IJAUP- INPRESS

Title:

Unveiling Pandemic Resilience in Mashhad, Iran: Lessons from the COVID-19 Pandemic

Malihe Ghorbani[1], Naser Barakpour[2], Melika Amirzadeh[3*]

1. **Faculty of Architecture and Urban Planning, University of Art, Tehran, Iran**

Email address: malihe.ghorbani@alumni.um.ac.ir

2. **Full Professor, Faculty of Architecture and Urban Planning, University of Art, Tehran, Iran**

Email address: barakpoo@art.ac.ir

3. **Planning Consultant, Urbis, Sydney, Australia**

[*]Corresponding author:

Email address: mamirzadeh@urbis.com.au

Address: Angel Place, Level 8, 123 Pitt Street, Sydney, NSW 2000, Australia

Abstract

This study aims to investigate the urban resilience of Mashhad as a representative metropolitan city in Iran in the context of pandemics. The study adopts an exploratory approach rather than solely relying on existing literature and established frameworks. Initially, data collection involved conducting semi-structured interviews with two distinct groups: authorities and experts, as well as residents. The collected data were analyzed using thematic content analysis with the assistance of MAXQDA to develop the Resilience Framework of Mashhad (RFM). In the second phase, primary data was gathered through a survey using questionnaires. The data were ranked and analyzed using qualitative methods, descriptive statistics, and an expert panel weighting system. The RFM is structured into two major levels: Macro-level (International, national, and regional scales) and Urban level (Urban community, local community, and housing and architecture). Employing simple random sampling, 342 questionnaires were completed by citizens, while the remaining 53 were filled out by experts and authorities. The overall composite urban resilience score of Mashhad city in response to pandemics was evaluated based on 16 variables and 38 indicators. The results indicated that the national and regional scale and the urban community, and the local community scales exhibited resilience levels below moderate. The RFM can serve as a valuable tool for scholars, urban planners, and policymakers to deepen their understanding of urban resilience in a Global South city.

Keywords: Urban resilience; Resilience assessment; COVID-19; post-pandemic city; Epidemic disease.

1. Introduction

Despite advancements in science, medicine, and urban planning measures aimed at improving public health and preventing the spread of diseases in cities, such as the implementation of modern sanitation systems, healthcare facilities, and regulations, the COVID-19 pandemic highlighted the ongoing vulnerability of cities to pandemics (Bereitschaft & Scheller, 2020). The World Health Organization reports that as of September 2023, the pandemic has resulted in approximately 771,151,224 cumulative cases and 6,960,783 deaths worldwide (WHO, 2023). In addition to the high rates of infection and mortality, this crisis has caused widespread disruptions that necessitate new perspectives and significant changes in urban planning knowledge (Salama, 2020; Shakil et al., 2020; Sharifi & Khavarian-Garmsir, 2020) Prior to 2020, there was limited research exploring the potential contributions of urban planning and design in mitigating the impact of pandemics. Policymakers primarily focused on short-term measures such as city lockdowns, public transport closures, and physical distancing as key strategies for managing pandemic risks (Amirzadeh et al., 2022). The onset of COVID-19 underscored the urgent need for urban resilience in the face of evolving challenges. The pandemic revealed the vulnerabilities of urban systems to health risks and highlighted the crucial roles that different city characteristics play in prevention, mitigation through containment measures, and post-pandemic planning and risk management strategies (Lai et al., 2020; Block et al., 2020). As a result, discussions on pandemic resilience have gained traction in academic and policy circles in recent years. These discussions typically analyze the challenges posed by pandemics and propose strategies for communities to strengthen their preparedness, response, and recovery capabilities (Litman, 2020).

Understanding the interplay between urban resilience and pandemics is crucial for effective preparedness and response strategies. Urban resilience plays a vital role in enhancing a city's ability to withstand and recover from the challenges brought about by pandemics. Several scholars have highlighted the essential role of urban planning and design in creating resilient cities to address pandemics (AbouKorin et al., 2021; Afrin et al., 2021; Majewska et al., 2022; Banai, 2020).While previous studies provide valuable insights into urban resilience during pandemics (Amirzadeh et al., 2023; Chen & Quan, 2021; Suleimany et al., 2022), several criticisms can be raised. Inconsistencies in conceptualizations and frameworks regarding key dimensions, indicators, and methodologies may impede comparability and generalizability. Moreover, most frameworks lack empirical validation, casting doubts on their practicality and efficacy (Lak et al., 2020; Suleimany et al., 2022). Contextual factors are often disregarded, potentially limiting the applicability of resilience strategies across diverse regions. Neglecting interdisciplinary perspectives and stakeholder engagement can also undermine the robustness of the frameworks. Addressing these criticisms through promoting contextual sensitivity, interdisciplinary collaboration, and stakeholder involvement can enhance the quality and relevance of frameworks on urban resilience in the context of pandemics. Moreover, there is a gap in the literature regarding the unique characteristics of cities in the global south. These cities may necessitate tailored resilience-building approaches due to their specific contextual challenges and requirements.

