Discover Health Systems

Case Study

Investigating the main drivers of COVID-19 outbreak challenges in metropolis management: a case study of Mashhad, Iran

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Abstract
The COVID-19 pandemic has had a significant global impact, particularly in developing countries. Understanding the specific challenges faced by urban areas like Mashhad is crucial for effective planning and policymaking. This study utilized the Delphi method to identify and evaluate key challenges presented by COVID-19 in Mashhad. A survey involving 27 experts in urban affairs and COVID-19 management was conducted, and data analysis was performed using MicMac software. The study pinpointed ten major challenges in Mashhad, encompassing economic, social, environmental, and political dimensions. The most notable challenges found were socioeconomic issues, such as the lack of diagnostic facilities and government deficiencies in poverty reduction. These findings offer valuable insights for urban planners and policymakers to address the pandemic's impact on Mashhad and strive towards a more resilient urban future. The absence of diagnostic facilities due to inadequate government management ranked highest in both direct and indirect influences, underscoring a significant systemic issue. The substantial scores (647 direct, 604 indirect) highlight the pressing need for enhanced healthcare infrastructure and efficient local government management. This shortfall not only impedes immediate response efforts but also contributes to the virus's transmission, leading to broader public health crises. Furthermore, the results shed light on systemic challenges like government inadequacies in poverty alleviation and the repercussions of political tensions presenting the crisis's complexity. Lastly, income stability (409 direct, 411 indirect) is vital for sustaining household well-being and economic resilience. Job losses and income insecurity worsen socio-economic disparities and hinder recovery, making it a critical area of focus.

Keywords Pandemic · COVID-19 · Metropolis · Mashhad · Crisis management · MicMac

1 Introduction

In the last century, there have been three devastating epidemics: in 1918, 1957, and 1968, along with significant social and economic impacts of COVID-19 [1]. Both the economy and individuals' lives have been greatly affected by this epidemic. Various studies have focused on the consequences of different disasters in urban areas, as well as the

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planning, adaptation, and design needed to achieve strong resilience [2]. The infectious disease known as Coronavirus 2019 (COVID-19) is caused by the coronavirus that leads to severe acute respiratory syndrome (SARS-CoV-2) [3]. Over the past 2 to 3 years, it has crossed borders, presenting numerous challenges and issues for both developed and developing nations [4]. The situation of cities and metropolises as high-density geographic areas differs and is more complex than others due to various policies and strategies implemented, such as lockdowns, strengthening telecommunications, infrastructure, and e-government in urban spaces to break the disease's transmission cycle. Cities, being high-density and global economic and political hubs, are particularly vulnerable to the impacts and challenges posed by the coronavirus. While the coronavirus is often seen as a recent global illness with the potential to trigger a smaller-scale epidemic resulting in millions of deaths, it is essential to recognize that these diseases have a long history [5, 6].

The impact of the COVID-19 pandemic on cities has underscored the need for a significant shift in urban design and planning. Throughout history, pandemics have influenced the development of cities, highlighting the importance of incorporating health considerations into city planning [7]. The current crisis has emphasized the necessity of addressing issues such as population density, redesigning streets for pedestrian and cyclist safety, and leveraging smart city technologies for effective pandemic response [8]. Cities like Helsinki exemplify functional urban centers with sustainable features that can better withstand future crises [9]. Going forward, it is essential for designers, planners, and public health officials to collaborate in creating healthier and more resilient cities to navigate and thrive in a post-pandemic world. The number of COVID-19 cases varied based on population density and community characteristics [10]. Cities with high density, low per-capita living space, and overcrowding have experienced higher rates of infection and death [11]. High-density and overpopulated cities, typically large cities, have longer public transportation commutes compared to smaller and medium-sized cities. Wealthier cities and affluent areas often have better indoor and outdoor spaces, leading to lower rates of social contact and transmission compared to poorer areas and individuals living in poverty, which are generally less conducive to healthy living even in normal circumstances.

Location and mobilization are key challenges in pandemic control during each outbreak [12–14]. The COVID-19 pandemic hit New York City in early March, disrupting education at all levels, from elementary school to graduate and professional schools. Columbia University suspended all in-person sessions on March 9, 2020, 2 days after New York State declared a state of emergency [15]. The outbreak's epicenter, affecting not only Malaysia but also Brunei, Singapore, Cambodia, Thailand, and Indonesia, was quickly identified as Sri Petaling, a suburb of Kuala Lumpur. Approximately 16,000 people attended a 4 day event organized by the local Tablighi Jama'at chapter, a global Islamic missionary movement, with 90% of attendees being locals. During the event, there were no government ministers in charge from February 27 to March 1 [16–18]. The spread of any pandemic is closely linked to the interplay between location and mobilization. Like the COVID-19 outbreak in Wuhan, China, virus outbreaks often originate in a single location. Movement Order Controls (MOC) are implemented during lockdowns to reduce the risk of spreading new cases from high-risk areas to low-risk areas [19, 20]. Urban areas tend to see a faster influx of new cases compared to smaller towns or cities due to their high population density. These urban areas serve as hubs for various goods and services, attracting people from both within and outside the country [21, 22].

