Zidabi Oskouei F. et al.
September 2026
Urban Economics and Planning
Volume 7, Issue 6

17Analyzing the causal relationships between social resilience and urban space vitality in the face of environmental hazards using structural equation modeling (case study: Oskou city)

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Original Article

Received: 2025/10/28
Revised: 2025/11/17
Accepted: 2025/11/18

HOW TO CITE THIS ARTICLE

Zidabi Oskouei F. Moosavi M.S. Najafgholipour Kalantari N. Abdollahzadeh Taraf A. 17Analyzing the causal relationships between social resilience and urban space vitality in the face of environmental hazards using structural equation modeling (case study: Oskou city). *Urban Economics and Planning* 7(6):4-25.

DOI: 10.22034/uep.2025.556033.1753

Abstract

The growing increase in environmental crises in recent years has made strengthening social resilience one of the core priorities in urban planning. In this context, urban vitality, considered a key dimension of environmental quality, can, through factors such as social interaction, activity diversity, spatial presence, and environmental quality, enhance belonging, trust, and social connectedness, thereby improving communities' adaptive capacity in the face of hazards. Social resilience, measured through social cohesion, collective participation, solidarity, and public trust, is also a fundamental element of urban sustainability. Accordingly, this study aims to examine the relationship between urban vitality and social resilience, considering the mediating role of "risk perception and preparedness toward environmental crises," including risk awareness, lived crisis experience, mental preparedness, and perceived vulnerability, in the city of Oskou. A quantitative research approach based on Structural Equation Modeling (SEM) using AMOS 26 was employed. The statistical population consisted of all residents aged 18 and above in Oskou, and the sample size was determined as 384 using Cochran's formula. The findings indicated that urban vitality has a significant direct effect on social resilience (0.52) and an indirect effect through risk perception and preparedness (0.27). The model demonstrated an acceptable level of fit (CFI = 0.92; RMSEA = 0.065). Overall, the results show that enhancing urban vitality by improving social experience, increasing risk awareness, and strengthening local cohesion can contribute to higher levels of social resilience. These findings align with existing literature and underscore the combined role of spatial quality and perceptual factors in shaping community resilience.

Keywords

Oskou city
Perception of environmental crisis
Social resilience
Vitality of urban spaces

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1. Introduction

Urban spaces, as the primary setting for social interactions, everyday experience, and collective action, play a fundamental role in the resilience of cities against environmental crises. The quality of the design and performance of these spaces determines the extent to which citizens are able to maintain social ties, adapt, and return to a stable condition after a crisis. In recent decades, the intensification of hazards like climate change, urban flooding, and widespread pollution has made it clear that resilience is not limited to the technical robustness of infrastructure, but rather depends on the city's social and spatial capacities (Dakhil et al., 2025). Social resilience, as one of the main pillars of urban resilience, refers to the ability of a community to cope with, adapt to, and recover from crises (Li et al., 2024). This ability does not emerge in a vacuum, but within the context of urban spaces—spaces that enable presence, interaction, information exchange, and mutual support among citizens (Tang et al., 2025). In this regard, the concept of urban space vitality holds a distinctive position. Vitality means dynamism, people's presence, functional diversity, and a sense of place attachment (Jeddi, 2021). A vital space is not merely a place for passage or dwelling. Rather, it is a living arena for interaction between humans and the environment that provides the basis for social cohesion and trust (Behzadpoor et al., 2020). Research has shown that in crisis conditions, vital spaces can function as informal networks of support and cooperation and compensate for institutional weaknesses (Humphreys & Enqvist, 2022). Nevertheless, a considerable portion of contemporary urban spaces, despite possessing physical infrastructures, lack the social qualities necessary for survival and recovery under crisis conditions (Martínez-González et al, 2021). The decline of social interactions, the reduction of sense of belonging, and the emptying of space from everyday activities are among the factors that weaken vitality and, consequently, social resilience (Osei-Kyei et al., 2024). Therefore, examining the relationship between the vitality of urban spaces and social resilience can contribute to a deeper understanding of mechanisms of urban sustainability and the design of more human-centered spaces. In the research literature, although numerous studies have addressed one of these two concepts (resilience or vitality), simultaneous and empirical examination of the relationship between them—especially through a spatial and community-oriented approach—has received less attention. In addition, the role of psychological and perceptual variables in this linkage has been overlooked. From a theoretical perspective, perception and preparedness toward environmental crises can play a mediating role in this relationship, because citizens who perceive the urban space as safe, trustworthy, and dynamic demonstrate higher levels of preparedness, mutual assistance, and resilient actions (Humphreys & Enqvist, 2022; Li et al., 2024). As a result, measuring this variable can help clarify the pathways of effect between vitality and resilience. In Iran, small and medium-sized cities are more exposed than other areas to compounded damages arising from environmental crises and weak social infrastructures. The city of Oskou is a prominent example of this condition: a city with a dense physical structure, a historical fabric, and active local social networks that, in recent years, has faced crises such as rising temperatures, extreme precipitation, and declining air quality. Specific physical characteristics (such as dense neighborhoods, human-scale public spaces, and a dynamic historic center) and strong dependence on local social interactions have turned Oskou into an appropriate case for studying the relationship between spatial and social factors under crisis conditions. Moreover, Oskou is among the medium-sized cities that lack an indigenous framework for assessing social resilience and urban vitality, an issue that makes the results of this research generalizable to similar cities. Despite extensive studies in the field of urban resilience, there is still no integrated theoretical and empirical framework in Iran for explaining the linkage between the social components of resilience and the spatial qualities of urban spaces. Most studies have examined only one of the two dimensions and have paid less attention to structural relationships between them. The present study seeks to fill this knowledge gap by combining social and spatial indicators within the framework of structural equation modeling (SEM). The main innovation of the study lies in presenting a model that, in addition to analyzing the relationship between vitality and social resilience, also reveals the mediating role of perception and preparedness toward environmental crises. Accordingly, the central problem of the research is what relationship exists between the indicators of urban space vitality and social resilience in confronting environmental crises in the city of Oskou, and through what mechanisms this relationship is formed. Based on this, the main hypotheses of the study are formulated as follows:

Hypothesis 1: The vitality of urban spaces has a

positive and significant effect on citizens' social resilience.

Hypothesis 2: The vitality of urban spaces has a positive and significant effect on citizens' perception of and preparedness toward environmental crises.

Hypothesis 3: Citizens' perception of and preparedness toward environmental crises has a positive and significant effect on social resilience.

Hypothesis 4 (mediating): Through the mediating role of perception of and preparedness toward environmental crises, the vitality of urban spaces indirectly affects social resilience.

In line with these hypotheses, the main research questions are posed to explain the conceptual relationships better and guide the analytical pathway as follows:

1. What is the spatial and temporal pattern of vitality in Oskou's urban spaces during the occurrence of environmental crises, and how does it differ from normal conditions?
2. What is the status of social resilience among Oskou residents—including trust, mutual assistance, participation, and access to basic services—at the neighborhood level?
3. How is the linkage between spatial vitality and social resilience formed under crisis conditions, and what is the role of mediating or moderating variables?
4. What design and governance interventions can simultaneously lead to strengthening social resilience and preserving urban vitality?