To address the existing gap in the literature, this study aims to examine the resilience of a specific metropolitan city in the global south, namely Mashhad, by considering the perspectives of relevant stakeholders and experts. The research is

guided by two primary research questions. The first research question delves into the fundamental factors and dimensions that influence the resilience of Mashhad in the context of pandemics. The second research question focuses on assessing the extent of Mashhad's resilience in the context of a pandemic using the established framework. By scrutinizing Mashhad's response to pandemics, this study aims to extract valuable insights and recommendations that can benefit other cities in the global south grappling with similar challenges.

2. Guiding literature

As urban systems have become increasingly exposed to uncertainty and complex risks, resilience has emerged as a central concept in urban planning theory and practice. Originally introduced in ecology by Holling (1973), the concept was later adopted into urban planning during the 1990s (Amirzadeh et al., 2025; Sharifi & Yamagata, 2016). Although there is no universally accepted definition of urban resilience (Amirzadeh et al., 2022), it is generally understood as the ability of urban systems to withstand, adapt to, and transform in response to shocks and stresses that affect cities and their subsystems (Manyena et al., 2019; Schwanen, 2016). As cities have increasingly faced complex environmental, social, and public health challenges, the concept has evolved beyond a narrow focus on disaster resistance and recovery towards a broader, multidimensional understanding encompassing governance, institutional capacity, infrastructure, socioeconomic conditions, and community wellbeing.

The COVID-19 pandemic brought the dimensions of urban resilience into particularly sharp focus and generated extensive research into how cities and governments responded to an unprecedented global crisis. South Korea has been among the most widely studied cases because of its comparatively effective management of the pandemic (Anttiroiko, 2021). You (2020) attributed this effectiveness to comprehensive infectious disease preparedness, close public–private collaboration, rigorous contact tracing, a flexible healthcare system, and transparent government communication. These findings have prompted further research into the governance arrangements and institutional capacities underpinning South Korea’s pandemic response. Based on interviews with public health experts and government policy advisors, Kim et al. (2021) argued that, although the country’s response was highly effective, many measures were implemented reactively in response to emerging outbreaks rather than through proactive preventive planning. Similarly, Cho and Park (2023), using secondary data, SWOT analysis, and an indigenous administrative framework, highlighted the influence of cultural values, institutional arrangements, and policy instruments on pandemic governance. Kim et al. (2022) further identified transparent governance, public participation, and the Three-T strategy—testing, ICT-enabled contact tracing, and treatment—as key factors contributing to South Korea’s response. They also emphasised the role of strong crisis leadership and clearly defined national response protocols in enabling coordinated and evidence-based decision-making. Extending this governance perspective, Moon and Wu (2022) argued that resilience depends not only on institutional capacity but also on governance innovation, including collaboration with non-government actors, closer integration of scientific knowledge and policy, and the effective adoption of emerging technologies. Collectively, these studies demonstrate that governance capacity, institutional coordination, technological capability, and public participation are important components of pandemic resilience.

Alongside this governance-focused literature, researchers have developed a range of conceptual and analytical frameworks to capture the

multidimensional and multiscalar nature of urban resilience during pandemics. Zhang and Wang (2023), for example, proposed a comprehensive evaluation framework comprising four interrelated subsystems: infrastructure, governance, socioeconomic factors, and energy-material flows. By integrating system dynamics, epidemic simulation, and composite indicators, their framework enables the assessment of urban resilience under different pandemic scenarios. Similarly, AmirzadeAmirzadeh et al. (2023) developed a conceptual framework that examines resilience across four spatial scales—housing, neighbourhood, city, and regional and national levels—and incorporates three complementary dimensions: pandemic-related health requirements, environmental psychological principles, and general resilience principles. These frameworks demonstrate that understanding pandemic resilience requires attention not only to multiple dimensions of urban systems but also to the interactions between different spatial scales. This multiscalar perspective is further supported by the growing recognition that urban resilience is embedded within the resilience of the wider territories and societies upon which cities depend. Rather than viewing cities as self-contained systems, the literature increasingly emphasises their interdependencies across spatial, functional, and institutional scales. The COVID-19 pandemic particularly exposed these interconnections, demonstrating how disruptions to health systems, supply chains, mobility networks, and essential services can extend across administrative and geographic boundaries. UN-Habitat (2022) therefore emphasised the need for holistic and multiscale approaches to resilience that recognise the interdependence between urban areas and their surrounding territories. From this perspective, resilience planning needs to extend beyond administrative city boundaries to encompass the wider city-region, including peri-urban and rural areas that contribute to urban functioning through the provision of essential resources and services. Addressing resilience at this scale also requires multilevel governance, involving both horizontal coordination among local authorities and vertical integration across national, regional, and local levels (Amirzadeh & Barakpour, 2021).

Other studies have sought to identify the specific dimensions and capacities that contribute to resilience before, during, and after pandemics. Suleimany et al. (2022), for instance, proposed a community resilience assessment framework comprising five dimensions: social, economic, infrastructural, institutional, and demographic. Their findings suggest that strengthening resilience requires integrated policies that address multiple community assets and vulnerabilities simultaneously. Chen and Quan (2021) similarly developed a multidimensional evaluation index based on infrastructure, economic, ecological, and social systems and applied it to assess urban resilience in China's Yangtze River Delta. Lak et al. (2020) further expanded the scope of analysis by examining resilience across housing, neighbourhoods, public spaces, and cities. Their framework identifies five resilience dimensions and six key resilience qualities: robustness, redundancy, resourcefulness, efficiency, flexibility, and adaptability. Aygün Oğur et al. (2021), meanwhile, developed a conceptual framework integrating urban resilience principles with strategic recovery planning to support cities in preparing for and responding to future pandemic events. However, the diversity of dimensions and approaches identified across the literature also highlights the need for more integrated frameworks that can account for their interrelationships across different spatial scales and governance contexts.

