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Article

The role of infrastructure in enhancing urban resilience to natural hazards: a case study of Tehran

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ABSTRACT

Urban resilience is paramount in mitigating the vulnerability of worn urban fabrics to natural hazards and safeguarding cities against irreparable damage. This study focuses on worn-out areas of Tehran city, analyzing their social and physical resilience dimensions. Adopting a descriptive-analytical approach, the research employs statistical methods such as one-sample t-tests, Pearson correlation, and regression coefficient analysis using SPSS and GIS. The statistical population comprises 230 randomly selected citizens residing in the study districts. The findings show that the physical dimension, with a score of 3.31, is more important than the social dimension, with a score of 2.81, which emphasizes the need to strengthen urban resilience. According to the results of this study, the studied areas do not have sufficient stability and resilience against natural disasters. Prospective analyses conducted using Geographic Information System (GIS) and the Mic Mac strategic studies model indicate the complexity of factors affecting urban resilience. These analyses reveal the high impact of variables and the interrelationships between them. In particular, it has been found that indicators related to infrastructure and management have a more significant impact in Region 7 compared to Region 15, which emphasizes the need to develop targeted intervention strategies. This comprehensive study provides a better understanding of urban resilience mechanisms and emphasizes the importance of coordinated planning and preventive measures to strengthen vulnerable urban areas. Ultimately, the results of this study show that adopting appropriate and coordinated measures is essential to ensure the safety and sustainability of cities.

1. Introduction

Earthquakes have increased both the probability and consequence of natural disasters such as floods, storms, and droughts [1]. Infrastructure resilience must be increased to reduce the harmful effects of natural disasters [2]. Most urban management programs emphasize the high resilience of infrastructure networks before a disaster occurs [3]. Infrastructure must be developed in such a way that, first, it suffers minor damage during disasters, and second, it can return to its previous state in the shortest possible time. The term resilience is often left to debate and does not have a general definition or consensus, although it is more used in

integrated urban drainage management [4]. The concept of resilience is widely applied in many fields of study (economics, engineering, psychology, sociology). In economics, resilience is the ability to quickly recover from a shock. In earthquake engineering, resilience is the ability to reduce hazards and do retrieval activities in ways that minimize social disorders and reduce the effects of future earthquakes [5]. In social science, resilience is the ability of groups or communities to deal with anxiety and external disturbances due to social, political, and environmental changes. The community's resilience is the ability of a society to be resilient against disaster, which refers to the ability to prevent or protect against major threats. In general, resiliency indicates the capacity of an urban system or society at risk of compliance with resistance or change to reach an acceptable level of performance, organization, and structure. The growing pace of urbanization around the world has brought unprecedented challenges to human societies. This paradigm shift has created complex issues, especially in the context of future urbanization in developing countries [6]. These challenges cover various areas, including urban sustainability, infrastructure development, the urban environment, and the resilience of aging structures. With the increasing pace of urbanization, the need to adopt a forward-looking approach to confront these challenges is becoming increasingly apparent [7]. Urban managers and policymakers are forced to develop strategies to create sustainable urban systems, especially in metropolitan areas that face the complexities of sustainable growth and development. The conceptual framework of resilience, first proposed in 1973 by Holling in the field of bioecological sciences, has become the basis for numerous subsequent definitions over time. In this context, resilience does not simply mean the ability to survive but includes broader concepts such as sustainable livelihoods, the ability to resolve crises, and building resilient communities [8].

Researchers have defined resilience as the ability of a city to cope with and adapt to a wide range of shocks and stresses, such that the structures critical to maintaining urban function remain efficient in crisis conditions [9]. In the specialized field of dilapidated urban textures, resilience has emerged as an independent concept and plays a central role in contemporary urban planning literature. This aspect of resilience is not only a physical feature but also a mental-spatial category that requires a fundamental review and modernization of urban structures to provide targeted services tailored to the needs of citizens. In the context of the increasing global population, especially in urban areas, the complexities and challenges in different sectors are also intensified [10]. Therefore, risk management in urban planning and design is particularly important and requires adopting strategic measures for crisis management, reducing vulnerabilities, promoting safety, and improving the quality of life. In this regard, the city acts as a dynamic platform for various events and highlights the vital role of urban planning in predicting, preventing, and managing crises [11]. The dilapidated areas in District 7 of Tehran are an example of the social, economic, and political challenges that have arisen due to the migration of the original residents to other parts of the city, the arrival of immigrants with diverse economic and cultural backgrounds, the lack of social solidarity and the weakness in citizenship education. One of the fundamental issues in this area is the lack of a sense of belonging among the residents, which exacerbates the problems of this urban context. Given the historical importance of Tehran, this city has a special place for studying urban resilience, and analyzing this issue in District 7 is of particular necessity [12]. This research seeks to conduct a comprehensive analysis of resilience measures in the dilapidated urban fabric of District 7 of Tehran, focusing on social and cultural dimensions. Using a mixed approach that includes quantitative and qualitative methods, this study aims to assess social and physical resilience [11]. In addition to identifying key driving forces in each dimension, this research will propose practical and effective solutions to strengthen the resilience of dilapidated urban fabrics in District 7 of Tehran. In this way, the present research will contribute to the broader discourse of urban resilience and provide insights and suggestions for increasing the adaptive capacity of urban spaces against natural disasters and other disruptive events [8].