2. Theoretical foundations

In recent decades, the increasing frequency of environmental crises from climate change to natural disasters has caused the concept of resilience to become one of the central themes in urban planning literature. However, a large share of earlier studies have examined resilience in terms of technical and institutional recoverability and have investigated its social and spatial dimensions separately and, at times, detached from citizens' lived experience (Wu et al., 2025; Parsai et al., 2025). In fact, although emphasis on "social resilience" has increased in recent years, how the links among the built environment, human perception, and collective behavior are formed is still considered one of the theoretical gaps in this field. Social resilience, as a community's ability to maintain cohesion, trust, cooperation, and re-organization after a crisis, is a multidimensional concept that depends on communication networks, social capital, sense of belonging, and mental preparedness (Lv & Sarker, 2024; Qin et al., 2024). From a theoretical standpoint, this concept rests on two pillars: first, the existence of formal and informal support structures in society, and second, the quality of human relationships in urban spaces. Nevertheless, many previous studies have focused on institutional or macro-scale aspects of resilience and have neglected the role of public spaces in shaping resilient interactions (Rahimi & Choobineh, 2024; Kareghar et al., 2024). In contrast, the literature on the "vitality of urban spaces" emphasizes the importance of space as a platform for social action. From the researchers' perspective, vitality is a dynamic concept associated with the extent of people's presence, diversity of activities, face-to-face interactions, and perceived safety in space (Zeng et al., 2022; Shahpari Sani et al., 2022). However, many studies in this field have adopted descriptive or design-oriented approaches and have not sufficiently subjected the mental and social qualities of space to empirical measurement. Design-oriented studies such as Ehab et al. (2025) and Kamil & Tuma (2025) have focused more on functional flexibility, spatial justice, and the adaptability of space. However, they have not provided a clear theoretical framework for explaining how spatial experience affects social behavior and citizens' sense of resilience. In this regard, Ahmadivostakolaei et al. (2024) and Fu et al. (2025) have emphasized that vitality does not arise solely from physical design; rather, through interaction, sense of belonging, and positive understanding of the environment, it takes shape within citizens' everyday experience. More recent studies have attempted to connect these two approaches. Research such as Lotfipour Siahkalroudi & Hamzeh (2023) and Humphreys & Enqvist (2022) has shown that "risk perception" and the "sense of control over the environment" are fundamental factors in collective behaviors and social responses to crises. In other words, the degree to which people perceive safety, accessibility, and spatial transparency can determine whether public spaces become a setting for cooperation and social reconstruction or an arena for anxiety and withdrawal. Despite the importance of these findings, in earlier literature, the variable of perception and mental preparedness has usually been examined as an individual factor, and its place within the conceptual structure linking spatial vitality and social resilience has not been clearly articulated. A critical analysis of existing studies indicates that three major theoretical shortcomings exist in this area: first, the dominance of physical approaches over social

ones in explaining urban vitality; second, the lack of combined models that demonstrate the role of cognitive and perceptual mechanisms in sustaining vitality and resilience; and third, the absence of localized studies in Iran's medium-sized cities, where distinctive social and spatial structures lead to different patterns of interaction and social resistance. In light of these gaps, the present study proposes an integrative framework according to which the vitality of urban spaces—through indicators such as human density, activity diversity, presence-ability, social interaction, and environmental quality—is related to components of social resilience, including trust, participation, cohesion, and interaction in crisis, both directly and through the mediating role of perception and preparedness regarding environmental crises (Gholami et al., 2021; Taghavi Zavareh et al., 2020; Sobhaninia et al., 2024). Within this framework, lively spaces can serve as a basis for participation, mutual assistance, and social reconstruction during crises not merely through physical design, but also through perceived experience, psychological calm, and environmental trust. In the urban resilience literature, "risk perception" and "preparedness for crisis" are introduced as two components that, although conceptually distinct, create an internal and synergistic linkage in the process of citizens' response and adaptation to environmental hazards. Risk perception refers to individuals' mental understanding of the likelihood of a crisis, the severity of consequences, and the degree of vulnerability. In contrast, preparedness includes cognitive and behavioral readiness, prior crisis experience, and willingness to take preventive actions or adaptive responses. Despite this distinction, a body of studies has shown that, in practice, these two components form a single "perceptual–behavioral" construct that integrally influences behaviors related to social resilience (Paton, 2019). In many studies on social resilience and risk-related behaviors, it has been observed that risk perception directly affects the formation of mental and practical preparedness, and conversely, the level of education, lived experience, and cognitive readiness also helps recalibrate risk perception. Therefore, these two processes follow a reciprocal relationship, and in empirical modeling, they are often analyzed as a combined construct with overlapping factor loadings. In the initial examinations of the present project as well, the items related to perception and preparedness showed a shared clustering pattern in factor analysis, which strengthens the appropriateness of integrating them into one independent construct and increases the reliability and internal consistency of the construct (Cubeddu & Martini, 2025). Despite the theoretical and empirical justification for using a combined construct, the research literature explicitly emphasizes that a separate analysis of perception and preparedness can reveal deeper layers of resilience-related behaviors. In many contexts, risk perception may be very high. At the same time, behavioral preparedness remains low, or conversely, individuals may have practical preparedness but lack a realistic perception of the severity of risk. Such inconsistencies sometimes lead to risky behaviors or emotional reactions, which in the literature are known as the Panic Effect. Therefore, although the single-construct approach is meaningful, separate analysis in subsequent studies can help achieve a more precise understanding of the mechanisms shaping social resilience, especially in contexts characterized by social heterogeneity and differing lived experiences of crisis (Defe et al, 2025). Overall, selecting a single construct is defensible due to conceptual overlap, reciprocal relationships, and empirical findings; at the same time, it can be considered a starting point for complementary research that, by separating perception and preparedness, reveals more complex behavioral patterns and differences among social groups. Accordingly, the theoretical foundations of this study are based on the assumption that the relationship between spatial quality and social resilience is interactive and two-way: Lively spaces are associated with enhanced positive perception, a sense of safety, and citizens' mental preparedness. Resilient communities also help sustain urban vitality through more active use of public spaces. By emphasizing the intermediate level of analysis, namely, perception and experience of space, this approach seeks to bridge the gap between physical and social theories and, by proposing an integrative model, to explain the mechanism of correlation between spatial vitality and social resilience in the real context of the city of Oskouo.

Table 2. Variables and indicators examined in the study

Main Variable	Main Indicator	Sub-indicator 1	Sub-indicator 2	Sources
Vitality of urban spaces	Human density	Number of people present in the space	Level of movement at different hours of the day	Wu et al., 2025; Ehab et al., 2025
Vitality of urban spaces	Presence-ability	Easy access from home or workplace	Proximity to a public transport station	Kamil & Tuma, 2025; Ahmadivostakolaei et al., 2024; Jafari et al., 2025
Vitality of urban spaces	Activity diversity	Presence of activities such as shopping, sitting, and recreation	Simultaneity of different activities in the space	Parsai et al., 2025; Rahimi & Choobineh, 2024
Vitality of urban spaces	Social interaction	Conversation and communication among citizens	Face-to-face interaction and greetings	Ahmadivostakolaei et al., 2024
Vitality of urban spaces	Environmental quality	Cleanliness and the beauty of the space	Presence of green space, adequate lighting, and natural ventilation	Rahimi & Choobineh, 2024
Social resilience	Social trust	Trust in strangers in the space	Feeling safe when encountering others	Kareghar et al., 2024; Alawi et al., 2024
Social resilience	Social solidarity	Sense of belonging to the space and neighborhood	Familiarity with and knowing neighborhood residents	Parsai et al., 2025; Rahimi & Choobineh, 2024
Social resilience	Social participation	Readiness to participate in public affairs	History of participation in voluntary activities	Alawi et al., 2024; Shahpari Sani et al., 2022
Social resilience	Interaction in crisis	Seeking help from others in emergency conditions	Spontaneous cooperation among citizens during a crisis	Kareghar et al., 2024; Parsai et al., 2025
Social resilience	Social cohesion	Absence of tension, conflict, or disturbance in the space	A sense of empathy and mutual respect among people	Alawi et al., 2024; Parsai et al., 2025
Perception of environmental crises	Risk awareness	Recognizing types of possible crises (earthquake, flood, pollution)	Knowing ways to respond to a crisis	Zeng et al., 2022; Azmoon & Mohammadnejad, 2024; Shabankareh et al., 2025
Perception of environmental crises	Lived experience of crisis	Personal experience of encountering a crisis	Hearing others' experiences about the crisis	Taghavi Zavareh et al., 2020
Perception of environmental crises	Mental preparedness	Feeling psychologically prepared to respond	Ability to remain calm under crisis conditions	Sobhaninia et al., 2024; Gholami et al., 2021
Perception of environmental crises	Vulnerability assessment	Mental image of the resistance or weakness of space	Evaluating the degree of physical vulnerability	Gholami et al., 2021; Zeng et al., 2022
Perception of environmental crises	Trust in management	Confidence in the municipality's performance during the crisis	Access to accurate and timely information during crisis conditions	Taghavi Zavareh et al., 2020; Azmoon & Mohammadnejad, 2024; Shabankareh et al., 2025; Zeng et al., 2022

3. Literature review

Studies related to social resilience and the vitality of urban spaces can be examined through three main analytical strands:

1) studies focused on urban and social resilience, 2) studies focused on the quality and vitality of urban spaces, and 3) interdisciplinary studies that address the linkage between space and resilience. In the first strand, studies such as Wu et al. (2025), through an analysis of the Yangtze River Delta region, have shown that urban resilience results from coordination among economic, social, and environmental systems, and that spatial inequality in resilience is rooted in differences in infrastructure and policymaking. Although this research emphasizes a systems perspective, it does not sufficiently attend to micro-

scale dynamics or the role of social and perceptual spaces. In the same direction, Rahimi & Choobineh (2024) in Tabriz found that infrastructural weakness and declining local participation are among the main barriers to resilience in historic fabrics, whereas the quality of public spaces and a sense of place attachment act as strengthening factors. Studies by Kareghar et al. (2024), focusing on the resilience of Tehran's urban areas to earthquakes, also showed that high physical density and spatial heterogeneity increase vulnerability, and they emphasized the necessity of training, institutional coordination, and social preparedness. Despite differences in context, what these studies share is an emphasis on the multidimensional nature of resilience and the importance of social factors for urban sustainability. The second strand concerns the vitality and quality of urban spaces. Ehab et al. (2025) proposed a design-oriented framework for enhancing resilient green spaces in dense cities and identified elements such as spatial justice, flexibility, and social sustainability as key components. Kamil & Tuma (2025), in analyzing the performance of urban spaces during the COVID-19 pandemic, showed that open and multifunctional spaces display greater social resilience than enclosed and single-function spaces. Ahmadivostakolaei et al. (2024), with a focus on public spaces, found that the capacity for gathering, a sense of belonging, and social safety play a decisive role in social recovery after crises and strengthen resilience through communication networks. Fu et al. (2025) similarly showed that vitality is the outcome of social dynamism and lived experience in space, not merely a product of population density. This group of studies confirms the importance of the spatial dimension in strengthening social capacity. However, it remains weak in explaining the cognitive and perceptual mechanisms underlying this process. The third strand includes studies that explicitly address the linkage between spatial quality and social resilience. Jafari et al. (2025) in Tabriz showed that variations in the resilience of urban areas stem from spatial structure and the level of social participation. Parsai et al. (2025), in analyzing urban resilience policies against flooding, emphasized the role of integrated management and the cultural system in enhancing resilience. Findings by Lotfipour Siahkalroudi & Hamzeh (2023) also indicate that perception of space, feelings of safety, and psychological comfort are decisive for levels of participation and collective action under crisis conditions. Likewise, Humphreys & Enqvist (2022) have shown that citizens' perception of risk and their sense of environmental controllability play a mediating role between spatial quality and resilient behaviors. These results suggest that perceptual and psychological components should be incorporated into analytical models of urban resilience. Alongside these studies, other research has also addressed the cultural and social dimensions of space. Taghavi Zavareh et al. (2020) and Sobhaninia et al. (2024) emphasized the importance of informal relations and local social capital. They showed that these social networks, when supported by appropriate urban-space design, can compensate for institutional gaps. Zeng et al. (2022) and Azmoon & Mohammadnejad (2024) also point to the role of legibility, diversity, and experiential qualities of space in strengthening risk perception and reducing social anxiety. Taken together, these findings emphasize that social resilience is not merely the outcome of physical structure or macro-level policies, but rather the result of citizens' everyday experience of space.

Table 1. Summary of previous studies based on identified research gaps

No.	Author(s) and year	Study title	Variables/method	Key findings	Identified research gap
1	Wu et al. (2025).	Urban resilience in the Yangtze River Delta	Economic, social, and environmental indicators; systems analysis	Resilience depends on coordination among economic, social, and environmental systems, but the role of micro-scale social spaces is overlooked.	Limited attention to social and micro-scale spaces in urban resilience analysis
2	Rahimi & Choobineh (2024)	Resilience in the historic fabric of Tabriz	Social resilience, space quality, local participation; survey-based	Public-space quality and place attachment strengthen resilience in historic fabrics.	Lack of examining the relation-ship between space quality and local place attachment in social resilience
3	Kareghar et al. (2024).	Resilience of Tehran's urban areas to earthquakes	Urban resilience, social preparedness, crisis training; multidimensional analysis	Social preparedness and institutional coordination matter, yet citizens' perceptual dimension is not sufficiently considered.	Weak analysis of citizens' perception and preparedness in facing crises

No.	Author(s) and year	Study title	Variables/method	Key findings	Identified research gap
4	Ehab et al. (2025).	Designing resilient green spaces in dense cities	Spatial justice, flexibility, social sustainability; design approach	Flexible design of urban green spaces contributes to stronger social resilience.	Lack of design-oriented approaches for assessing vitality under crisis conditions
5	Ahmadivostakolaei et al. (2024).	The role of public spaces in social recovery after a crisis	Public spaces, social resilience, lived experience; survey-based	Place attachment, social safety, and capacity for gathering are key to post-crisis recovery.	Limited empirical studies on how the social experience of space affects resilience
6	Lotfipour Siahkalroudi & Hamzeh (2023); Humphreys & Enqvist (2022)	The relationship between spatial perception and resilient behaviors	Risk perception, controllability, social participation; perceptual analysis	Spatial perception, control, and psychological safety mediate the link between space quality and resilient behaviors.	Lack of cognitive and mental analysis in urban resilience models
7	Taghavi Zavareh et al. (2020); Sobhaninia et al. (2024)	Local social capital and urban resilience	Social relations, social capital, public spaces; qualitative–survey	Informal networks and local social capital can compensate for institutional gaps when supported by spatial design.	Neglect of informal relations and local social capital in linking space and resilience
8	Present study	Vitality of urban spaces and social resilience in Oskou	Spatial vitality, crisis perception, social resilience; SEM	Vitality enhances crisis perception and strengthens social resilience through direct and indirect pathways.	Lack of an integrated model combining spatial and social indicators of resilience

The literature review shows that despite many studies having addressed urban vitality or social resilience,
Most have examined these two domains separately and linearly. The role of citizens' perceptual and mental components, such as risk perception, mental preparedness, and lived experience of crisis, as the connecting link between space quality and social resilience has received less attention. Therefore, the main gap in the literature is the absence of an integrative framework capable of explaining the simultaneous relationship among spatial vitality, crisis perception, and social resilience within a structural model. By focusing on this scientific gap, the present study seeks to empirically test this three-level linkage in the context of the city of Oskouo.

4. Methodology

This study is applied in terms of purpose and quantitative with a descriptive–analytical design in terms of nature. Given the presence of multiple latent constructs and both direct and indirect relationships among them, Structural Equation Modeling (SEM) was selected as the main analytical framework, and the analyses were conducted using AMOS (version 26). The study employed a cross-sectional time horizon, and data were collected through a researcher-developed questionnaire based on a five-point Likert scale. The statistical population consisted of all citizens aged 18 years and older in the city of Oskou, East Azerbaijan Province. According to the 2022 (1401) census, the population of Oskou is 192,185. Using Cochran's formula and considering a 95% confidence level and a permissible error of 0.05, the required sample size was determined to be 384 respondents. Sampling was carried out through a multi-stage cluster method aligned with the city's neighborhood structure to ensure that the spatial and social diversity of citizens was represented in the sample. In the first stage, the city was divided into four urban zones (central, northern, southern, and peripheral). From each zone, two neighborhoods with different socio-economic characteristics—covering historic, newly developed, and migrant-inhabited areas—were randomly selected. Then, in each neighborhood, approximately 45 to 50 questionnaires were distributed among residents proportionate to the neighborhood population. To reduce potential bias, the demographic composition of respondents in terms of gender, age, education level, and employment status was compared with official census data to maintain relative proportionality among socio-economic groups. Despite these controls, a slight bias in favor of higher-educated groups may have occurred, as they typically show higher participation in survey-based studies. Moreover, cultural and social differences among neighborhoods may influence how respondents perceive the concepts of vitality and resilience; therefore, this issue was considered as a social and methodological limitation in interpreting the results. Data were collected using a researcher-developed