3. Materials and Method

3.1. Study area

Mashhad is situated in the Razavi Khorasan province in the northeast of Iran. It shares borders with Turkmenistan to the north and northeast, as well as with Afghanistan to the east. As of the most recent population and housing census in 2016, Mashhad had a population of 3,001,184, positioning it as the second most populous city in Iran, covering an area of 351 km² (Deputy of Planning and Development of the Human Capital of Mashhad Municipality, 2020). Figure 1 depicts the location of Mashhad city within Iran.

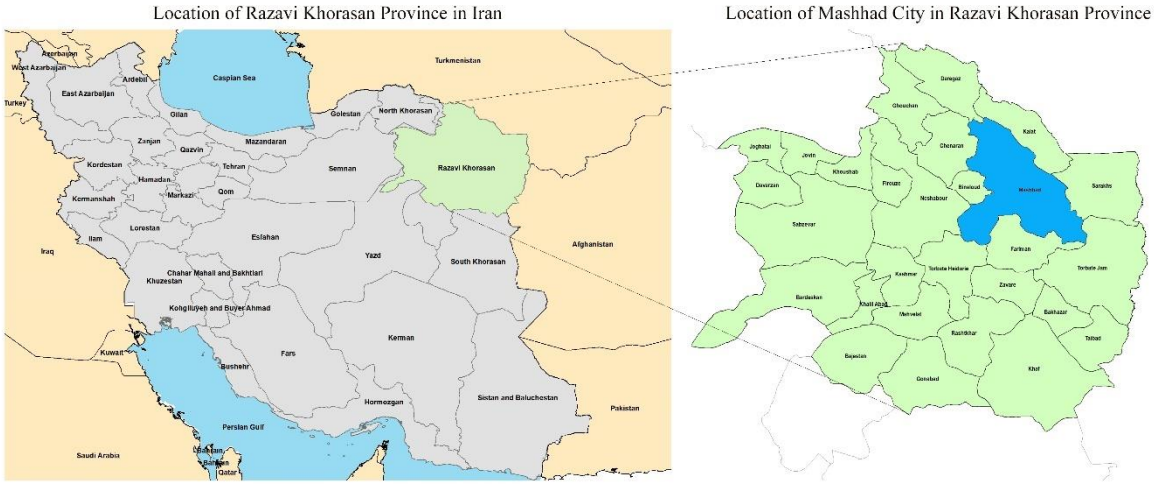


Fig 1. The location of Mashhad city in Iran.

Mashhad holds a significant place in Iran as one of its holiest cities. This is primarily due to the presence of the shrine of Imam Reza, the eighth Imam of Shia Muslims. The shrine serves as a major pilgrimage site, drawing millions of pilgrims from Iran and around the world each year, making Mashhad a major religious and cultural hub. The city has witnessed a significant increase in the number of tourists visiting, including pilgrims and travelers, from about 100,000 in 1929 to approximately 20 million in 2019, as reported in the Mashhad City Yearbook of 2019 (General Diretorate of Cultural Heritage Tourism and Handicrafts of Khorasan Razavi Province, 2019). Based on official statistics, in 2018, a total of 32,901,705 tourists entered Khorasan Razavi province. Despite the outbreak of COVID-19 in late 2019, there was no significant change in the number of tourists in this year (General Diretorate of Cultural Heritage Tourism and Handicrafts of Khorasan Razavi Province, 2019). However, during the pandemic, the number of foreign travelers entering the city of Mashhad drastically decreased, with only 431,650 people reported in 2020 (Rasad-khane Shahrie Mashhad, 2020).

This decline was particularly significant among non-Iranian tourists, highlighting the vulnerability of Mashhad to the COVID-19 pandemic (General Diretorate of Cultural Heritage Tourism and Handicrafts of Khorasan Razavi Province, 2019).

3.2. Sampling, data collection and analysis

To address the research objectives, a two-part research design was employed, involving qualitative research methods in the initial phase and quantitative research methods in the

subsequent phase. The details of both phases will be discussed in the following paragraphs.

3.2.1. First phase

Semi-structured, in-depth interviews were employed for data collection. The questions were primarily formulated during the interviews based on the guiding literature to address any gaps or uncertainties in the participants' responses. Out of a total of 38 interviews conducted, 9 participants were female and the remaining were male. Among these individuals, 17 participants had expertise in urban planning and design, while 5 individuals had expertise in urban transportation planning. Additionally, 7 individuals from civil society were also interviewed. The list of participants is provided in Table 1.