Due to their high population density, metropolitan cities were more vulnerable to the COVID-19 outbreak compared to smaller, low-density urban areas [23]. The spread of the virus in metropolitan areas poses a long-term risk to the general public. Cities, which account for 80% of global GDP, are particularly at risk for rapid transmission of epidemics due to factors such as urbanization, population growth, and extensive use of transportation [24]. The impact of COVID-19 on urban environments presents significant challenges, especially in cities like Mashhad. These challenges are more pronounced in urban areas, particularly in developing countries. Extensive research has been conducted on the intersection of COVID-19 and urban issues. Metropolitan cities like Mashhad, with a centralized political system in a developing country, face challenges related to e-government, development, and economy. This study aims to identify the specific challenges that COVID-19 has brought to Mashhad. By addressing these challenges, planners and policymakers can work towards improving the quality of life in Mashhad. Given the religious significance of cities like Mashhad, it was crucial to address the COVID-19 outbreak immediately. Many visitors to the shrine are devout believers, making it essential to prevent the rapid spread of the virus. To achieve this, authorities implemented a strict lockdown in Mashhad to control the arrival of tourists from across Iran and the Middle East.

2 Literature review

The outbreak of the infectious disease COVID-19 was first detected in Wuhan, China, in December 2019 [25]. Since then, the virus has spread rapidly worldwide, leading to recurring epidemics [26]. While symptoms of COVID-19 can vary, fever is a common sign, as discussed by [3]. Other symptoms that individuals may experience include coughing, headaches, fatigue, breathing difficulties, and loss of taste and smell [27]. Symptoms typically appear within 1 to 14 days after exposure to the virus. It is worth noting that around one-third of infected individuals may not show any symptoms [28]. Among those with symptoms, up to 14% may develop severe manifestations like shortness of breath, hypoxia, or extensive lung involvement. However, the majority (approximately 81%) tend to have mild to moderate symptoms. Severe cases of COVID-19 can lead to organ dysfunction, shock, and respiratory failure, with older individuals being more vulnerable to severe symptoms. Some individuals may also experience organ damage, and a subset may have lingering symptoms known as "prolonged COVID" for months after recovery [29]. Long-term studies are ongoing to understand the lasting effects of the disease. Cities are crucial hubs for global economic and technological advancement, given their high population density. Even smaller-scale epidemics can result in significant loss of life, as seen in the devastating epidemics of 1918, 1957, and 1968 [30]. The COVID-19 pandemic has had profound economic and societal impacts, emphasizing the importance of ongoing research, preparedness, and mitigation strategies to address global infectious disease challenges [30, 31].

In addition to the essential elements of planning, adaptation, and design to enhance resilience on a larger scale, numerous studies have been conducted to evaluate the impact of various disasters in urban areas [32, 33]. The rapid urbanization, population growth, and extensive use of transportation systems have all contributed to increased rates of disease transmission in cities. It is worth noting that cities, which account for 80% of the world's Gross Domestic Product (GDP), bear significant responsibility for this heightened vulnerability, as highlighted in the World Bank Annual Report for 2019 [34]. A metropolis is essentially a large urban area that serves as the hub of regional or global trade, communication, and the core of a nation's or region's economic, political, and cultural activities. The term "metropolis" originates from Greek roots, where it referred to the "mother city" in the traditional sense—a city that attracted immigrants to establish colonies. Over time, its meaning expanded to include any significant and influential city within a nation, or any location recognized as the focal point of a specific activity. It is important to clarify that "metropolis" does not refer solely to large cities that are part of a larger urban conglomerate but rather to those with a distinct center or concentration [35, 36]. Meanwhile, the field of urban studies has historically focused on population density, a trend that emerged during the Industrial Revolution and has remained a key area of interest in the study of urban environments.

Cities, due to their high population density and busy nature, are vulnerable to the negative impacts of natural and man-made disasters. In response to this vulnerability, a significant amount of research has been conducted on the effects of various catastrophes on urban areas, as well as strategies for planning, recovery, and disaster management [37, 38]. Previous studies on epidemics in cities have mainly focused on the inequalities that make marginalized and economically disadvantaged groups more susceptible to disease outbreaks [39, 40]. Urban management faces unprecedented challenges in light of the COVID-19 pandemic, which has evolved from a health crisis to an economic and social crisis, exacerbating the vulnerability of specific demographic groups. The elderly, individuals in need of long-term care, those with precarious employment, the homeless, disabled individuals, migrants, undocumented migrants, and victims of domestic violence have all become more vulnerable. Additionally, independent contractors, small business owners, and employees in sectors like arts, culture, sports, and hospitality are now at risk of poverty due to income loss and job insecurity. Cities are struggling with budgetary constraints due to decreased local tax revenues and increased demand for welfare services and income support. The closure of local businesses, enterprises, and cultural institutions has led to a rise in unemployment, impacting cities connected to global value chains and those reliant on tourism.

Urban environments play a crucial role in influencing the dynamics of epidemics, a topic that has not been extensively studied in existing literature. The recent outbreak has highlighted various challenges that call for a more flexible approach to urban development [41, 42]. The high concentration of people in densely populated areas can potentially turn them into hotspots for the rapid spread of pandemics. Interestingly, the relationship between death rates and population density in the context of COVID-19 does not show a clear positive correlation, with studies indicating a relatively low mortality rate in densely populated regions [43]. Additionally, research in urbanized countries like the Netherlands [44] has found a negative correlation between density and pollution levels in densely populated areas. In specific cases, such as Wuhan, China, traffic congestion has worsened the impact of COVID-19. The traditional link between dispersion rates and population density has been disrupted by the changing dynamics of the pandemic. Interestingly, it has been

noted that dispersion rates are lower in highly populated areas [45, 46]. However, COVID-19 cases have been reported in densely populated regions like Beijing, Shenzhen, and Guangzhou [47]. Similarly, countries like Italy have seen higher transmission rates in densely populated areas [48–50]. This highlights the significant challenge of maintaining physical distancing in densely populated urban areas.