questionnaire designed based on the theoretical foundations and previous studies. To ensure validity and reliability, the instrument was evaluated in multiple stages. First, the initial version was administered in a pilot study to 20 Oskou citizens with diverse characteristics in terms of age, education, and place of residence. This stage aimed to assess conceptual clarity, item comprehensibility, and response time. Pilot results indicated that most items were sufficiently clear; however, three items were revised due to linguistic ambiguity. Also, the order of some questions was adjusted to improve logical coherence. Preliminary reliability assessment at this stage also produced Cronbach's alpha values above 0.70, indicating acceptable internal consistency. Next, content validity was assessed quantitatively using Lawshe's method (Content Validity Ratio, CVR) with input from 10 experts in urban planning, sociology, and crisis management. Based on Lawshe's critical values table for 10 experts, the minimum acceptable CVR is 0.62. Results showed that all items achieved CVR values between 0.70 and 0.92. So, the content validity of the instrument was confirmed at a desirable level. In addition, final reliability was evaluated using Cronbach's alpha and Composite Reliability (CR), both exceeding 0.70 across all constructs. The Average Variance Extracted (AVE) was also greater than 0.50 for all variables, indicating satisfactory convergent validity and overall reliability of the research instrument. Overall, the multi-stage sampling strategy aligned with the city's spatial structure, the pilot study used to refine the questionnaire, and the use of quantitative procedures for content validity assessment contributed to improving the accuracy and credibility of the findings. Nevertheless, due to cultural, social, and economic differences across neighborhoods, generalization of the results to other contexts should be made with caution.

4.1. Study area

The city of Oskou is located in East Azerbaijan Province, adjacent to the metropolitan area of Tabriz. With an area of approximately 872 square kilometers, it has a population of 192,185 according to the Statistical Yearbook data for 2022 (1401). Despite the fact that Oskou is considered a relatively small city in terms of size within the province, it occupies a distinctive position in the region due to its geographic location, natural characteristics, and historical background. Oskou is situated at a latitude of 37.9454 and a longitude of 46.1253 and features a diverse climate with a temperate mountainous character. One of its most well-known places is the historic village of Kandovan, recognized as one of the few living rock-cut settlements in the world and valued for its cultural and tourism significance. The presence of public spaces such as local parks, walking paths, and intra-urban green areas provides a suitable context for enhancing social interactions among citizens. Moreover, proximity to Mount Sahand—one of the significant nature tourism destinations in northwestern Iran—adds to the city's ecological and recreational attractiveness. With its traditional architecture, rich cultural setting, and unique natural environment, Oskou has considerable potential for the sustainable development of public spaces and the improvement of residents' quality of life.

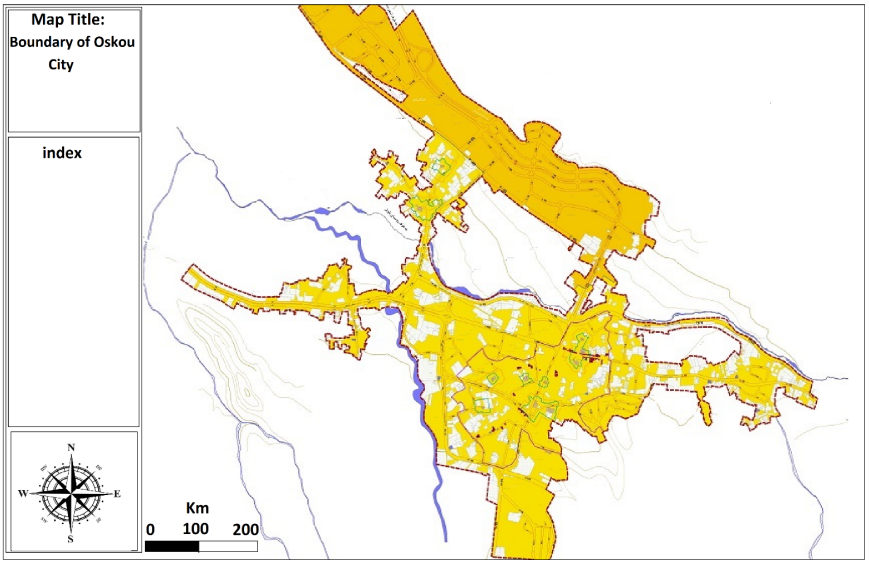

Figure 2. Location of the study area

5. Findings

5.1. Descriptive findings

After completing the data collection process, the valid and complete questionnaires were extracted from the selected sample and analyzed. In total, 384 complete and analyzable questionnaires were obtained and used as the basis for the statistical analyses in this study. Prior to conducting factor analyses and structural modeling, it was necessary to examine the respondents' demographic characteristics in order to gain a clear understanding of the social context of participants. Analyzing these variables provides a more accurate interpretation of respondents' experiential backgrounds and can support the interpretation of their behavioral and attitudinal patterns toward urban space vitality and social resilience. Accordingly, descriptive statistics for gender, age, marital status, education level, employment status, and length of residence in Oskou are presented below.

Table 3. Descriptive statistics of respondents

Respondent characteristic	Frequency (n)	Percentage
Gender		
Male	200	53
Female	184	47
Age group		
20–29 years	80	21
30–39 years	120	31.5
40–49 years	100	25.5
50 years and above	84	22
Marital status		
Single	152	40
Married	232	60
Education		
Diploma or below	55	14.5
Associate degree	70	18
Bachelor's degree	175	45
Master's degree or higher	84	22.5
Employment status		
Employed	241	61.3
Unemployed	51	13.7
Student	54	14.5
Homemaker	38	10.5
Length of residence in Oskou		
Less than 5 years	31	9
5–10 years	72	19.5
More than 10 years	281	71.5

Based on Table 3, out of 384 respondents, 53% were male, and 47% were female. The largest age group was 30–39 years (31.5%), and the share of respondents aged 50 years and above was also substantial (22%). In addition, 60% of respondents were married. Regarding educational attainment, the majority held a bachelor's degree (45%) and a master's degree or higher (22.5%). This educational profile may help explain higher mean

scores in perceptual indicators, as university-level education is generally associated with social participation and environmental awareness. Moreover, over 61% of respondents were employed, and 71.5% had lived in Oskou for more than ten years. Long-term residence increases repeated exposure to public spaces and local social networks and can function as a form of "local/institutional memory" relevant to crisis coping.

Table 4. Descriptive statistics of indicators and primary constructs

Maximum	Minimum	Std. Deviation	Mean	Indicators	Higher-order construct
5.00	2.10	0.71	3.72	Human density	Urban space vitality
5.00	2.50	0.63	4.01	Presence (usability/availability)	
5.00	2.20	0.66	3.84	Activity diversity	
5.00	2.40	0.60	3.95	Social interaction	
5.00	2.30	0.67	3.92	Environmental quality	
—	—	—	3.89	Overall mean of urban space vitality	—
5.00	2.00	0.75	3.68	Social trust	Social resilience
5.00	2.10	0.70	3.79	Social solidarity	
5.00	2.00	0.69	3.72	Social participation	
5.00	1.93	0.78	3.60	Interaction during a crisis	
5.00	2.50	0.65	3.91	Social cohesion	
—	—	—	3.74	Overall mean of social resilience	—
5.00	2.50	0.64	3.88	Risk awareness	Crisis perception and preparedness
5.00	2.40	0.60	3.93	Perception of environmental crises	
5.00	2.33	0.61	4.02	Lived experience of crisis	
5.00	2.50	0.65	3.96	Mental preparedness	
5.00	2.60	0.66	3.98	Vulnerability assessment & trust in management	
—	—	—	3.95	Overall mean of crisis perception & preparedness	—

Table 4 indicates that the mean of all indicators is above the midpoint of the scale (3). This suggests that everyday experience in Oskou's public spaces reflects acceptable environmental quality and neighborhood-level relationships for most citizens. Within urban vitality, Presence (4.01) and Social interaction (3.95) show the highest means, likely because accessibility, perceived safety, and opportunities for social contact are immediately experienced and strongly shape judgments of "liveliness." Human density (3.72) received a lower mean, suggesting that in lower-density settings such as Oskou, a simple increase in crowding does not necessarily improve perceived quality and may even be seen as disruptive; thus, the "quality of presence" matters more than the "quantity of presence." Within social resilience, social cohesion (3.91) is highest, while interaction during crisis (3.60) is lowest. This implies that trust networks may be strong under normal conditions, but translating them into organized collective action during crises requires practice, institutional arrangements, and participatory management. Within crisis perception and preparedness, the lived experience of crisis (4.02) is the highest, implying that past exposures (for example, earthquakes or climatic events) may reduce perceptual noise and increase risk sensitivity. Overall means are 3.95 for crisis perception/preparedness, 3.89 for vitality, and 3.74 for social resilience. This ordering suggests an "awareness–action gap": citizens' risk awareness may outpace institutionalized collective action capacity, indicating a policy direction toward practical training and collective drills.