Table 1. List of interviewees

The main interviewee groups				**Expertise**	**Number of interviews**
Urban level	Governmental organizations and NGOs	Municipality	Deputies of municipality	Urban planning and transportation planning	10
			Affiliated organizations	Transportation planning	
			Medical Center	Medical	
		City council	Members of commissions	Transportation planning	3
			Staff	Urban planning	
			Research center	-	
		Governorate		Urban planning	1
		Astan-e Qods (the administrative organization which manages the Imam Reza shrine)		-	2
	Experts		University faculty members	Urban planning	13
			Graduates		
	Private sector			-	1
	Civil society			-	7
Macro-level	National headquarters foe COVID-19 pandemic control		Technical committees	-	1
Total					38

Different sampling strategies were used to recruit participants from the various stakeholder groups. Random sampling was applied to recruit participants from civil society. For the other stakeholder groups, an initial list of key stakeholders and experts was developed, and participants were recruited through purposive sampling based on their knowledge and relevance to the study. As the interviews progressed, additional participants were identified through snowball sampling, with interviewees recommending others who could contribute valuable insights. The recruitment process continued until data saturation was reached,

meaning that no new themes or significant insights emerged from the interviews.

The interviews were conducted from January to May 2022, with each session lasting 45 minutes in average. Comprehensive recordings were made of each interview, and following each session, the collected data underwent thorough analysis using thematic content analysis facilitated by the MAXQDA software. The data analysis process involved three primary stages. Initially, the interview transcripts were inputted into MAXQDA, and codes were assigned to capture specific emerging concepts from the data. This coding process employed two methods: the application of theoretical concepts, alongside the use of researcher-generated labels for coding the raw interview content. Subsequently, the assigned codes were organized into categories, leading to the identification of overarching themes and sub-themes based on the coded data. Efforts were then made to streamline and refine the codes due to the abundance of extracted codes. A review of the codes was conducted, resulting in revisions aimed at eliminating redundancies, grouping similar codes into new categories, merging certain codes, and introducing new codes where necessary. This iterative approach enabled a thorough and detailed analysis of the data. Subsequently, a framework was derived from analyzing the 38 semi-structured face-to-face interviews. It is noteworthy that no new codes emerged after the 36th interview. Nevertheless, data analysis persisted until reaching saturation, ensuring a comprehensive examination of the gathered data.

3.2.2. Second phase

To gather primary data through surveys, we created two distinct questionnaires tailored for experts, authorities, and citizens. These questionnaires were crafted based on specific indicators identified in the initial phase of the study. With a sample size of 385, determined using Cochran's formula with a 95% confidence level and a 0.5% error rate, our goal was to capture diverse viewpoints. The questionnaire encompassed a wide array of questions corresponding to 38 indicators categorized across five scales: 'international', 'national and regional', 'urban community', 'local community', and 'housing and architecture'. Data collected through the questionnaires was analyzed using spreadsheets. Each question's reliability was assessed using Cronbach’s alpha, ensuring a minimum reliability level of alpha > 0.72 for the citizens' questionnaire and alpha > 0.94 for the authorities and urban experts' questionnaire. These findings demonstrated a satisfactory level of internal consistency for both sets of questionnaires, bolstering the research's credibility. Subsequently, graphical charts were generated to visually interpret the results. A pretest involving 10% of households from the total sample size was conducted, followed by the main survey after refining and finalizing the questionnaire. The data collection process occurred in July 2022, employing both online and in-person methods. Out of the completed questionnaires, 342 were filled out by citizens, while the remaining 53 were completed by experts and authorities. Data analysis, including the computation of variable values, was carried out using SPSS, and Microsoft Excel was used to create graphical radars.

Each index value underwent conversion to a percentage during the calculation process to eliminate the necessity for normalizing the index results. Additionally, an expert panel was utilized to assess and allocate scores to the specified indicators in Table 2. The expert panel, consisting of five members, comprised two representatives from the Mashhad municipality, two university lecturers, and one resilience specialist from the private sector. Their responsibility entailed assigning weights to each domain on a scale ranging from 0 to 1. Initially, scores were evaluated on a percentage scale and then transformed into a range between 0 and 1. The

percentage values of indicators from sampled households and experts' questionnaires were divided by the panel's designated values. This approach, previously utilized by researchers (Pazhuhan & Amirzadeh, 2024; Qasim et al., 2016), interpreted the results as lower resilience values (close to 0) and higher resilience values (close to 1). Since no indicators negatively impacted resilience, the ranking system aligned with the expert panel's evaluations.

4. Results

As mentioned earlier, the study follows a two-phase research process, and the findings are presented in two main sections. The first section involves the development of the RFM, while the second section focuses on assessing the resilience of the Mashhad metropolis against the COVID-19 pandemic based on the developed framework.

4.1. Developing the RFM

Initially, 52 primary codes were extracted. After multiple reviews, the codes were refined, combined based on similarities in various stages, and organized into two main categories: macro and micro levels. Ultimately, the influential factors on the resilience of Mashhad metropolis were determined, resulting in 16 themes and 38 sub-themes within two major classes: macro-level, which includes international and national and regional scales, and urban level, which includes urban community, local community, as well as housing and architecture. The Resilience Framework of Mashhad (RFM) to the COVID-19 pandemic, categorized into themes and sub-themes at this stage, is presented in Table 2, based on analysis of the interview texts.