The large cities have struggled to enhance their urban responses to COVID-19 due to the loss of urban green infrastructure, which has been removed due to urban decline, gentrification, or urban sprawl. Urban spaces connected to urban ecosystem services have played a crucial role during and after COVID-19. Factors such as urban density, building proximity, transportation networks, ventilation systems, and air circulation in neighborhoods have determined the success or failure of cities in managing the pandemic [51, 52]. Urban walkability and connections between schools, housing estates, shopping centers, public buildings, and other important places have been linked to the increase in new cases and COVID-19 infected clusters. It is important for new strategies in urban planning and design to take into account the spatial and temporal influences of urban ecosystems during pandemics, with a greater emphasis on the benefits of urban ecosystem services [53–56].

The objective of this research is to thoroughly investigate and understand the diverse impacts of the COVID-19 pandemic on densely populated urban areas, specifically focusing on the city of Mashhad. When analyzing the effects of epidemics in urban settings, it is essential to consider various factors beyond population density [57–62]. These factors include the region's level of development, the adequacy of preventive and response measures, the state of public health infrastructure, the effectiveness of treatment protocols, and adherence to social distancing guidelines. The study aims to shed light on the unique challenges and crises that have emerged in densely populated urban areas, particularly in the global south, due to the pandemic. A significant research gap exists in the comprehensive exploration of the consequences of the COVID-19 pandemic in urban environments, considering not only disease transmission but also its broader socioeconomic, political, and cultural impacts. This study seeks to fill this gap by examining the specific events, crises, and challenges faced by Mashhad, a city with distinct characteristics such as being the second-largest pilgrimage destination globally and having a unique traditional city layout. The uncontrolled physical expansion of Mashhad has raised various concerns and issues during the COVID-19 outbreak, significantly impacting the well-being of its residents and emphasizing the urgent need for sustainable urban planning and development strategies to address the challenges posed by rapid growth under unprecedented hazards.

3 Study area

Mashhad, the capital of Iran's Khorasan Razavi province, is situated at an elevation of 985 m in the Kashaf River valley, near Turkmenistan. It is positioned at approximately 36°20′ north latitude and 59°35′ east longitude, as documented by the Municipality of Mashhad in 2012. This city, covering an expanse of 351 square kilometers and comprising 13 municipal districts, was home to 3 million residents in 2016. Mashhad holds the distinction of being Iran's second-largest city, following Tehran, and it once served as the nation's capital during the Afsharian era [63] (Fig. 1).

4 Methodology

In the initial round, a survey was distributed via email to 35 experts who were part of an independent panel to gather their insights on the key factors influencing the sustainable development of the border areas of Mashhad metropolitan economic, natural and physical, political and security, and social and cultural aspects. In the subsequent round, experts were requested to assign weights to 36 statements in a Delphi questionnaire matrix based on the variables identified in the first round. They utilized a 4-point Likert scale to evaluate the impact of each variable on the corresponding statement. In the final round, experts were tasked with assigning weights to 7 factors identified from the demographic profile of the experts, which included specialist planners, decision makers, local government managers, townhall managers, and professors in urban planning geography, regional security, and political geography. The expert panel was established using a non-probability snowball sampling method, with initial experts recommending additional participants. The Delphi panel comprised planning specialists and university professors specializing in regional development, sustainable security, and Mashhad Municipality. A total of 27 experts were invited to participate in the Delphi survey. Typically, 14–30 experts from a homogeneous population are deemed adequate to reach consensus in the Delphi process.