2. Theoretical concepts

Resilience, a concept that was first introduced in biology, is known as a tool for analyzing the ability of systems to cope with shocks and recover from them. This concept is particularly important in the urban context, as modern cities have become the focus of attention and resilience studies due to their social, economic, and environmental complexities [11]. In fact, resilience and adaptation in cities mean their ability to manage unexpected challenges and environmental pressures so that these spaces are able to cope with crises and return to stable and efficient states. Global studies have shown that the vulnerability of urban communities depends on several factors, including demographic diversity, socioeconomic status, and physical and infrastructural conditions. Crises are not limited to physical damage but also have widespread economic and social impacts [12]. This situation requires urban planners and officials to take a comprehensive and strategic approach to strengthening resilience and reducing damage. Resilience can be examined from different angles [13]. The three main approaches in this field include sustainability, recovery, and transformation. Each of these approaches emphasizes specific dimensions of resilience and represents different ways to analyze and improve the capacity of cities to face crises. In the sustainability approach, resilience is defined as the ability of a system to maintain the status quo in the face of crises and return to its initial conditions after the crisis occurs [14]. Communities with high tolerance can overcome severe pressures and quickly return to their previous state. This approach is particularly useful in assessing the capacity of communities to deal with environmental and social challenges. In the recovery approach, resilience emphasizes more on the timing and quality of the return to a stable state. Resilient communities are able to quickly and efficiently return to their original state, and this characteristic indicates their capacity to absorb and adapt to change. This aspect of resilience is particularly important in urban planning and interventions, as it can provide solutions to reduce the effects of crises and accelerate the reconstruction of communities. In the transformation approach, resilience is seen not only as a return to the previous state but also as a process of adaptation

and acceptance of change. In this view, change is inevitable and a positive force that can lead to the transformation and evolution of societies [15]. Resilient communities in this approach can exploit crises as an opportunity to grow and evolve into new and more stable states. Finally, these different approaches to resilience, especially at the urban level, provide a comprehensive and comprehensive framework for the analysis and management of urban crises. These concepts practically help urban officials and planners design appropriate policies and strategies to strengthen resilience and address upcoming challenges [16]. By embracing resilience as a dynamic concept that encompasses sustainability, recovery, and transformation, urban planners and policymakers can formulate adaptive strategies to enhance the resilience of urban spaces against a spectrum of shocks and tensions. Table 1 shows the definition of resilience in the literature.

2.1 Social resilience

The concept of social resilience, rooted in understanding dynamic systems and their intricate interplay with the environment, offers profound insights into the complexities of societal responses to unforeseen events. This perspective is particularly valuable for decoding the decisions and adaptations related to natural resources management, spotlighting the inherent characteristics of how different social classes navigate unexpected challenges. Social resilience is multifaceted, encompassing three vital aspects: resistance, recovery, and creativity. These elements collectively define a society's ability to not only withstand shocks but also to rebound and innovate in the aftermath [26].

The intricacies of social resilience parallel the broader concept of resilience but introduce an added layer of complexity due to the diverse components that constitute society—natural, social, and economic environments. Similar to resilience, social resilience operates at different levels, reflecting the interconnected nature of societal elements. In the contemporary world, where societies are consistently exposed to a spectrum of risks, social resilience emerges as a critical imperative. Achieving social resilience necessitates the mobilization of various forms of capital, with social capital playing a pivotal role in fortifying communities' adaptive capabilities and comprehensive crisis response [27].

2.2 Economic resilience

Economic resilience, a cornerstone of societal well-being, entails society's capacity to adapt strategically and minimize losses stemming from risks [28]. This adaptability is manifested across the five pillars of resilience: anticipation, resistance (sustainability), absorption, response, and adaptation and recovery. Economic resilience isn't merely reactive; it is a proactive endeavor aimed at preserving the structure and functionality of the economy, even in the face of uncertainty. The economic resilience of a society is intricately connected to the foundational principles of economic stability and equilibrium [29].

2.3 Institutional and organizational resilience

Within the dimension of institutional and organizational resilience, the physical attributes of organizations play a pivotal role in shaping a society's ability to withstand and recover from crises. The number of local institutions, access to timely information, the preparedness of forces and volunteers, adherence to crisis management guidelines, and the effectiveness of laws and regulations—all contribute to the resilience of institutions. Additionally, the satisfaction of local residents with institutional performance, especially in areas like housing construction, determines the overall robustness of the societal response to crises [30].