Table 2. The Resilience Framework of Mashhad (RFM)

Level	Scale	No	Theme (Variables)	No	Sub-theme (Indicators)
Macro-level	International	1	Global governance (GG)	1	The impact of other countries' actions on the country's status (GG1)
		2	International legislation and regulations (IL)	2	Effectiveness of rules and guidelines in different stages of the pandemic (IL1)
	National and regional	3	National and regional governance (NG)	3	The stability of the national governance system (NG1)
				4	Legitimacy and acceptability of the national governance system (NG2)
				5	Governance structure (The level of autonomy of provinces) (NG3)
				6	Effective communication between different organizations/ provinces (NG4)
		4	The economic status (ES)	7	Prosperity and economic stability of the country (ES1)
		5	National legislation and regulations (NL)	8	Effectiveness of laws in different stages (NL1)
		6	Digital information and communication (NDI)	9	Digital and smart services (NDI1)
Urban level	Urban community	7	Form and function of the city (UFF)	10	Fair access to service uses and urban facilities (UFF1)
				11	Ease of access to public and multifunctional green and open spaces (UFF2)
				12	Efficient urban transportation (UFF3)

				13	Planning for the public physical and mental health (UFF4)
				14	Strategic vision and scenario planning in urban planning and management (UFF5)
		8	Urban Equity (UE)	15	Social unity and solidarity (UE1)
				16	Social support of national government institutions (UE2)
				17	Housing for low-income groups (UE3)
				18	Water, sewage and urban waste management (UE4)
		9	Robust and sustainable urban economy (URE)	19	Sustainable economy (URE1)
				20	Financial mechanisms to support citizens and businesses (URE2)
		10	Integrated and efficient urban governance (IG)	21	The legitimacy of the urban governance system (IG1)
				22	Coordination and cooperation between different organizations (IG2)
				23	Effectiveness of city rules and regulations (IG3)
				24	Monitoring the implementation of national laws (IG4)
				25	Dealing with administrative corruption (IG5)
		11	Digital information and communications (UDI)	26	Digitalization of services (UDI1)
	Local community	12	Form and function of neighborhoods (LFF)	27	Equitable access to service users and local facilities (LFF1)
				28	Ease of access to green spaces and multi-functional public spaces (LFF2)
				29	Efficient local public transportation (LFF3)
		13	Robust local economy (LRE)	30	Social solidarity (LRE1)
				31	Social support of urban government institutions (LRE2)
				32	Economic status of local institutions and households (LRE3)
		14	Digital information and communication (LDI)	33	Creating a platform for providing electronic and smart services (LDI1)
		15	Efficient local governance (LG)	34	Proper implementation of national and municipal laws (LG1)
				35	Monitoring the implementation of national and municipal laws (LG2)
				36	Existence of active civil groups (LG3)
	Housing and architecture	16	Form and function of buildings (AFF)	37	High quality buildings (AFF1)
				38	Access to open and green space in the buildings (AFF2)

The RFM is divided into two major classes: Macro-level (including international and national scales) and Urban level (encompassing urban community, local community, and housing and architecture). Additionally, different driving aspects of resilience, such as physical, social, economic, environmental, and institutional, have an impact on different scales.

4.1.1. *Macro-level (international and national and regional scales)*

A section of the data extracted from the interview texts at the macro level is related to international aspects. In the RFM at the international level, two themes, namely global governance and international rules and regulations, have been included by researchers. It is worth mentioning that urban experts primarily highlighted these aspects. One of the interviewees discussed the adverse impact of sanctions on the disease control in Iran:

"[...] For example, in Iran, due to various reasons, the country's sanctions have directly or indirectly affected the control of this disease." (R17).

Another section of the extracted data from the interview texts at the macro-level pertains to national and regional factors, such as efficient national governance, economic status, national legislation and regulations, and digital information and communications. It is important to highlight that a diverse group of interviewees touched upon these topics. For instance, one participant discussed the impact of laws and regulations in effectively controlling the spread of the disease on a national level:

"[...] We didn't have adequate laws to control the situation. For example, at different points in time, decisions were made to close various businesses, and we clearly saw the impact this had on people's lives." (R24)

4.1.2. *Urban level (urban community, local community as well as housing and architecture scales)*

One of the scales mentioned at the urban level is the urban community scale. The extracted themes of this scale included urban form and function, equity, robust and sustainable urban economy, integrated and efficient urban governance, and digital information and communication. Regarding this scale, an interviewee highlighted the importance of integrated and efficient urban governance:

"We lack integrated urban management at the city level, especially in situations like the coronavirus pandemic [...] There is a lack of coordination among us when it comes to receiving directives from higher authorities. This lack of coordination not only creates confusion but also leads to dissatisfaction among the people with our actions." (R6)

The research RFM includes the local community scale as the second scale mentioned at the urban level. Within this scale, four themes have been identified: the form and function of neighborhoods, a robust local economy, digital information and communications, and efficient local governance. One respondent emphasized the importance of the existence and fair distribution of land uses within neighborhoods, stating:

"[...] On the one hand, in my opinion, the distribution of land uses, both in terms of density and location, can be important at the neighborhood level, and it should also be fair." (R1)

Additionally, the housing and architecture scale is included as the smallest scale within the RFM. This scale specifically focuses on the form and function of buildings, particularly housing. One interviewee highlighted the need to revise existing housing patterns, stating:

"The problem that existed in the cities of the country before this disease, perhaps the pattern of apartment living and the structure of

apartment buildings in Mashhad, provide people with smaller spaces. [...]" (R30)

4.2. The resilience assessment of Mashhad metropolis against the COVID-19 pandemic

As shown in **Table 2**, the RFM includes 38 indicators at the macro-level and urban levels. These themes cover the five scales of international, national, urban community, local community, and housing and architecture.

