneration and disaster management strategies hinges on the effective management of building data. By prioritizing the development and maintenance of a comprehensive building data model, cities like Istanbul can navigate the complexities of urban development while ensuring safety, sustainability, and resilience for future generations.

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