Table 1. Resilience definition in literature

Author	Resilience definition
Bahrami et al. [14] (2014)	The ability of a system to absorb disruptions, adapt during changes, and reorganize itself is crucial for preserving its core principles, functions, identity, structure, and feedback mechanisms.
Jutidharabongse et al. [15] (2024)	The capacity of a system to uphold its function and structure amidst internal and external changes.
Hall et al. [16] (2011)	The system's capacity to endure environmental shocks while retaining its effective resource allocation capability.
Palik et al. [17] (2002)	Sustaining structure and function in the aftermath of disturbances is imperative for ongoing and continuous development.
Rodríguez et al. [18] (2007)	It encompasses the capability to recuperate and deliver essential life, business, industry, government, and societal functions in the face of calamities and various risks.
Madni et al. [19] (2009)	It denotes the capability of a system or society to endure encountered challenges and dangers, adapt proactively, and efficiently mitigate adverse effects, all the while preserving its fundamental structure and functionality.
Leichenko [20] (2011)	The capacity to endure a diverse range of shocks and stresses.
Desouza and Flanery [21] (2013)	It represents the city's capacity to absorb disruptions while preserving its function and structure.
Folke [22] (2006)	The system's capability to revert to its initial state following a natural disturbance or an issue induced by human activities.
Zahedi et al. [23] (2023)	The system's capability and capacity to persist in functioning amid challenges and adverse conditions.
Shi et al. [24] (2021)	The capability to adapt to and respond effectively to changes within urban systems.
Estelaji et al. [25] (2024)	It embodies an organization's capacity to adapt to changes within its economic and institutional environment.

Preserving ancient values is a primary goal for resilient societies, and historical contexts and old neighborhoods serve as tangible repositories of identity and culture. Mosques, cisterns, baths, cells, markets, and historical houses embody the spirit of a community and are deemed invaluable. Unfortunately, inefficient urban planning and management policies jeopardize the potential for reusing and maximizing these historical assets. This not only compromises the preservation of cultural heritage but also contributes to the gradual deterioration of central core tissues in cities, intensifying conflicts within urban contexts [31].

In this research, a focal point has been the exploration of social resilience, especially concerning the challenges faced by cities and worn-out urban tissues. Social resilience, as a core dimension of broader societal resilience, empowers positive responses to changes, the maintenance of essential functions, and the preservation of societal fabric despite external pressures. The examination of social resilience is crucial in understanding and fortifying societies against the multifaceted challenges of the modern world. In conclusion, the augmentation of resilience, stability, and adaptability against tensions, risks, and dangers represents a transformative pathway toward revitalizing the capacities and potentials of a society. A more flexible social system correlates with diminished societal vulnerability to crises and tensions. Social resilience, extending beyond mere responsiveness to social, political, and environmental changes, emerges as an indispensable determinant in a society's ability to confront external pressures and disturbances.

2.4 Worn texture and urban dilapidation

Urban decay has a special place in the urban landscape, bringing signs of disorder, imbalance, and neglect [32]. This phenomenon is considered a narrative of urban history that shows the developments and changes in neighborhoods and urban spaces over time. Worn-out textures that were once alive and dynamic have now become serious urban problems due to neglect, for which physical restoration alone is not enough, and special attention should be paid to preserving cultural identity and social cohesion [33, 34]. The distinctive features of worn-out buildings include various elements, including architectural features and the quality of urban infrastructure. These buildings are often associated with historical monuments and show signs of non-compliance with technical standards. The old facade of these buildings and the use of traditional materials such as brick, wood, and iron, in addition to their own beauty, indicate an inability to comply with modern construction principles. Narrow streets and irregular accesses contribute to the sense of disorganization and highlight the need for a comprehensive strategy for urban renewal. The challenges of these contexts go beyond aesthetic aspects and are rooted in the structural deficiencies of these buildings [35]. The lack of proper earthquake resistance and inadequate maintenance have accelerated their deterioration. This necessitates the need for strategic measures to strengthen these buildings and ensure the safety of their residents. Also, the lack of infrastructure and services in these areas has created additional problems for residents, including the lack of open spaces and a lack of cultural and educational facilities [36]. The dilapidated buildings in District 7 of Tehran are emblematic of larger problems in urban development. Historical neglect and spatial disorganization have exposed these areas to natural and unnatural hazards and pose a threat to the health of the community. These problems are not only visible in physical deterioration but also in the decline of social and cultural values [37]. Loss of social dignity and disregard for cultural values exacerbate the problems of these urban spaces and make them vulnerable to various threats. A comprehensive and multidimensional approach is needed to revitalize these contexts. While physical reconstruction is essential, revitalizing the social and cultural aspects is equally important. Urban planning and management must go beyond infrastructure renovation to preserve culture and strengthen social cohesion [38]. The renovation process must aim to restore a sense of identity and social pride in addition to restoring physical structures.