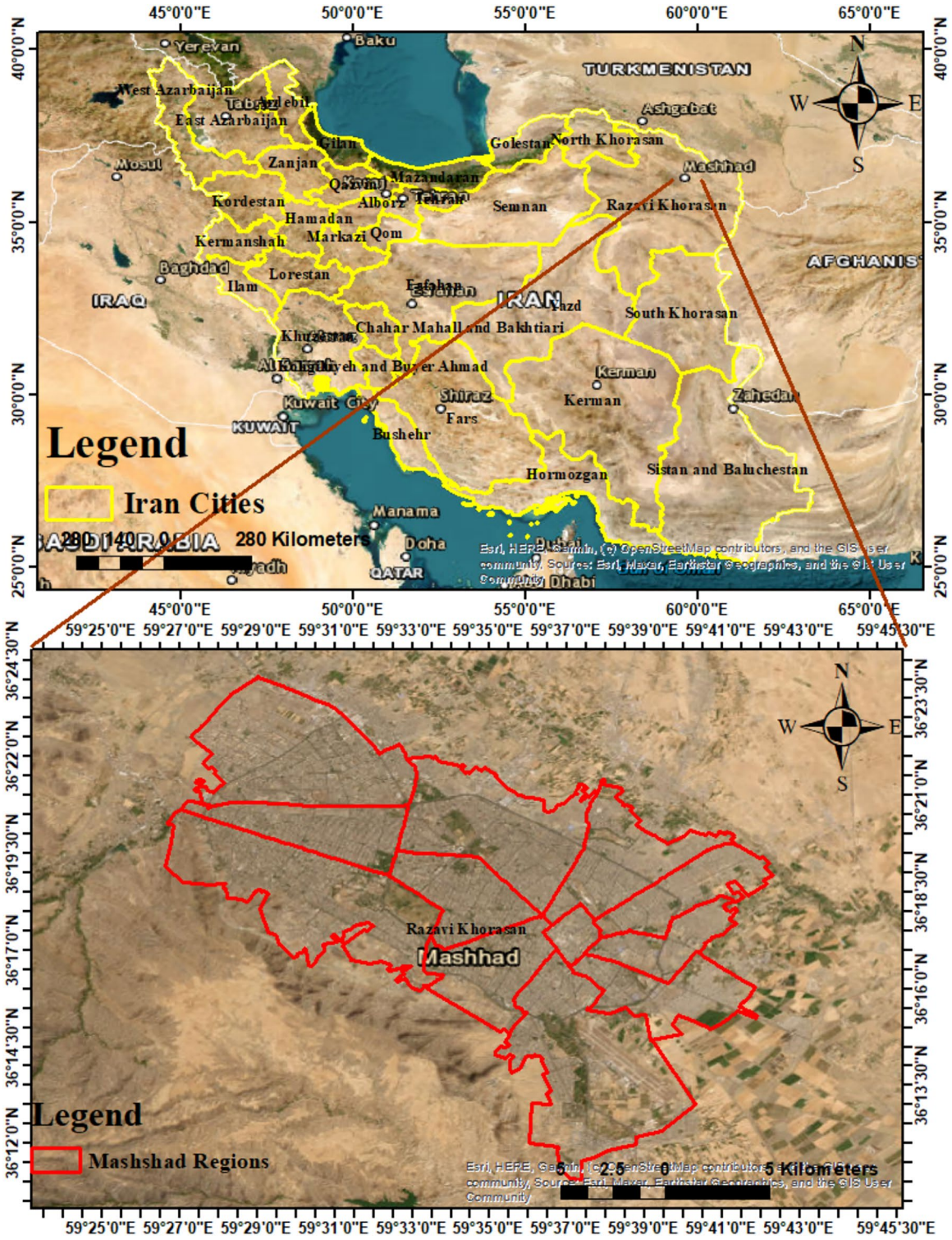

Fig. 1 Study area

The effectiveness of MicMac (Matrice d'Impacts Croisés Multiplication Appliquée à un Classement) analysis lies in its ability to handle complex, often imprecise interrelationships between various factors, particularly in the context of project delay factors and risk analysis [64]. It offers a valuable approach for evaluating the influence and dependencies among these factors, making it a robust tool for decision-making and problem-solving in diverse domains. In the specific context of project delay factors, the MicMac analysis provides a structured framework to assess influential and dependent

risk variables. This methodology aids in identifying critical risk factors and understanding their interplay, ultimately contributing to effective project management and risk mitigation [65, 66]. Beyond project management, MicMac analysis can also be employed in various fields such as supply chain modeling, where it helps uncover essential relationships and dependencies among different elements of the supply chain. This facilitates more efficient and responsive supply chain management.

Moreover, MicMac analysis can be utilized in the realm of dispute resolution, as exemplified by its application in collective bargaining processes. In this context, it serves as a tool to evaluate the effectiveness of mechanisms like collective bargaining in resolving disputes between employees and employer representatives [67, 68]. By identifying key factors and their interdependence, MicMac analysis can guide the negotiation process, leading to more effective conflict resolution. Briefly, the effectiveness of MicMac analysis stems from its capacity to navigate complex, interrelated factors, making it a versatile tool applicable to various domains, from project management to supply chain optimization and dispute resolution [69–72].

4.1 Stage 1: introduction and context

- Begin by introducing the importance of foresight in planning and its growing complexity of the COVID-19 outbreak in Mashahad as the second populated metropolitan in Iran
- COVID-19 outbreak highlight the need for software to facilitate foresight analysis and show what are the current and future changes.
- Emphasize the role of the MicMac program in scenario formulation and analysis for COVID-19 outbreak in Mashhad.

4.2 Stage 2: interaction analysis

- In a complex city like Mashhad, it is essential to gather data to illustrate the intricacies of the urban system. Therefore, interaction analysis is highlighted as a valuable qualitative method for assessing complex situations.
- This involves combining selected change drivers and factors in a detailed process. It is crucial to provide qualitative explanations of potential outcomes and utilize interaction analysis to identify conflicting concepts and make informed future assumptions. Additionally, distinguishing between leading trends and lagging drivers is important in this analysis.

4.3 Stage 3: utilizing MicMac

- Establish the significance of MicMac, especially in addressing the challenges presented by the COVID-19 pandemic.
- Cite the study by [73] to support MicMac 's effectiveness in handling pandemic-related challenges.
- Highlight that MicMac aids in defining the parameters of the study region.

4.4 Stage 4: identifying challenges during COVID-19

- Introduce the Delphi approach as the method for identifying challenges faced by metropolises during the COVID-19 pandemic.
- Mention the collection of 27 expert perspectives through a survey.
- Explain that 36 challenges were identified and categorized.
- Describe the categories, such as influential, key, regulatory, and others, based on the pandemic's impact on the city.

4.5 Stage 5: MicMac analysis

- Describe how professionals and specialists rated the impact of various variables on each other using a scale from 1 to 3.
- Explain that MicMac software analyzed the interactions, assigning values (e.g., zero for no influence, one for moderate effect, etc.).
- Mention that the software also assessed the penetration strength and level of reliance of each variable.
- Emphasize that this analysis was conducted after collecting the necessary data.

Table 1 Preliminary analysis of crossover effect matrix data

Indicator	Value
Matrix size	36
Number of iterations	2
Number of zeros	517
Number of ones	318
Number of twos	310
Number of threes	151
Number of P	0
Total	779
Fillrate	60/10802%

Table 2 Degree of utility and matrix optimization

Itération	Influence (%)	Dépendance (%)
1	100	99
2	99	100

By breaking down the methodology into these clear stages, it becomes easier to understand the logical progression of the research process.