As mentioned in the Method, to evaluate the resilience of Mashhad metropolis against the COVID-19 pandemic, two questionnaires were created based on the initial research phase findings. The questionnaire for authorities and experts focused on the higher spatial scales, namely international, national, and urban community. Conversely, the citizens' questionnaires included relevant questions regarding the lower spatial scales, such as local community and housing and architecture, to obtain more precise resilience assessment results for Mashhad metropolis against the pandemic. The resilience assessment results for Mashhad metropolis against the COVID-19 pandemic are presented below, categorized into the macro-level and urban levels.

4.2.1. Resilience level of the macro-level (international and national and regional scales)

Figure 2 depicts the scores of the 6 identified themes of the RFM at the macro-level. It should be noted that, except for international legislation and regulations and digital information and communication, the scores of the other themes were evaluated as below average by authorities and experts. Additionally, it is important to highlight that the theme of international legislation and regulations received a score of 0.60, which is one of the highest scores among the macro-level themes. Conversely, the theme of the economic status of the government obtained the lowest score of 0.34 compared to the other themes at this level.

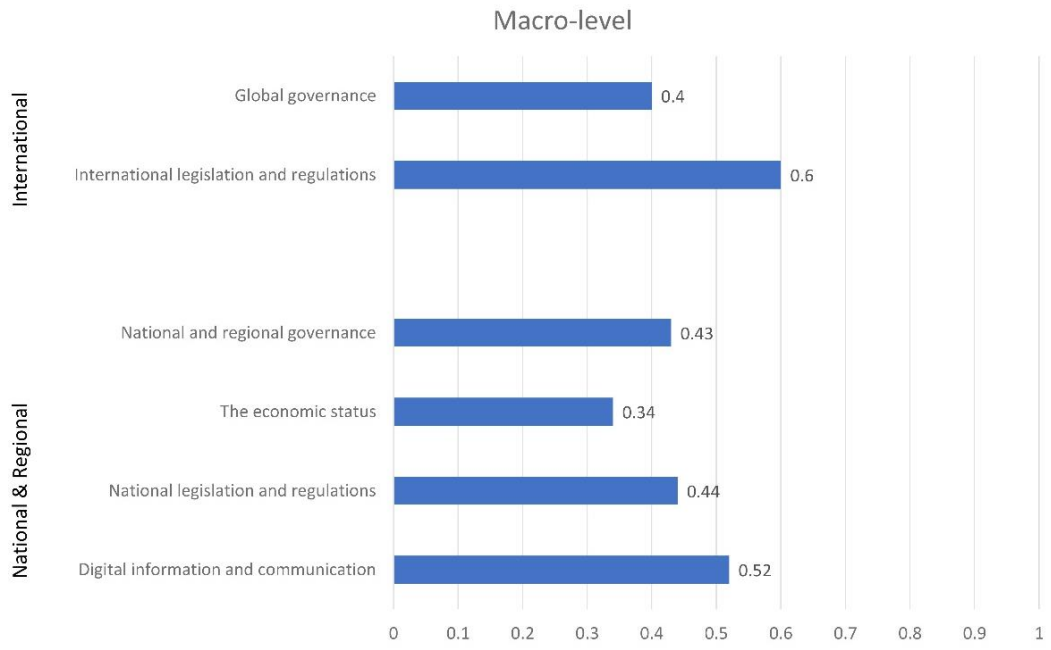


Fig 2. Scores of the themes at the macro-level.

4.2.2. Resilience level of the urban level (urban community, local community, and housing and architecture scales)

In total, out of the 10 themes at the urban level, only the theme of the form and function of buildings at the housing and architecture level received a score higher than 0.60. Following that, the theme of digital information and communication in the local community and urban community received the highest scores, with 0.53 and 0.51 respectively. It is important to note that the overall scores at this level were quite low, indicating the inadequacy of the themes in both the urban community and local community scales. This highlights the need for efficient planning to address the raised issues in these two scales.

Figure 3 presents the scores of 10 identified themes of the RFM against COVID-19 at the urban level.