3. Methodology

This research uses a qualitative approach to examine the challenges and resilience strategies in Districts 7 and 15 of Tehran and considers comparative and applied case analyses as its main approach. For data collection, a semi-structured questionnaire is used as the main tool, which allows for a detailed analysis of the resilience indicators related to these areas. In this research, purposive sampling is carried out among long-term residents, especially people who have lived in these areas for more than 15 years, so that the data is rich in real experiences and long-term perspectives. This methodology allows the research to comprehensively and accurately examine the specific challenges and resilience strategies of each area and provide a better understanding of urban resilience. The research will include all residents of Districts 7 and 15 to gather a wide variety of experiences and opinions related to urban resilience. The sample size was calculated using the Cochran formula, resulting in the selection of 230 residents of the Atabek neighborhood as a representative sample of the community. This method ensures that the research results are statistically accurate and fully reflect the opinions and experiences of the majority of residents in these areas.

3.1 District 7 of Tehran

The population recorded in the last census of 2015 was approximately 330,000 people living in 91,000 households. The district is demarcated by Districts 3, 8, 6, 12, and 11 on its various sides and is recognized for its vulnerability due to an aging urban infrastructure. Data from the Reconstruction Organization [37] indicates significant urban renewal efforts, with 639 building permits issued over the past decade, leading to the renovation of over 83,671.1 square meters of deteriorated fabric. The deteriorating state of buildings in these areas, particularly in neighborhoods like Armenians, poses a safety risk and highlights the need for extensive redevelopment. Approximately 15.52% of the district's area is considered deteriorated, housing a population of 86,788, which underscores the critical challenges facing District 7 and justifies its selection for a focused study on urban resilience and revitalization. Figure 1 likely presents a detailed map of District 7, delineating its division into 5 zones and 14 neighborhoods, offering an essential overview of its geographical and administrative layout. This map is

foundational for visualizing the district's spatial organization and aids in the identification of specific areas for focused study or intervention.

Figure 1. Zones and Neighborhoods

3.2 Gorgan neighbor

Gorgan neighborhood, covering 60 hectares with 22.8 hectares of deteriorated urban fabric, hosts a population of 21,390, reflecting a slight growth since 2010. This area exhibits a balanced gender ratio and an average household size of 2.7, showcasing a predominantly young demographic, with the largest age group being 30 to 34 years. Historically a migrant hub during Tehran's expansion in the 1930s, Gorgan's diverse population and physical landscape have evolved significantly, incorporating both residential and commercial zones. Despite its urban advancements, Gorgan maintains a strong residential character, with over 80% of its plots dedicated to housing. The quality of neighborhood buildings is shown in Table 2.

Table 2. The quality of neighborhood buildings

Buildings Quality	Number of Buildings	Percentage
Newly Constructed	586 buildings	21.4%
Under Construction	64 buildings	2.3%
Maintainable	854 buildings	31.2%
Dilapidated/Destructible	1206 buildings	44.1%
Vacant/Non-essential Structures	23 buildings	0.8%
Unspecified	2 buildings	0.07%
Total	2733 buildings	100%

Urban planning in Gorgan faces challenges, particularly in traffic management and accessibility, due to narrow streets, primarily less than 6 meters wide. The neighborhood's development strategy emphasizes the creation and enhancement of east-west passageways to improve traffic flow and access. This approach underlines the ongoing need for urban renewal that prioritizes improved living conditions, infrastructure enhancements, and the addition of green spaces.

3.3 Shahed neighbor

Shahed is the largest neighborhood in District 7's Zone 1, covering approximately 130 hectares, with 62 hectares classified as deteriorated fabric. The neighborhood has a population of 42,153, reflecting a slight increase since the 2010 census and constituting 55% of the zone's population. The gender ratio is balanced, with 98.4 males per 100 females and an average household size of 2.8, aligning with regional averages. The social fabric comprises middle-class, educated residents, primarily employed in government and private sectors. A significant number of immigrants contribute to the area's social diversity. Established in the 1920s and 1930s, the neighborhood has experienced substantial transformations due to demographic shifts and urban development. Notable landmarks include Tavakoli Garden and Behrami Children's Hospital. Challenges include residential congestion, inadequate north-south connectivity, and a network of narrow alleyways, exacerbated by the construction of the Imam Ali Highway, causing spatial disconnection.

3.4 Nezam Abad

Nezam Abad covers approximately 58 hectares, with 34 hectares classified as deteriorated fabric. The population stands at 12,264, with a balanced gender ratio and an average household size of 2.8. The demographic composition indicates a young population, with a majority in the 20-40 age group. The neighborhood evolved post-1930s, initially housing workers and later accommodating Armenian, Zoroastrian, and Jewish communities, whose presence has since declined. Urban development has been affected by the Imam Ali Highway, creating a spatial divide. The area features residential, commercial, and industrial activities but faces accessibility challenges due to narrow streets and limited urban renewal. The neighborhood consists of three superblocks with distinct characteristics. Older buildings typically have one to two stories, while newer structures, post-1980s, include up to six stories. Facilities such as Imam Hossein Hospital significantly influence the area's urban fabric.