5 Results and findings

Table 1 provides an overview of the system environment. In this analysis, the variable interaction repetition is considered twice, resulting in a matrix filling degree of 60.108%, indicating the extent of challenges encountered. Within this matrix, out of the 779 assessable relationships, 517 were assigned a zero, 318 received a one, 310 were assigned a two, and 151 were designated a three. Notably, the questionnaire exhibited a high level of validity and responses, attested by a 99% utility rate and the optimization of the statistical indicator matrix through two data rotations Table 2.

5.1 Evaluate the effectiveness and direct influence of variables

Utilizing the MicMac software, we conducted an assessment to determine the magnitude and degree of direct effects among various variables. The outcomes of this analysis, presented in Table 3, reveal valuable insights into the distribution of challenges across the system, indicating potential system instability. As a result of this analysis, five distinct categories of factors have emerged, namely affective, two-dimensional, regulatory, affective (repeated), and independent variables. To gain a comprehensive understanding of these variables and their impact, please refer to Table 3, which also provides information on the effect sizes associated with each.

Table 3 presents a detailed overview of different types of variables, their significance, and impact on the challenges. Figure 2 visually displays the spatial distribution of these challenges, showing distinct patterns. The northwest quadrant shows significant variations, highlighting the importance of controlling these variables due to their impact on system dynamics. This quadrant includes five challenges with bidirectional variables. The northeast quadrant contains seven challenges with similar characteristics. The center of the map represents regulatory variables, which can be transformed into bidirectional or efficient variables, with five challenges in this category. The southern region features affected variables that drive outcomes and influence system dynamics, with seven challenges in this category. The southwest corner includes independent variables, totaling 12 challenges, each playing a unique role in shaping the system's behavior. This breakdown provides a comprehensive understanding of variable types and their spatial organization, emphasizing their importance in addressing the challenges (Figs. 3 and 4).

The analysis in Table 4 provides a concise and insightful overview of the challenges faced by metropolises during the COVID-19 pandemic. By using the MICMAC program, the study carefully examines the direct and indirect influences of key

Table 3 The extent of direct impact and the type of challenges facing metropolises in the face of the COVID-19

Challenge	Short name	Influence	Dependence	T. I
Tax revenues and other government duties	Var01	366	237	Adjustment
Revenues from tourism and travelers	Var02	287	395	Impressive
Income from jobs	Var03	409	409	Two-sided
Prices of basic needs of citizens	Var04	388	201	Effective
Stock market crash	Var05	416	143	Effective
Stagnation of markets and trade	Var06	503	280	Effective
Domestic violence	Var07	79	237	Independent
Academic productivity	Var08	7	294	Impressive
Managing migrant groups with host communities	Var09	43	165	Independent
Management of cultural and religious sites	Var10	93	222	Independent
Management of recreational and sports facilities	Var11	122	265	Independent
Management of cultural ceremonies and customs	Var12	86	265	Independent
The presence of citizens in the electoral arenas	Var13	158	409	Impressive
The presence of citizens in political and national relations	Var14	165	460	Impressive
Tensions over political issues	Var15	524	445	Two-sided
International political relations of cities	Var16	186	345	Impressive
Providing administrative and educational services	Var17	287	294	Adjustment
Providing health services	Var18	258	330	Impressive
Lines of communication and vehicles	Var19	273	244	Adjustment
Digital infrastructure (broadband internet, telephone, computer, etc.)	Var20	424	294	Effective
Digital technology training	Var21	352	215	Adjustment
Epidemic control and management technologies	Var22	474	301	Two-sided
Manage and protect user information, cybercrime	Var23	71	129	Independent
Weaknesses in cooperation and participation between stakeholders (people, government and private sector)	Var24	460	460	Two-sided
Weakness of local governments in reducing poverty and inequality	Var25	567	373	Two-sided
Lack of facilities to detect people infected with the virus due to poor management of local governments	Var26	647	258	Effective
Sanitary equipment to combat the spread of the virus	Var27	481	301	Two-sided
Capacity of medical staff	Var28	222	172	Independent
Ability to access hospital and medical services	Var29	251	323	Impressive
Pollutants after the period of restrictions	Var30	71	201	Independent
People tend to be less densely populated and invade the environment	Var31	86	215	Independent
Soil and surface and groundwater pollution	Var32	158	115	Independent
Weak service delivery to poor areas	Var33	337	330	Adjustment
Weakness in providing services to crowded and public areas (active sales centers, public transport, etc.)	Var34	366	352	Two-sided
Lack of medical centers and hospitals	Var35	222	186	Independent
Lack of green spaces and recreation centers	Var36	143	115	Independent