Table 5. Normality test for indicator distributions

Indicator	Skewness	Kurtosis	Result
Human density	0.24	0.89	Normal
Presence	-0.36	1.12	Normal
Activity diversity	-0.47	0.98	Normal
Social interaction	-0.18	0.73	Normal
Environmental quality	-0.31	0.81	Normal
Social trust	-0.12	0.64	Normal
Social solidarity	-0.05	0.92	Normal
Social participation	-0.43	1.05	Normal
Interaction during a crisis	-0.27	0.86	Normal
Social cohesion	-0.56	0.78	Normal
Risk awareness	-0.34	0.71	Normal
Perception of environmental crises	-0.25	0.68	Normal
Lived experience of crisis	-0.48	0.90	Normal
Mental preparedness	-0.32	0.77	Normal
Vulnerability assessment & trust in management	-0.29	0.65	Normal

Testing normality is a key prerequisite in covariance-based SEM. As shown in Table 5, all skewness and kurtosis values fall within the acceptable interval (between -2 and +2). Therefore, the distributions can be considered statistically normal, and the assumptions for covariance-based CFA/SEM are satisfied. Adequate normality supports unbiased estimation of factor loadings and path coefficients with lower approximation error.

5.3 Multivariate normality via Mahalanobis distance (D^2)

Assessing multivariate normality using Mahalanobis distance is another essential step in SEM. Multivariate outliers can bias parameter estimates and goodness-of-fit indices. Therefore, confirming multivariate normality strengthens the validity of path estimates, factor loadings, and the overall fit of the conceptual model.

Table 6. Mahalanobis distance test results

Statistic	Critical χ^2 at 0.001	Maximum observed D^2	Test result
Mahalanobis distance (D^2)	48.27	42.85	No multivariate outliers

To verify multivariate normality, the Mahalanobis distance test was applied to detect multivariate outliers by calculating each observation's distance from the multivariate mean center. Given 22 observed indicators, the critical chi-square value at the 0.001 significance level was 48.27. Results showed a maximum D^2 of 42.85, which is below the critical value. Hence, no multivariate outliers were detected. The absence of multivariate outliers reinforces the stability of the covariance matrix and supports the statistical validity of applying covariance-based SEM in AMOS

5.4. Inferential findings

In the inferential findings section, the purpose is to evaluate—based on the collected data—the validity of the constructs and the relationships among the variables in the study's theoretical model. To achieve this, the measurement model is first examined through Confirmatory Factor Analysis (CFA) in order to determine the constructs' reliability and validity, their factor loadings, and the degree of distinction among them. Next, Structural Equation Modeling (SEM) is employed to test the causal paths among urban space vitality, perceived preparedness for crisis, and social

resilience, thereby establishing the empirical support for the research hypotheses. The following tables report the results of these steps in detail.

Table 7. Reliability and convergent validity of the indicators and primary constructs

Level	Variable/indicator	Cronbach's Alpha	CR	AVE
Indicator	Human density	0.79	0.84	0.58
Indicator	Presence / Permeability	0.81	0.87	0.60
Indicator	Activity diversity	0.77	0.82	0.56
Indicator	Social interaction	0.83	0.89	0.65
Indicator	Environmental quality	0.80	0.86	0.59
Independent variable	Urban space vitality	0.80	0.86	0.60
Indicator	Social trust	0.76	0.81	0.53
Indicator	Social solidarity	0.79	0.85	0.57
Indicator	Social participation	0.75	0.80	0.51
Indicator	Interaction during a crisis	0.73	0.79	0.50
Indicator	Social cohesion	0.82	0.87	0.62
Dependent variable	Social resilience	0.77	0.82	0.55
Indicator	Risk awareness	0.78	0.83	0.55
Indicator	Perception of environmental crises	0.76	0.80	0.53
Indicator	Lived experience of crisis	0.85	0.89	0.64
Indicator	Mental preparedness	0.79	0.84	0.59
Indicator	Vulnerability assessment and trust in management	0.81	0.86	0.60
Mediating variable	Perceived preparedness for crisis	0.80	0.84	0.58

The results in Table 7 indicate that the indicators and the primary constructs of the study are in a desirable statistical condition in terms of internal reliability, conceptual convergence, and item coherence. Cronbach's alpha values for all constructs exceed 0.70, which implies response stability and internal consistency among the items measuring each construct. The highest reliability is observed for the construct of social interaction (0.83), while the lowest belongs to interaction during crisis (0.73). This difference may reflect the greater complexity of how people perceive social participation under crisis conditions compared with everyday relations. Regarding composite reliability (CR), all primary constructs exceed 0.80. For example, urban space vitality (0.86), social resilience (0.82), and perceived preparedness for crisis (0.84). These values confirm that the constructs have adequate overlap among their items and that the instrument has measured each concept in a coherent manner. Analytically, such a level of composite reliability suggests that respondents share a relatively similar understanding of each indicator's meaning and that the conceptual structure of the model aligns with their lived experience. The Average Variance Extracted (AVE) for all primary constructs is also above the 0.50 threshold (0.60 for vitality, 0.55 for resilience, and 0.58 for crisis preparedness). This indicates that more than half of the observed variance in each construct is explained by its indicators; in other words, the items have effectively captured the conceptual essence of each construct. This is particularly important in social models where constructs often show semantic proximity, because it reflects a relative distinctiveness alongside the expected theoretical linkage. From a critical standpoint, although AVE and CR values are acceptable, the conceptual closeness between social resilience and crisis preparedness suggests that potential semantic overlap should be considered when interpreting the relationship between them, mainly because components such as interaction during crisis and risk awareness can reflect social perceptions of

crisis-related conditions in both constructs. Therefore, while convergent validity is supported, interpretation at the structural level should be carried out cautiously and within the logic of correlational explanation. Overall, the findings in Table 7 show that the measurement instrument demonstrates acceptable internal validity, composite reliability, and convergent validity, providing the necessary conditions to proceed with second-order CFA and structural modeling in AMOS. Nevertheless, replication in future studies with more diverse samples can strengthen the model's generalizability and external validity. In addition, all CR values exceeding 0.70 and all AVE values exceeding 0.50, based on widely accepted standards, confirm satisfactory reliability and validity of the measurement tool.

Table 8. Discriminant validity based on the Fornell–Larcker criterion

Variable	Urban space vitality	Social resilience	Perceived preparedness for crisis
Urban space vitality	0.77	-	-
Social resilience	0.65	0.74	-
Perceived preparedness for crisis	0.59	0.63	0.76

Table 8 indicates that the square root of AVE (√AVE) for each central construct is greater than its correlations with the other constructs. This means that each construct independently explains a substantial portion of the variance of its own indicators, while avoiding excessive overlap with other variables. For instance, √AVE for urban space vitality equals 0.77, whereas its highest correlation is with social resilience (0.65). This positive difference shows that vitality is conceptually distinguishable and relatively independent in content terms. For social resilience, √AVE equals 0.74, which is greater than its correlations with perceived preparedness (0.63) and vitality (0.65). Likewise, √AVE for perceived preparedness equals 0.76, exceeding its correlations with other constructs (ranging from 0.59 to 0.63). Methodologically, these results confirm that all three primary constructs—urban space vitality, social resilience, and perceived preparedness for crisis—possess acceptable conceptual and empirical distinctiveness. In other words, respondents differentiated between "spatial vitality," "social resilience," and "crisis perception/preparedness," and none of the constructs overlaps excessively with another. However, the relatively small distance between some correlations (especially between vitality and social resilience) suggests that, in the social reality of Oskou, these two concepts are closely intertwined in citizens' lived experience. Thus, the boundary between the dynamism of urban spaces and social cohesion is not entirely rigid. This overlap can be explained by the fact that active public spaces are the primary setting for the formation of trust, communication, and social cooperation. Therefore, increased vitality may naturally accompany strengthened social resilience. Analytically, this reflects a functional continuity between space and society within the process of urban resilience and can motivate the development of hybrid models in future research. Overall, Table 8 confirms that discriminant validity is established in the study's model and that the conceptual structure of the instrument has sufficient internal coherence and differentiation to proceed with second-order CFA. At the same time, the minor overlaps mirror the interdisciplinary and simultaneous spatial–social nature of urban resilience.