3.5 Atabak

Atabak is characterized by significant commercial activities along its main streets and mixed residential zones with multi-story buildings. Historically, the neighborhood has evolved from its early settlement by residents from the city gates area, many of whom were involved in land trading businesses from the 1960s. Previously known as Atabak, the area encompassed neighborhoods from Bisim to Hashem Abad, while its current boundaries extend from Civil Street to Besat Highway. Urban challenges include balancing commercial expansion with residential needs and addressing

the infrastructural gaps resulting from historical development patterns.

3.6 Valiasr (Bisim)

Valiasr neighborhood, also known as Bisim, is characterized by a lack of educational facilities due to recent urban development. The demolition of three schools for the construction of Imam Ali Highway has left the northern part of the neighborhood devoid of educational facilities. The neighborhood's residents are primarily government and municipal workers, and the area also includes the notable Tavakoli Garden and Behrami Children's Hospital.

3.7 Minabi

Minabi neighborhood occupies an area of 78 hectares and has a population density of 323 people per hectare. It has a balanced gender ratio and a relatively young population, with active individuals constituting the largest demographic segment. The neighborhood has seen extensive urban development since 2005, particularly with the construction of Imam Ali Highway. Its demographic changes have been significant due to the displacement and resettlement caused by the highway construction.

4. Results and discussion

In this chapter, following an understanding of the study area and employing the methods outlined in section 3, the collected data is analyzed, and the research findings are presented. Initially, resilience indicators in both the social and physical dimensions, derived from theoretical foundations, are extracted. The reliability of the researcher-created questionnaire is then ascertained using Cronbach's alpha method. Standard deviation and the impact of variables on social resilience in both Districts 7 and 15 are determined through one-sample t-tests in each social and physical dimension separately. Convergent validity (AVE) is utilized to ensure the research model's suitability for social resilience in both districts. PLS software outputs are employed to conclude whether the model is fit for purpose in terms of resilience indicators for deteriorated urban textures. Subsequently, the evaluation of resilience indicators for social and physical dimensions for Districts 7 and 15 is derived through one-sample t-tests, after which the overall resilience in social and physical dimensions is established. The relationship between social and physical resilience dimensions with overall resilience is analyzed for each district. Pearson correlation tests are used to assess the correlation between variables due to the interval nature of the questions and the use of a five-point Likert scale for indexing. In assessing the physical dimension, optimized boundary methods for form and texture indices and other physical dimension indicators are evaluated using spatial analysis, geographical data statistics, and network analysis tools in GIS software. For future-oriented analysis of social and physical resilience in Districts 7 and 15, questionnaires and impact matrices are formulated to analyze the final results. Influential and influenced factors are identified and analyzed within the MicMac software framework. The research findings for District 7 show that internal reliability calculated through SPSS using Cronbach's alpha was significant, as indicated in Table 1, with a Cronbach's alpha of 0.74 for the questionnaire items, confirming the study's reliability.

For District 15, one-sample t-tests with a test value of 3 were conducted. It was found that if the mean variable for social interactions, neighborhood identity, sense of belonging, social participation, civic education, security, and social resilience is statistically less than 3, these variables, and ultimately social resilience, are in a state of disorder. The fundamental research model is assessed for fit, with essential statistics such as the average variance extracted, composite reliability (C.R), and Cronbach's alpha examined. With the PLS output, Table 3 and Table 4 confirm that the model is suitable in terms of fit indices. Figures 2 through 8 depict the over 30-year-old buildings, the number of floors in deteriorated fabric, and the granularity of deteriorated fabric in District 7, Zone 1. These Figures highlight areas requiring renovation, the current state of urban aging, and the granularity of deteriorated textures.