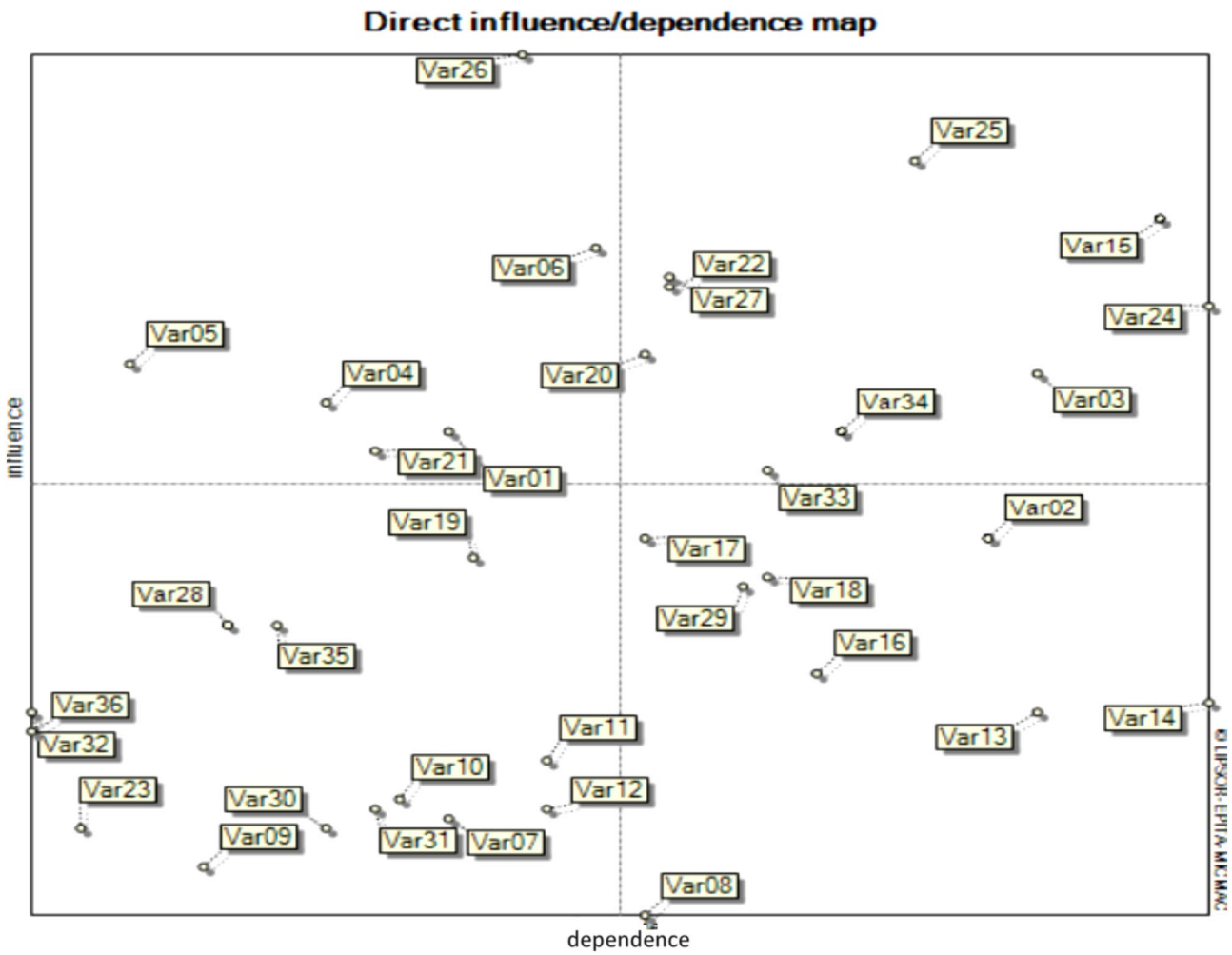

Fig. 2 Direct influence map

factors, offering a structured understanding of their importance. The table reveals a hierarchy of challenges, ranked by their influence scores, highlighting areas that require immediate attention. The most significant concern identified is the lack of diagnostic facilities for infected individuals, worsened by inadequate governmental management, as indicated by its high influence score of 647. Additionally, the table emphasizes systemic issues like government failures in poverty alleviation and the impact of political tensions, underscoring the complexity of the crisis. These findings not only shed light on the critical challenges but also provide a basis for informed decision-making and targeted interventions to address the diverse needs of metropolises dealing with the repercussions of COVID-19. While the table helps prioritize responses, it also emphasizes the interconnected nature of challenges, calling for holistic approaches that consider and address these interdependencies. Therefore, Table 4 serves as a reminder of the need for comprehensive and collaborative efforts to navigate the complex dynamics of the current crisis.

These key factors, both in their direct and indirect influences, provide valuable insights into the challenges faced by metropolises during the COVID-19 pandemic. They are ranked based on their significance, shedding light on the multifaceted dynamics of this global crisis.