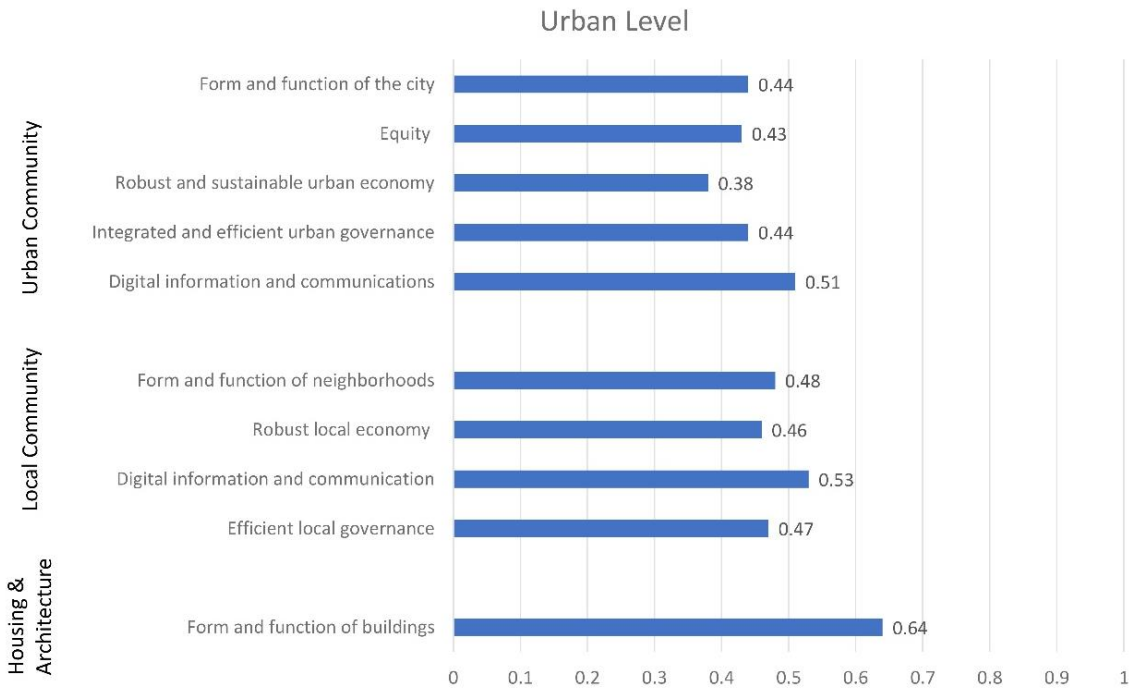


Fig 3. Scores of the themes at the urban level.

4.2.3. Resilience scores for different scales

The comparison of average scores across different scales indicates that the housing and architecture scale obtained the highest resilience score of 0.64, while the national and urban community scales obtained the lowest resilience score of 0.43. At the macro-level, a total of 9 sub-themes under the international and national and regional scales were assessed, with an average score of 0.67. The international scale had a higher average score of 0.5 compared to the national and regional scale's average score of 0.43, indicating that statistically, the international scale was more resilient compared to the national scale after the outbreak of COVID-19. At the urban level, a total of 29 indicators were assessed, with an overall average score of 0.49. Comparing the average scores for the sub-themes of the three aforementioned scales, the scores of 0.43, 0.48, and 0.64 were obtained, indicating that statistically, the sub-themes of the housing and architecture scale were in better condition compared to the sub-themes of the other two scales. It is important to note that the national and urban community scale had the lowest level of resilience among the five mentioned scales, according to the survey results from authorities and experts. In conclusion, considering the two major levels and the five spatial scales mentioned in the resilience assessment of Mashhad against COVID-19, the housing and architecture scale had a higher average score of 0.64 compared to the other scales. Meanwhile, with score of 0.43, the national and regional and urban community scales obtained the lowest level of resilience among the five scales in the framework (Figure 4).

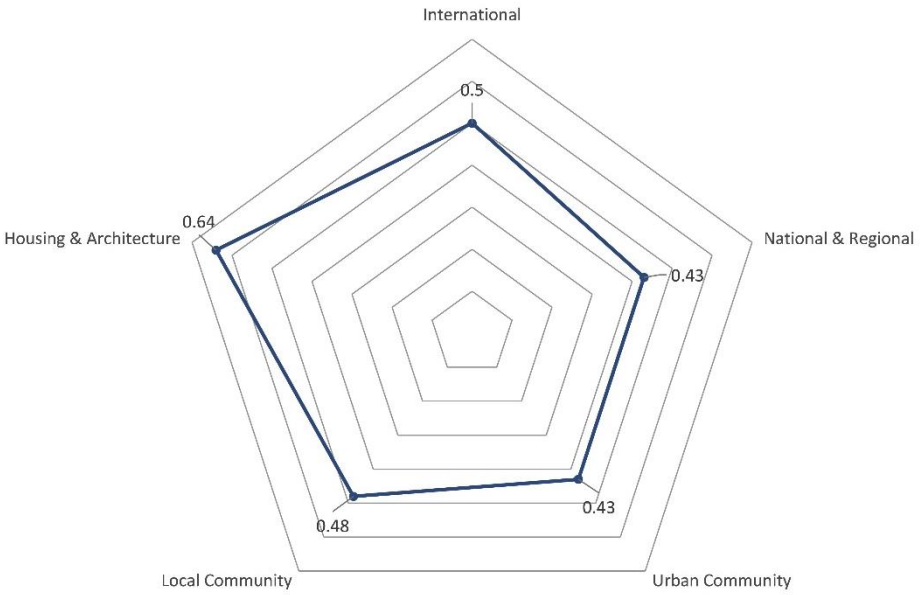


Fig 4. The resilience scores for different scales

5. Discussion

The RFM categorizes themes and sub-themes into two major classes: Macro-level (including international and national and regional scales) and Urban level (encompassing urban community, local community, and housing and architecture). This division allows for a more coherent and accurate representation of the factors. Upon comparing our research with previous studies, it is evident that while Lak et al. (2020) proposed a general framework, our objective was to develop an operational framework specifically tailored to the unique conditions of Mashhad city. Furthermore, unlike Suleimany et al. (2022) and Chen and Quan (2021), we recognized the complexity of the subject and the importance of close and continuous communication with various stakeholders at multiple spatial scales, ranging from macro to micro levels. By adopting this approach, we were able to develop a framework that addresses the diverse factors and challenges associated with urban resilience against pandemics.