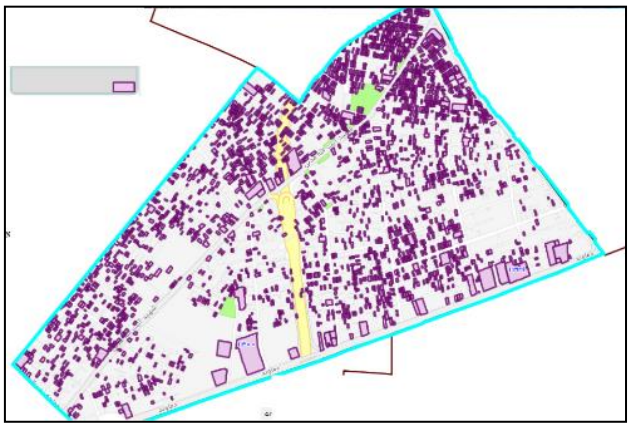

Figure 2. Buildings over 30 years old in Zone 1 of District 7

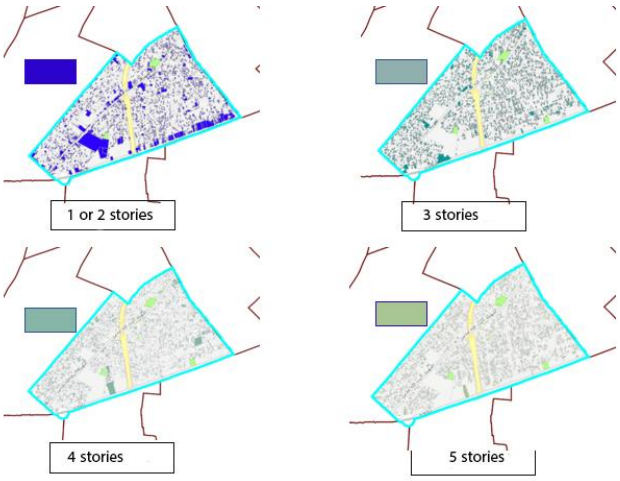

Figure 3. Buildings over 30 years old in Zone 1 of District 7

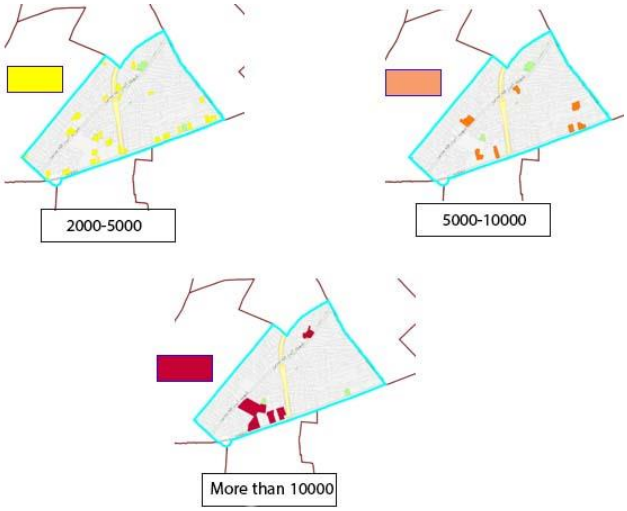

Figure 4. The number of floors in the deteriorated fabric of Zone 1 of District 7

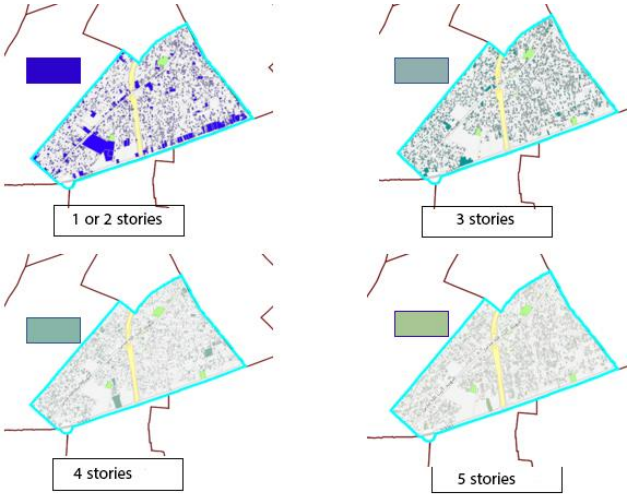

Figure 5. The number of floors in deteriorated fabric

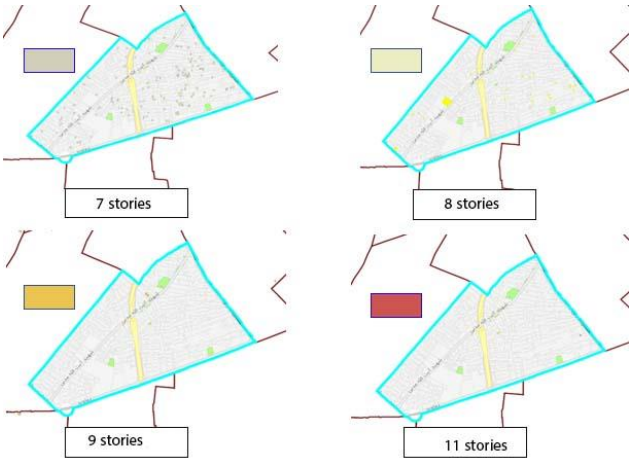

Figure 6. The granularity of deteriorated fabric in the neighborhoods of Zone 1, District 7

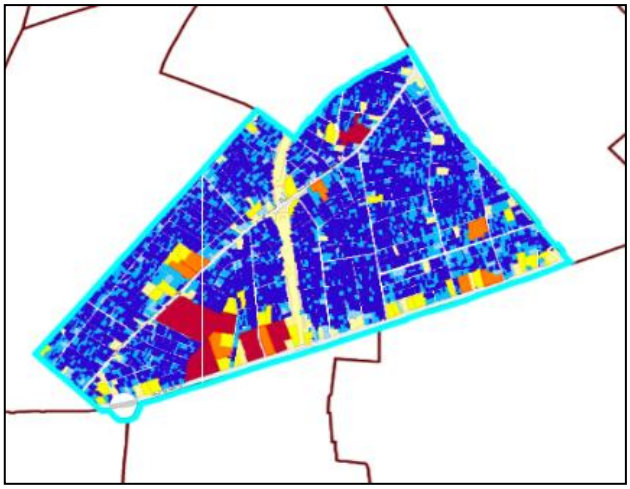

Figure 7. Particle size distribution of the deteriorated fabric in the neighborhoods of Zone 1, District 7

Figure 8. Percentage of renewal in the deteriorated fabric block of Zone 1, District 7

Table 3 and Table 4 details the mean and standard deviation of social resilience variables in District 15, while Tables 2 provide one-sample t-tests for satisfaction levels with social and physical resilience indicators, respectively.