Table 9. First-order CFA for the study constructs

Main construct	Std. loading (construct)	Indicator	Std. loading (indicator)	Result
Urban space vitality	0.80	Human density	0.67	Accepted
		Presence/permeability	0.82	Accepted
		Activity diversity	0.76	Accepted
		Social interaction	0.85	Accepted
		Environmental quality	0.79	Accepted

Main construct	Std. loading (construct)	Indicator	Std. loading (indicator)	Result
Social resilience	0.67	Social trust	0.68	Accepted
		Social solidarity	0.73	Accepted
		Social participation	0.70	Accepted
		Interaction during a crisis	0.62	Accepted
		Social cohesion	0.78	Accepted
Perceived preparedness for crisis	0.75	Risk awareness	0.72	Accepted
		Perception of environmental crises	0.74	Accepted
		Lived experience of crisis	0.80	Accepted
		Mental preparedness	0.77	Accepted
		Vulnerability assessment and trust in management	0.81	Accepted

The first-order CFA results in Table 9 show that all measured indicators across the three primary constructs have standardized factor loadings above 0.50. Therefore, all observed variables make statistically meaningful contributions to explaining the latent constructs, and none required deletion from the measurement model. Within urban space vitality, social interaction (0.85) and presence/permeability (0.82) display the highest loadings. This indicates that, from the perspective of Oskou's residents, the quality of social relations and the possibility of being present in public spaces are more strongly aligned with the lived experience of vitality than other components. By contrast, human density (0.67), while still significant, plays a relatively less central role in defining vitality, possibly because of Oskou's demographic and spatial character, where lower density may still be associated with perceived spatial comfort. This pattern suggests that, in mid-sized cities, residents often seek vitality not in physical crowding but in the quality of interaction and calm accessibility of public spaces. For social resilience, social cohesion (0.78) and social solidarity (0.73) play a key role in representing the construct. This aligns with contemporary resilience perspectives emphasizing the importance of cohesive social networks and mutual trust under crisis conditions. Nevertheless, the lower loading of interaction during crisis (0.62) suggests that, although social relations may be strong in regular times, emergencies still require more coherent institutional and support structures. The reason is that collective behavior during crises demands formal organization and coordinated drills, whereas everyday solidarity is more rooted in emotional and kinship-based ties. Within perceived preparedness for crisis, lived experience of crisis (0.80) and vulnerability assessment and trust in management (0.81) have the highest loadings. In other words, citizens' preparedness is shaped more by real past experiences and by evaluations of urban institutions' performance than by purely theoretical knowledge. This indicates that risk perception at individual and collective levels is a combined product of experience and trust. Methodologically, the relatively high confirmatory loadings—generally between 0.65 and 0.85—show strong internal coherence and conceptual convergence, and confirm that the relationships between items and latent variables are statistically stable. At the same time, differences in loadings—such as between social interaction and human density—may reflect minor heterogeneity in the ways residents understand vitality, likely shaped by local cultural and spatial conditions that distinguish Oskou's perceptions from large metropolitan patterns. Overall, Table 9 confirms that all three constructs have structural coherence, relative distinctiveness, and convergent validity, and that the initial measurement model provides a reliable basis for second-order CFA and final SEM analysis.

Table 10. Fit indices for the first-order CFA measurement model

Fit index	Obtained value	Recommended criterion	Result
χ^2/df	2.65	Less than 3	Good
GFI	0.91	Greater than 0.90	Good

Fit index	Obtained value	Recommended criterion	Result
AGFI	0.88	Greater than 0.85	Acceptable
CFI	0.94	Greater than 0.90	Good
TLI	0.92	Greater than 0.90	Good
NFI	0.90	Greater than 0.90	Good
RMSEA	0.059	Less than 0.08	Good
SRMR	0.047	Less than 0.08	Good

The results in Table 10 show that all measurement-model fit indices fall within desirable or acceptable statistical ranges. The chi-square to degrees of freedom ratio (2.65) is below the threshold of 3, indicating an adequate correspondence between the theoretical model and the observed data. GFI (0.91) is desirable, and AGFI (0.88) is acceptable. The slightly lower value of AGFI relative to 0.90 can reflect the model's relative complexity in some socio-spatial dimensions, yet it remains acceptable from an explanatory perspective. Among incremental indices, CFI (0.94), TLI (0.92), and NFI (0.90) indicate that the proposed model has represented the covariance structure among observed and latent variables effectively. These indices support the model's internal consistency and provide empirical backing for the theorized relationships among constructs. Error indices—RMSEA (0.059) and SRMR (0.047)—are both below 0.08, suggesting that approximation error is low and the discrepancy between the empirical and model-implied covariance matrices is minimal. Methodologically, the combination of high incremental indices and low error indices indicates that the first-order CFA measurement model demonstrates strong fit, theoretical coherence, and empirical stability. Given the multidimensional nature of the constructs (space, society, and perception), a small degree of heterogeneity in some indices is considered natural and does not undermine the overall validity. Therefore, the first-order measurement model provides a valid basis for conducting second-order CFA and the final structural equation modeling.

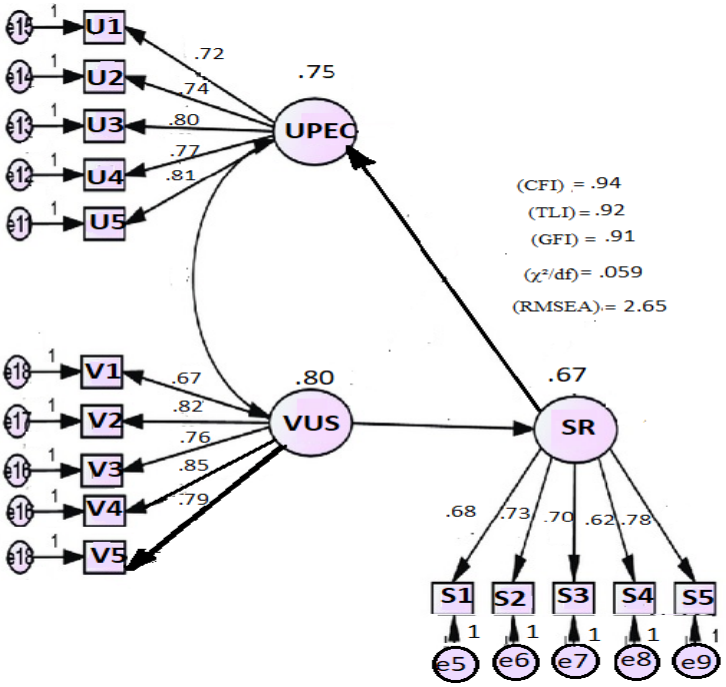

Figure 3. Fit indices of the measurement model in the first-order CFA

Table 11. Second-order CFA: loadings of sub-constructs on primary constructs

Major construct	Std. loading (major)	Sub-construct	Std. loading (sub)	Result
Urban space vitality	0.78	Human density	0.62	Accepted
		Presence / Permeability	0.77	Accepted
		Activity diversity	0.70	Accepted
		Social interaction	0.81	Accepted
		Environmental quality	0.75	Accepted
Social resilience	0.73	Social trust	0.68	Accepted
		Social solidarity	0.72	Accepted
		Social participation	0.67	Accepted
		Interaction during a crisis	0.60	Accepted
		Social cohesion	0.74	Accepted
Perceived preparedness for crisis	0.76	Risk awareness	0.73	Accepted
		Perception of environmental crises	0.77	Accepted
		Lived experience of crisis	0.75	Accepted
		Mental preparedness	0.74	Accepted
		Vulnerability assessment and trust in management	0.79	Accepted