One notable difference in our study is the hierarchical structure used to categorize the key components of urban resilience against pandemics. These variables and indicators encompass various themes related to governance, economic status, digital information and communication, urban planning, social equity, and sustainable economy, among others. Which shows the multifaced nature of pandemic resilience. In addition, the hierarchical structure of the framework allows for a more detailed and comprehensive categorization of the framework components. While Lak et al. (2020) focused on three scales, including neighborhoods/public spaces, and housing, and Amirzadeh et al. (2023) considered four spatial levels, including national and regional, city, neighborhoods, and housing scales in their conceptual frameworks for urban resilience against COVID-19, by including five spatial scales, our study takes into account a wider range of factors and perspectives. These variations in the number and types of spatial scales highlight the different perspectives and approaches taken in each study to address the complex nature of urban resilience against pandemics.

Furthermore, it has been emphasized in previous studies that stakeholder groups play a crucial role

in the resilience assessment (Panneer et al., 2021; Jayasekara et al., 2021). However, some studies have predominantly focused on single-level frameworks, failing to examine these groups at various scales, ranging from macro to micro. For instance, Gholami et al. (2021) solely relied on expert input to identify factors or variables with the highest impact or susceptibility, unlike our study where we aimed to involve a wide range of stakeholders and influential groups. By conducting interviews with diverse stakeholders, our research framework is more inclusive compared to previous studies. Additionally, the involvement of a wide range of stakeholders enhances the validity and applicability of our framework as it reflects the diverse needs and concerns of the different stakeholders. Therefore, our study offers a comprehensive and inclusive approach to understanding and addressing urban resilience against pandemics.

Another notable aspect is the detailed inclusion of digital information and communication indicators at different scales, highlighting the importance of technology in enhancing resilience. The emphasis on digitalization of services, effective communication between organizations, and digital platforms for providing electronic services underscores the role of smart city and digital technology in crisis management and response were also emphasized in previous studies (Pazhuhan & Amirzadeh, 2024).

The repeated inclusion of digital information and communication indicators across different scales within the Mashhad resilience framework underscores their significance in enhancing overall resilience. By integrating these indicators into various domains, such as healthcare systems, emergency response mechanisms, and community engagement, the framework acknowledges the critical role of technology in building resilience to pandemics.

Furthermore, the Mashhad framework addresses governance structures and coordination mechanisms at the national, regional, urban, and local levels, reflecting a comprehensive approach to resilience planning. The indicators related to governance legitimacy, coordination between organizations, monitoring of laws, and social support mechanisms demonstrate a focus on building robust governance systems to withstand pandemics. In comparison to other frameworks, the Mashhad resilience framework also places significant emphasis on urban planning and community-level resilience. Indicators related to fair access to services, efficient urban transportation, social unity, sustainable economy, and access to green spaces highlight the importance of creating resilient and livable urban environments to combat pandemics effectively.

This study faced several limitations, including the absence of community-level data in Iran's statistical system, which does not include most resilience data, especially related to pandemics. Consequently, we had to collect primary data and use survey methods for data collection. To address this limitation, we implemented a comprehensive primary data collection approach. This involved conducting surveys and interviews with various stakeholders, including community members, local organizations, and institutions. Moreover, the limited participation of local organizations and institutions in completing the questionnaires was another limitation. To overcome this limitation, we employed proactive strategies. By actively involving these stakeholders in the research process, we were able to gather a more diverse range of perspectives and ensure the validity and applicability of our findings.

6. Conclusion

The study proposes a framework for enhancing urban resilience against pandemics. The framework considers the macro and micro levels that influence urban resilience and identifies core themes and sub-themes that provide valuable insights for cities in preparing for and responding to future pandemics. In addition, the study highlights that decision-makers and policymakers should prioritize measures at different levels to enhance urban resilience against pandemics. National-level decision-making should consider the specific conditions and needs of individual cities. Moreover, multilevel governance and planning should adopt a transformative approach to effectively combat pandemics. Furthermore, comprehensive communication and collaboration with influential groups are essential for successful pandemic response. By implementing these findings and recommendations, urban planners and policymakers can better plan for cities that protect the well-being and safety of their residents.

The Mashhad resilience framework for pandemics is notable for its coverage of indicators at various levels, emphasizing digital information and communication, governance structures, urban planning, and community resilience. By integrating these components, the framework aims to bolster the city's ability to effectively respond to and recover from pandemics, serving as a valuable model for resilience planning in similar contexts. It is important to recognize that this framework represents an initial step in developing pandemic resilience strategies in Global South countries, and further research should expand and implement this framework in cities worldwide. Future studies should prioritize comparative analyses of multiple cities to evaluate their pandemic resilience, offering insights into common trends, best practices, and areas for enhancement across diverse urban settings. Moreover, there is a necessity to explore the impact of socio-economic factors on urban resilience during pandemics, particularly in the Global South.

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