To evaluate social resilience, 15 indicators were selected from theoretical and research backgrounds and assessed using single-sample t-tests, with significance set at the 0.95% confidence level. The findings revealed that most social resilience indicators showed low satisfaction levels among residents of Zone 1, District 7 in Tehran, indicating overall low social resilience. Exceptions include indicators related to voluntary cooperation to reduce vulnerability, institutional, and awareness of potential accident damages, which scored medium to high. Critical areas identified for improvement include first aid training, emergency response familiarity, and trust in official media, which recorded the lowest resilience levels. Table 3 in the study details citizens' satisfaction levels with these social indicators.

Table 3. Single sample T-test satisfaction level for social indicators

Indicator	T-Value	Mean	Mean Deviation	Degrees of Freedom (df)	P-Value
Awareness of Natural Disaster Risks	-13.83	2.118	-1.450	229	0.001
Residents' Awareness of Safe Places Map	-19.15	2.764	-1.671	229	0.001
Residents' Awareness of Housing Safety Regulations	-13.75	2.223	-0.450	229	0.01
Residents' Awareness of Emergency Facilities	-23.67	1.112	-1.471	229	0.001
Level of First Aid Training & Familiarity with Actions Like Transferring Injured, Injections, Bandaging	-31.45	2.310	-0.890	229	0.000
Residents' Skills in Providing First Aid	-28.15	2.211	-1.763	229	0.001
Mental Peace During and After an Incident	-18.80	1.568	-0.870	229	0.000
Trust in Official Media News	-37.56	2.406	-0.218	229	0.000
Collaboration in Crisis Problem Solving	-14.43	1.807	-1.910	229	0.001
Willingness to Volunteer for Reducing Vulnerability	11.32	1.340	0.450	229	0.01
Sense of Place Belonging	-13.87	2.674	-1.781	229	0.01
Mutual Trust Between People and Organizations	-19.56	2.809	-1.568	229	0.000
Trained and Volunteer Forces	-21.45	2.561	-0.740	229	0.000
Awareness of Reactions and Proper Behavior in Times of Crisis	-24.34	2.452	-1.430	229	0.001

Table 4. Single sample T-test satisfaction level for physical indicators

Indicator	T-Value	Mean	Mean Deviation	Degrees of Freedom (df)	P-Value
Access to Medical Centers	-18.32	2.756	-0.433	229	0.000
Access to Educational Centers	-12.65	2.562	-1.874	229	0.001
Condition of Neighborhood Water Piping	-17.67	2.561	-1.564	229	0.001
Access to Temporary Housing	-21.12	2.760	-0.430	229	0.001
Access to Public Transportation	-15.35	2.432	-0.989	229	0.01
Access to Green Spaces and Evacuation Routes	-18.45	2.542	-1.874	229	0.001
Access to Main Road Network	-21.67	2.654	-1.438	229	0.001
Distance from Natural Hazard Zones	-23.89	2.876	-0.211	229	0.000
Access to Fire Stations	-11.80	2.234	-1.870	229	0.001
Quality and Durability of Residential Buildings	-31.14	2.639	-0.890	229	0.000
Condition of Electricity and Electrical Installations	-23.34	2.333	-0.675	229	0.000
Presence of Evacuation Route Maps	-20.05	2.843	-0.963	229	0.001
Durability of Public Services	-18.11	2.564	-0.780	229	0.000
Quality of Alleys and Neighborhood Streets	-34.23	2.245	-1.460	229	0.001

For the assessment of physical resilience, 14 indicators were selected based on theoretical underpinnings and research background, evaluated through single-sample t-tests, with all indicators considered significant at the 95% confidence level. The results indicated that all the physical resilience dimension indicators are at a low level of satisfaction. Hence, it can be inferred that the satisfaction of residents living in the neighborhoods of Zone 1, District 7, regarding physical resilience indicators, averages at a very low level.

A closer look at the physical indicators revealed that the quality of streets and alleys and the quality and durability of residential buildings were identified as having the lowest levels of resilience. Table 4 details the citizens' satisfaction levels with physical indicators. For the hypothesis testing of the research, single-sample t-tests were conducted with a test value of 3. This means that if the mean of variables such as the level of social interactions, neighborhood identity, sense of place belonging, social participation, civic education, security, and social resilience is statistically less than 3, these variables,

and ultimately, social resilience, are considered to be in a state of disarray. The significance level of the t-test indicates that the means for the level of social interactions, neighborhood identity, sense of place belonging, social participation, civic education, security, and overall social resilience are below 3. According to Table 5, the mean for social interactions is 2.30, for neighborhood identity is 2.41, for a sense of place belonging is 2.58, for social participation is 2.33, for overall social resilience is 2.25, for civic education is 2.23, and for security is 2.18. These results confirm the primary hypothesis and the related sub-hypotheses, indicating lower levels of social interactions, identity, belonging, participation, resilience, civic education, and security than the benchmark level of 3.