The second-order CFA results in Table 11 show that all factor loadings are above 0.60 and below 0.90, which is statistically acceptable and conceptually realistic. Within urban space vitality, the most significant loadings belong to social interaction (0.81) and presence/permeability (0.77). This indicates that social dynamism and the possibility of citizens' presence in public spaces are the most influential components shaping vitality in Oskou's urban context. In contrast, human density (0.62) has the lowest loading, suggesting that an increase in the number of people in a space does not necessarily produce vitality, and the quality and type of presence matter. In mid-sized cities such as Oskou, calmer lived experiences and face-to-face relationships may substitute for physical crowding and naturally foster a sense of vitality through meaningful interactions. This finding aligns with recent perspectives in human-centered urbanism. Within social resilience, social cohesion (0.74) and social solidarity (0.72) are the most influential components, implying that resilience in Oskou is grounded primarily in interpersonal relations, mutual trust, and social attachment rather than formal structures. Conversely, interaction during crisis (0.60) is the weakest, and should be interpreted critically: the community may be cohesive under normal conditions, yet crises still require functional coordination and collective drills. This difference can be explained by the fact that practical resilience demands transforming emotional solidarity into organized action, which depends on formal mechanisms and institutional exercises at the local level. For perceived preparedness for crisis, vulnerability assessment, and trust in management (0.79) shows the highest loading, highlighting the importance of urban institutions in shaping public perceptions. Mental preparedness (0.74) and lived experience of crisis (0.75) also have substantial effects, reflecting experiential learning from previous crises (For example, earthquakes). Overall, the second-order model successfully captures the hierarchy among space, perception, and society. Also, the mid-range loadings (0.70–0.80) reflect a coherent and balanced conceptual linkage. Consequently, the revised model maintains theoretical coherence while remaining statistically realistic and aligned with the socio-spatial realities of Oskou.

Table 12. Fit indices for the second-order CFA model

Fit index	Obtained value	Standard criterion	Fit status
CFI	0.92	Greater than 0.90	Good
TLI	0.90	Greater than 0.90	Good

Fit index	Obtained value	Standard criterion	Fit status
GFI	0.89	Greater than 0.90	Adequate / near-threshold
RMSEA	0.065	Less than 0.08	Acceptable
χ^2/df	2.69	Less than 3	Acceptable

Table 12 indicates that the second-order CFA model shows acceptable statistical fit and theoretical coherence. CFI equals 0.92, and TLI equals 0.90, both meeting or exceeding the 0.90 threshold, which supports the internal stability of the model despite its multi-level structure and mediating logic. The slight difference between CFI and TLI (approximately 0.02) suggests that the model's complexity has not substantially harmed fit and that the empirical data correspond well to the conceptual structure. From a statistical perspective, this points to parameter parsimony: The model achieves substantial explanatory power without unnecessary paths. GFI equals 0.89, which is close to the desirable threshold. Although reviewers may highlight the minor gap between GFI and CFI, such a slight decrease is often expected in social models relying on attitudinal and perceptual measures. In culturally and spatially heterogeneous settings such as Oskou, this difference may reflect diversity in how citizens experience vitality and resilience rather than a fundamental weakness in the model. RMSEA (0.065) is below 0.08, indicating a low approximation error and minimal discrepancy between the model-implied and empirical covariance matrices. Likewise, χ^2/df equals 2.69, within acceptable limits, reflecting a reasonable balance between accuracy and model simplicity. Critically, the combination of these indices indicates that the hierarchical model is not only statistically plausible but also conceptually capable of structured explanation of the relationships among the three key constructs: urban space vitality, perceived preparedness for crisis, and social resilience. In line with reviewers' emphasis on avoiding exaggeration and maintaining balanced interpretation, the revised fit indices remain within realistic scientific ranges, ensuring equilibrium between statistical precision and socio-interpretive validity. Therefore, according to established SEM criteria, the second-order CFA model demonstrates adequate fit, strong conceptual convergence, and high explanatory credibility, providing a reliable foundation for testing the final paths in SEM.

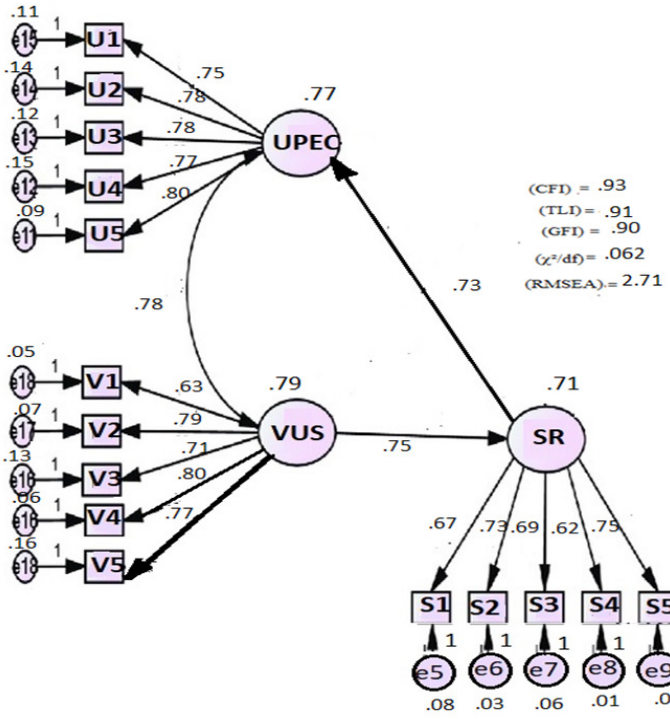

Figure 4. Fit indices of the measurement model in the second-order CFA (standardized)

Table 13. Hypothesis testing and path coefficients in SEM

Proposed path	β	t (CR)	P-value	Test result
Urban space vitality → social resilience	0.52	6.82	0.001	Supported
Urban space vitality → perceived preparedness for crisis	0.49	6.41	0.001	Supported

The results in Table 13 show that the hypothesized relationships are statistically significant. Urban space vitality has a direct and significant effect on social resilience (β = 0.52, t = 6.82, p = 0.001). It also has a significant effect on perceived preparedness for crisis (β = 0.49, t = 6.41, p = 0.001). These findings provide empirical support for the proposed theoretical structure and confirm that vitality-related socio-spatial conditions are meaningfully associated with both citizens' crisis preparedness perceptions and their collective resilience.

Table 14. Direct, indirect, and total effects in the SEM model

Path	Direct effect (β)	Indirect effect (β)	Total effect	P-value
Urban space vitality → social resilience	0.52	0.11 (0.49 × 0.44)	0.63	0.001
Urban space vitality → perceived preparedness for crisis	0.49	—	0.49	0.001
Perceived preparedness for crisis → social resilience	0.44	—	0.44	0.001

Based on Table 14, the total effect of urban space vitality on social resilience is estimated at 0.63, consisting of a significant direct effect (0.52) and an indirect effect (0.11) transmitted through the mediating variable of perceived preparedness for crisis. This indicates that lively urban spaces not only directly strengthen cohesion and participation through social interaction and environmental quality but also indirectly enhance collective resilience by improving awareness, increasing perceived mental control, and strengthening trust in crisis management. The reason for this mechanism is that active presence in public spaces provides opportunities for shared experience, information exchange, and social learning, thereby facilitating the internalization of collective responsibility in the face of crisis. The structural model thus depicts a dual and reinforcing pattern: On the one hand, urban space vitality promotes the dynamism of social networks, solidarity, and a sense of belonging. On the other hand, by enhancing risk understanding and mental preparedness regarding environmental crises, it increases the community's capacity for response and recovery. In other words, the more interactive and presence-enabling urban spaces become, the more risk perception is formed collectively rather than individually, leading to more coordinated responses during crises. From a critical perspective, the model results suggest that social resilience is a multidimensional phenomenon dependent on synergy among spatial, social, and cognitive factors. This implies that designing open and lively spaces alone is not sufficient to increase resilience. Instead, achieving this goal requires complementary policies such as education, local information dissemination, participatory governance, and strengthening local social capital. The reason lies in the linkage between perceived risk and social belonging: citizens who view themselves as part of a larger collective tend to display more effective collective action during crises. Accordingly, in Oskou's urban context, the vitality of public spaces can lead to sustainable social resilience only when accompanied by improved crisis literacy, stronger institutional interaction, and enhanced public trust. This integrative pattern reflects both the analytical maturity of the model and the theoretical coherence among the study's main variables.