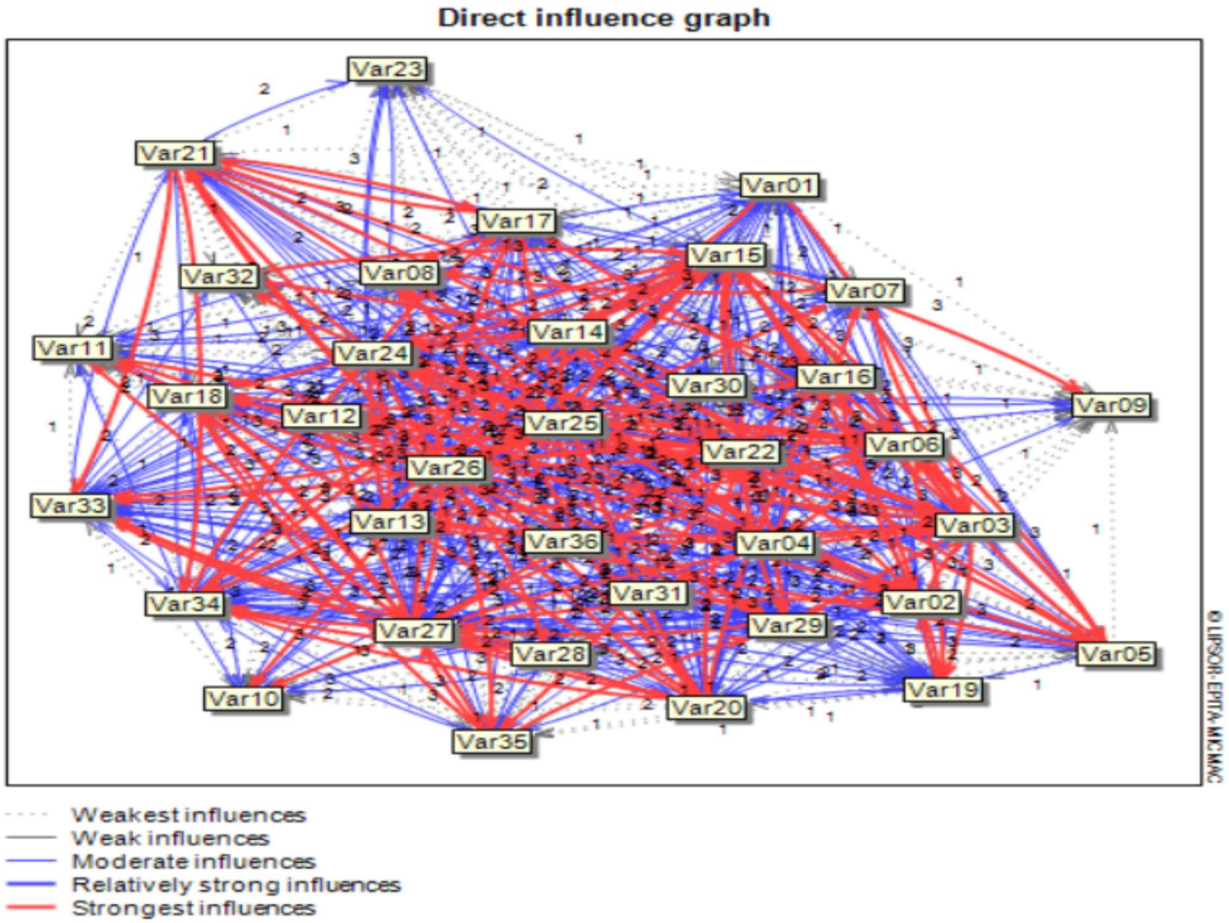

Fig. 3 Direct relationships between variables (very weak to very strong changes)

6 Discussion

The study's findings indicate that driving factors have the most substantial impact, both directly and indirectly, compared to other influencing factors. These factors present the main challenges faced by cities post-COVID-19, underscoring the urgent need for action. Socio-economic determinants [74], such as social class, income, and poverty levels, are crucial in shaping the effects of pandemics, a well-known and widely recognized phenomenon [75–78]. Iran's highly centralized decision-making system led to a lack of coordination and collaboration among different decision-makers and stakeholders. This centralized approach eroded public trust in the government and hindered the delegation of authority to other institutions and sectors. Notably, deficiencies in stakeholder participation and cooperation, involving the public, government, and private sector, were apparent. These shortcomings resulted in inadequate decision-making processes, limited collaboration among government bodies and sectors, and a lack of knowledge among urban managers in Mashhad. These issues posed a significant challenge, leading to errors in policy implementation and tool utilization. As a result, authorities in Mashhad faced significant hurdles in developing and implementing effective strategies to address and mitigate the various impacts of the COVID-19 pandemic. Previous studies mainly focused on the death toll and variations in mortality rates among different countries [79–84]. However, this study highlights the critical issue of "insufficient diagnostic facilities for identifying individuals with the virus due to ineffective governance at the local level." This lack of diagnostic resources hindered people from accessing accurate information, vaccinations, and essential support. Moreover, political considerations at multiple decision-making levels, spanning from the national to the subnational, have posed formidable challenges. These political dynamics have influenced the government's perception of individuals, both within and outside the nation. The prevalence of government-endorsed conspiracy theories in Iran, coupled with the politicization of COVID-19,