For testing the main hypothesis, structural equation modeling was conducted. Initially, the fit of the measurement model was examined. Model fit refers to the extent to which a model is consistent with and agrees with the observed data. Therefore, the research's proposed model fit was further analyzed to ensure its compatibility with the research data, ultimately aiming to derive answers to the research questions.

Table 5. Mean and standard deviation of social resilience variables in district 15

Type	Count	Mean	Standard Deviation
Sense of Place Belonging	200	2.58	0.6723
Neighborhood Identity	200	2.41	0.8761
Social Participation	200	2.33	0.9321
Level of Social Interactions	200	2.30	0.7645
Social Resilience	200	2.25	0.6132
Civic Education	200	2.23	0.9831
Security	200	2.18	0.6549

The examination of the conceptual model's fit was carried out in two stages: first, evaluating the fit of the model's measurement part and second, assessing the fit of the model's structural part, which is discussed in detail subsequently. Table 6 shows the Questionnaire Indicators and Their Reliability Coefficients. The description of the table below demonstrates that the impact of indicators such as the level of social interactions, sense of place belonging, social participation, and neighborhood identity on the resilience of deteriorated fabric in District 15 is statistically significant at the 0.001 level with a 95% confidence interval. Furthermore, according to the priority of each indicator in the Friedman test, it was shown that the sense of place belonging has the most significant impact, with social interactions and social participation ranking second and third, respectively. Therefore, based on the obtained results, it can be said that the researcher's hypothesis regarding the impact of social resilience indicators on deteriorated fabrics in District 15 is confirmed. In other words, factors like sense of place belonging, level of social interactions, social participation, and neighborhood identity have a significant effect on the social resilience of deteriorated fabrics in District 15. Single Sample t-test by Priority of Variable Impact is shown in Table 7.

Table 6. Questionnaire indicators and their reliability coefficients (District 15)

Index Number	Variable	α Value
1	Sense of Place Belonging	0.84
2	Social Participation	0.68
3	Civic Education	0.72
4	Level of Social Interactions	0.87
5	Social Resilience	0.78
6	Neighborhood Identity	0.69
7	Security	0.81

Table 7. Single Sample t-test by Priority of Variable Impact (District 15)

Variable	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Upper	Lower
Sense of Place Belonging	198	0.001	0.5634	0.7400	0.3871
Social Resilience	198	0.001	0.3341	0.7659	0.7843
Social Participation	198	0.03	0.2343	0.5943	0.1562
Level of Social Interactions	198	0.05	0.7765	0.4983	0.1875
Neighborhood Identity	198	0.05	0.3421	0.3290	0.1245
Civic Education	198	0.067	0.4351	0.7840	0.1670
Security	198	0.76	0.4565	0.7847	0.4312

5. Conclusions

In the research's conclusion, the discourse on resilience emerges as a contemporary subject within urban management. It addresses the gap between theoretical foundations of resilience and their practical application, highlighted by the lack of comprehensive studies on social and physical resilience. Natural disasters have led to a reconsideration of the approach to urban spaces, underscoring the necessity of creating resilient cities. This study aimed at a comparative analysis and evaluation of social and physical resilience in the deteriorated urban fabrics of Tehran's Districts 7 and 15. The findings reveal that the physical dimension of resilience scored highest, with a rank of 3.31, followed by the social dimension at 2.81. Conceptual views on urban space recovery and spatial sustainability exhibit a thorough understanding of resilience concerning deteriorated fabrics. By integrating the physical and social dimensions, the study faced challenges in data collection. The simultaneous examination of social and physical resilience required comprehensive observations of the inhabitants' connection with their living spaces, impacting the depth of the study. Despite these challenges, the study successfully employed various methods and techniques to enrich the data collection process. Through the deployment of appropriate variables and methodology aligned with the realities of urban resilience in the target fabrics of Districts 7 and 15, the research presented distinct outcomes compared to frequently repeated scientific approaches, which often yield similar results. The thorough analysis of research indicators, combined with approaches for identifying drivers and scenarios, allowed for the presentation of various strategies as part of a multifold strategy in subsequent phases. The study confirmed the second hypothesis, suggesting that a lack of neighborhood belonging and social participation are principal components in the disordered state of social resilience within the deteriorated fabric of District 15 of Tehran. The research process's reliability and validity were assured through meticulous data evaluation at various stages.

Ethical issue

The authors are aware of and comply with best practices in publication ethics, specifically with regard to authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests, and compliance with policies on research ethics. The authors adhere to publication requirements that the submitted work is original and has not been published elsewhere.

Data availability statement

The manuscript contains all the data. However, more data will be available upon request from the authors.

Conflict of interest

The authors declare no potential conflict of interest.

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