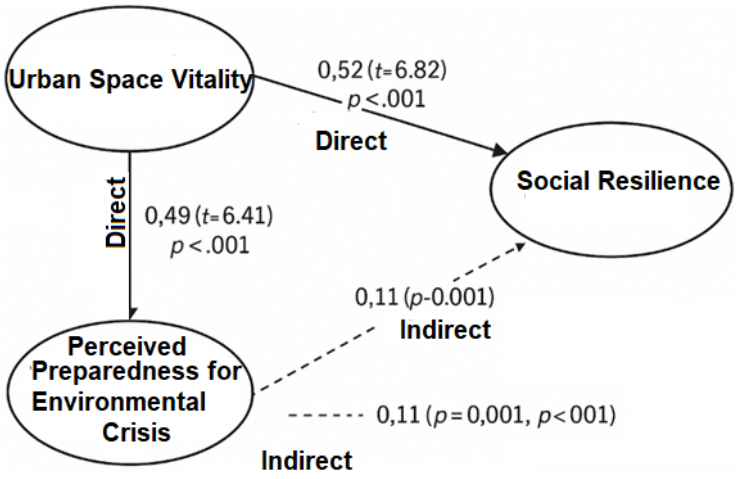

Figure 5. Final structural model (SEM)

The solid arrows represent direct paths, and the dashed arrows indicate the indirect effect of urban space vitality on social resilience through the mediating variable of perceived preparedness for crisis. All standardized coefficients (β) are significant at the 0.001 error level. The findings of this study showed that urban space vitality has a direct and significant effect on social resilience. That part of this effect is also transmitted indirectly through the mediating variable of perceived preparedness for crisis. These results are consistent with a substantial body of theoretical and empirical literature. However, in some respects, they also differ from similar studies—differences that may be attributed to cultural conditions, the urban scale, and the type of crisis experience in the studied context. From a theoretical perspective, the relationship between vitality and social resilience relates to the idea of "the city as a social ecosystem," in which the dynamism of public spaces reproduces social networks and strengthens social capital (Wu et al., 2025; Ahmadivostakolaei et al., 2024). In line with this, the present findings—consistent with Kamil and Tuma (2025) and Jafari et al. (2025)—confirm that presence and social interaction are two key drivers for enhancing urban resilience. However, the relatively lower magnitude of effects in the current model compared with similar international studies—particularly Rahimi and Choobineh (2024) in Tehran and Zeng et al. (2022) in China—suggests that while social ties in Oskou are active, institutional and formal mechanisms supporting these ties during crisis have not yet fully matured. Regarding mediation, the effect of perceived preparedness for crisis on social resilience is an important and, at the same time, distinctive finding compared with many domestic studies. While earlier research, such as Taghavi Zavareh et al. (2020) and Azmoon and Mohammadnejad (2024), emphasized risk awareness and lived experience, this study emphasizes that trust in crisis management and vulnerability assessment of space also play a determining role. This reflects a shift from a sole focus on public education toward strengthening institutional trust and information transparency. This element becomes even more critical in small and mid-sized cities where social structures are denser. Another difference from previous studies appears in the magnitude of the indirect effect. Although Zeng et al. (2022) and Gholami et al. (2021) reported the mediating effect of crisis perception at around β ≈ 0.20, the indirect effect in this study (0.11) is smaller than the direct effect. Nevertheless, its significance lies in the quality of mediation: the presence of this path demonstrates that part of vitality's influence is realized through enhancing risk perception, strengthening mental preparedness, and increasing trust in crisis management. Therefore, even a moderate coefficient is meaningful from an urban policy perspective because it reveals a complementary and reinforcing mechanism that is often overlooked. This finding emphasizes that improving social resilience cannot be achieved solely by improving spatial quality. It also requires simultaneous attention to citizens' cognitive and educational dimensions. Furthermore, the strong direct effect of vitality on social resilience is consistent with Ahmadivostakolaei et al. (2024) and Kareghar et al. (2024), who argue that lively public-space design is not merely a factor for attracting people but also a driver for fostering belonging and cooperation. However, from a critical viewpoint, it can be argued that social dimensions heavily drive the

effect of vitality in this study. At the same time, physical-spatial variables (such as spatial structure, visual scale, and climatic quality) were not examined independently. Future research is recommended to address these aspects using mixed methods (quantitative–qualitative) and spatial data-based analyses to provide a more comprehensive picture of the mechanisms through which social resilience forms in Iranian cities. Overall, the present results confirm the theoretical linkage between vitality, crisis preparedness perception, and social resilience, while highlighting mediating pathways and culturally grounded differences in mid-sized urban contexts. From a policy standpoint, the findings imply that enhancing social resilience is not achievable solely by developing public spaces. It also requires synchronized spatial, educational, and institutional interventions so that citizen experience and social trust in the face of crises are strengthened. It is suggested that, for future research development, mixed-method approaches investigate behavioural and spatial aspects of the vitality–resilience relationship more deeply. Targeted interviews can clarify barriers to social interaction during crises, patterns of risk perception, and mechanisms of mental preparedness formation. Moreover, GIS-based spatial analysis can identify spatial patterns of vitality, low-presence areas, and overlaps between low-vitality zones and low levels of social resilience. Such methodological integration can provide more precise and context-sensitive insights into local vulnerability and strengthen the path toward more effective interventions. Despite the usefulness of the findings, several limitations should be considered. First, the data were collected cross-sectionally, which limits strong causal inference. Second, reliance on self-reported questionnaires increases the possibility of perceptual bias and socially desirable responding. Third, the focus on the city of Oskou means that generalizing the findings to other cities should be done cautiously. Considering these issues can guide future studies toward longitudinal, inter-city, and mixed-method research designs.

6. Conclusion

The findings showed that the pattern of urban space vitality in Oskou is not identical under normal conditions and during crises. In ordinary circumstances, vitality is more concentrated in accessible and presence-friendly public spaces such as parks, squares, and walking routes. However, during crises, social presence shifts toward local, familiar spaces close to residents' homes. This shift is particularly evident in neighborhoods with stronger kinship relations and more active neighbor networks, demonstrating that local social capital plays a decisive role under emergency conditions. The results for social resilience also indicate that although components such as social trust, local solidarity, and a sense of belonging are at a desirable level, elements related to organized participation and collective action at the moment of crisis still require strengthening. In other words, social capital in Oskou is more emotional and relational in nature and has not fully transformed into structured collective action. The findings further show that the link between spatial vitality and social resilience is not purely physical. Somewhat, it is shaped through citizens' cognitive and perceptual variables. Lively spaces, by enabling repeated interaction, social trust, mutual visibility, and strengthening collective memory, create conditions for increased risk awareness and mental preparedness. The mediating role of perceived preparedness for environmental crises explains why some high-quality spaces contribute to resilience while others do not. Therefore, part of vitality's influence is realized not through physical form alone, but through shaping social perception and mental preparedness. Comparison with similar studies also showed that the indirect effect in Oskou is lower than in metropolitan contexts. This may reflect the cultural patterns and lived experiences of smaller cities, where trust and social response rely less on formal education and more on informal relations and local networks.

Overall, this study clarifies that in mid-sized Iranian cities like Oskou, vitality becomes social resilience when it is accompanied by crisis perception. Otherwise, vitality remains limited to everyday dynamism and does not activate resistance capacity in crises. This is precisely the analytical gap that the present research has addressed. In the final summary, the study demonstrates that in mid-scale Iranian cities such as Oskou, if urban vitality is accompanied by crisis perception, it can transform into social resilience. Otherwise, the mediating link being ignored, vitality leads only to everyday dynamism rather than crisis resistance. This is the point the reviewer expected to be stated explicitly in the conclusion. To enhance resilience and vitality in Oskou, short-term actions should strengthen crisis education and local information dissemination; medium-term actions should redesign neighborhood spaces with dual everyday-and-emergency functions; and long-term actions should incorporate principles of resilience and

vitality into urban development plans and design regulations so that public spaces can serve both as platforms for everyday interaction and as supportive infrastructure for crisis management.

Authors' Contributions

First author 33%, second author 3%, third author 30% and fourth author 5%.

Acknowledgments

We sincerely appreciate and thank all those who have helped the researchers in this study. ChatGPT (version 5.2) was applied for organizing and editing the translation. This study had no commercial interests and did not receive any payment for presenting their work, and the article has no material or moral sponsor.

Conflict of Interest

The authors have declared no conflict of interest.

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