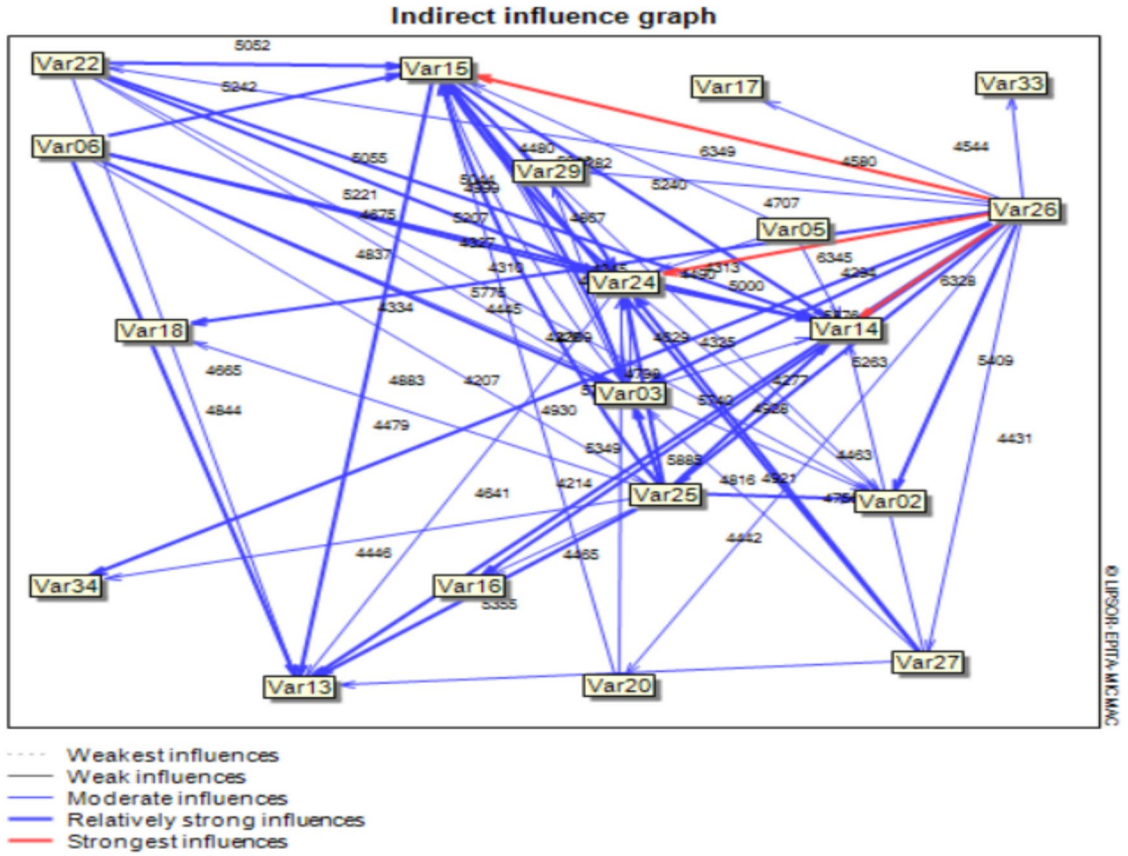

Fig. 4 Indirect relationships between variables (very weak to very strong changes)

has impeded the effective implementation of control measures. Notably, "tensions over political concerns" and "the involvement of citizens in political and national affairs" emerged as two prominent obstacles during this period. In sum, the study findings highlight the complex interplay of socio-economic, political, and administrative factors in shaping the challenges faced by metropolises during the COVID-19 pandemic. These insights underscore the critical importance of effective coordination, cooperation, and decision-making processes in managing and mitigating the multifaceted impacts of pandemics on urban centers like Mashhad.

7 Conclusion

In the years following its emergence, the coronavirus has evolved into a global pandemic, impacting diverse geographic regions with varying degrees of severity, adapting to the unique conditions and characteristics of each area. Metropolises, due to their distinctive circumstances and the increased density and connectivity among their residents, have emerged as significant epicenters of both the impact and transmission of this disease. To effectively manage this pandemic in urban settings, government officials and policymakers must develop a range of strategies tailored to the specific challenges faced by these dynamic urban centers. The city of Mashhad, with its robust economic ties and prominence as a hub for domestic and international religious tourism, has faced substantial security and economic challenges exacerbated by the presence of multiple coronavirus strains. These challenges have been further compounded by cross-sectional policies, ideological underpinnings, slow economic growth, and other contributing factors.

Field findings indicate that since the onset of the pandemic, Mashhad has grappled with several pressing security issues. These include a deficiency in diagnostic facilities due to inadequate local government management, the local government's limitations in addressing poverty and inequality, political tensions, stagnant markets and trade, limitations in epidemic control and management technologies, and deficiencies in cooperation and partnership among stakeholders, spanning individuals, government entities, and the private sector. Each of these challenges has had far-reaching

Table 4 Key factors (direct and indirect)

Rank	VAR (direct influence)	Score	VAR (indirect influence)	Score
1	Lack of facilities to diagnose people infected with the virus due to poor management of local governments	647	Lack of facilities to diagnose people infected with the virus due to poor management of local governments	604
2	Weakness of local governments in reducing poverty and inequality	567	Weakness of local governments in reducing poverty and inequality	547
3	Tensions over political issues	524	Tensions over political issues	499
4	Stagnation of markets and trade	503	Stagnation of markets and trade	496
5	Sanitary equipment to combat the spread of the virus	481	Epidemic control and management technologies	478
6	Epidemic control and management technologies	474	Weaknesses in cooperation and participation between stakeholders (people, government and private sector)	473
7	Weaknesses in cooperation and participation between stakeholders (people, government and private sector)	460	Sanitary equipment to combat the spread of the virus	455
8	Digital infrastructure (broadband internet, telephone, computer, etc.)	424	Income from jobs	411
9	Stock market crash	416	Stock market crash	408
10	Income from jobs	409	Digital infrastructure (broadband internet, telephone, computer, etc.)	400

consequences for the city's residents, making it increasingly challenging for them to sustain their livelihoods within the current urban environment. Consequently, there is a pressing need for the government to formulate policies and initiatives aimed at addressing these multifaceted challenges, ultimately improving the quality of life for Mashhad's inhabitants and bolstering the city's economy during times of crisis.

In this context, it is clear that urban governance and socioeconomic factors are key considerations in addressing the pandemic-related challenges in Mashhad. A significant issue is the breakdown in the urban planning system and a lack of awareness among urban managers and decision-makers. The city's vulnerability is exacerbated by a lack of preparedness for various threats, including pandemics and biological hazards. Additionally, environmental risks and climatic challenges have not been adequately addressed, highlighting the importance of proactive governance and preparedness. The COVID-19 pandemic serves as a reminder of the need for comprehensive planning and preparedness. To address these challenges, strong governance, socioeconomic interventions, and proactive urban planning are essential. Collaboration between government authorities and stakeholders is crucial to protect residents and enhance the city's resilience. This study contributes to understanding the impact of the COVID-19 pandemic on metropolitan areas and the importance of effective urban management. Future research should focus on mobilization policies during pandemics and urban design in densely populated developing countries to effectively address outbreaks. Developing countries need to prioritize outbreak response in urban development planning.

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Declarations

Ethics approval and consent to participate A. Ethical Approval: "The present study was approved by the Institutional Review Board of Ferdowsi University." b. Guidelines Followed Statement: "The study was performed in accordance with the Declaration of Helsinki guidelines."

Consent for publication Informed consent was obtained from all individual participants included in the study. Participants were informed about the purpose of the study, the procedures involved, and their rights to withdraw at any time without any consequences. Confidentiality and anonymity of the participants were maintained throughout the study.

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