KMAN PUBLISHING INSTITUTE
Journal Website

Article history:
Received 06June 2023
Accepted 25 August 2023
Published online 01 September 2023

International Journal of Innovation Management and Organizational Behavior

Volume 3, Issue 3, pp 203-211

IJIMOB International Journal of Innovation Management and Organizational Behavior

E-ISSN: 3041-8992

# Historical Trends in Smart City Governance for the Management of Ancient Urban Centers in Iran: A Case Study of Saqqez Municipality

Lucia. Nucci[1], Akbar. Heydari[2*], Najmedin. Gilani[3], Saleh. Aminpoor[4], Yang. Liu[5], Mehdi. Gheisari[5]

[1] Department of Architecture, Roma Tre University, Rome, Italy
[2] Institute of Artificial Intelligence, Shaoxing University, Shaoxing, China & Department of Geography & Urban Planning, Ferdowsi University of Mashhad, Mashhad, Iran
[3] Department of History, Ferdowsi University of Mashhad, Mashhad, Iran
[4] Department of History, Payam Noor University, Tehran, Iran
[5] Department of Computer Science and Technology, Harbin Institute of Technology, China

*** Corresponding author email address**: Heydariakbar@gmail.com

A r t i c l e  I n f o

**Article type:**
*Original Research*

**How to cite this article:**
Nucci, L., Heydari, A., Gilani, N., Aminpoor, S., Liu, Y., & Gheisari, M. (2023). Historical Trends in Smart City Governance for the Management of Ancient Urban Centers in Iran: A Case Study of Saqqez Municipality. *International Journal of Innovation Management and Organizational Behavior*, *3*(3), 203-211.
https://doi.org/10.61838/kman.ijimob.3.3.25



A B S T R A C T

**Objective:** This study aims to assess the risks and hazards associated with smart city governance in Saqqez Municipality, with a focus on identifying key threats across technological, organizational, and environmental dimensions.

**Methodology:** The research employed a quantitative approach, using a structured questionnaire distributed among experts within Saqqez Municipality. Data were analyzed using statistical methods, including structural equation modeling (SEM) to assess risk factors and their impacts across different dimensions of smart city governance.

**Findings:** The findings, derived from the CLA method, indicate that within the three dimensions analyzed, the organizational dimension of smart urban governance in Saqqez Municipality presents the most significant risks and threats. Within the technological dimension, artificial intelligence (0.85), pattern orientation (0.762), smart sensors (0.753), and cybersecurity (0.748) exhibited the highest factor loadings. In the organizational dimension, data preparation (0.754), electronic processes (0.817), and electronic communication (0.753) were identified as having the highest impact percentages.

**Conclusion:** The research concludes that comprehensive risk management strategies, including the integration of risk management organizations, establishment of a centralized data collection system, ongoing risk assessments, and recruitment of specialized professionals, are essential to enhance the safety, resilience, and sustainability of smart city initiatives in Saqqez Municipality.

**Keywords:** *Urban Governance, Smart Cities, Saqqez Municipality, CLA.*

## 1 Introduction

Globalization, urbanization, and industrialization have been identified as the three primary drivers of human civilization in the 21st century (Lee et al., 2014). The global urban population is projected to double, increasing from 2.6 billion in 2010 to 5.2 billion by 2050, at which point over 70% of the world's population will reside in urban areas (Lee & Yoon, 2022). This rapid population growth, coupled with structural inequalities and disparities in the provision of municipal services, is expected to lead to significant social and economic challenges (Lee et al., 2013; Neirotti et al., 2014). Furthermore, McKinsey & Company (2013) predict that urban areas will face numerous issues related to population density, competitiveness, and livelihoods. In response, central and regional governments globally have developed strategies to transform their cities into "smart cities" to address these challenges (Lee et al., 2014).

The concept of a "smart city," as described by Washburn et al. (2010), involves the use of information and communication technology (ICT) to enhance the efficiency and intelligence of urban infrastructure and services, including administration, education, healthcare, real estate, transportation, security, and public safety (Dewi & Jati, 2014). The term "smart city" has gained prominence in recent years, reflecting a global paradigm shift toward smarter materials, cities, management, and sustainability. A smart city, often referred to as a digital or informed city, integrates, analyzes, and senses critical data from core management systems to enhance urban functionality (Kummitha, 2020). It is characterized by its intelligent responses to various needs, such as industrial and commercial activities, daily interactions between residents and resources, public safety, environmental protection, and city services (Kummitha, 2020; Lee et al., 2014).

To support holistic city management, a smart city comprises smart residents, technologies, governance, transportation, infrastructure management, and other smart features. According to Su et al. (2011), smart cities are built upon three primary technological layers: application, network, and perception. These layers enhance the observability, quantifiability, and interoperability of smart cities, making them highly connected. The functionalities of smart cities include Wi-Fi connectivity, smart homes, smart transportation, smart public services, social management, smart urban management, smart healthcare, green initiatives, smart tourism, smart infrastructure, smart governance, smart policies, smart agriculture, smart education, smart economy, smart environment, smart industry, smart energy, and smart feedback mechanisms (Ahad et al., 2020; ul Hussnain et al., 2020; Ullah et al., 2021).

Yang et al. (2015) argue that organizations must assess their readiness for innovation, especially when implementing complex innovations such as smart cities. Suhono Supangkat emphasizes that successful smart city implementation requires not only adequate technical infrastructure but also well-coordinated governance and qualified personnel to manage and utilize the technology (Bhardwaj et al., 2022). Evaluating a complex innovation from a purely technological perspective is insufficient; organizational factors such as top management support, commitment, and the procedures for managing technological infrastructure are also crucial in the decision to adopt a complex innovation (Bhardwaj et al., 2022; Cofriyanti & Hidayanto, 2013).

By 2026, smart cities are projected to contribute $20 trillion to the global economy. Businesses are being incentivized to sponsor Smart City projects through green stimulus packages and measures that reduce financial risks while offering opportunities for additional revenue. Researchers argue that prioritizing urban infrastructure improvements is essential for the development of smart cities, as it lays the foundation for future solutions and services. They anticipate four key investment sectors to become increasingly prominent. Smart cities are described as resilient, inclusive cities created through collaborative efforts to enhance the quality of life for all citizens (Bhardwaj et al., 2022; Kourtit & Nijkamp, 2012).

According to Giffinger and Pichler-Milanović (2007), smart cities excel in six key areas: environment, economy, mobility, people, living, and governance. These cities emerge from knowledge-intensive, creative approaches aimed at improving socioeconomic, ecological, logistical, and competitive performance, relying on a combination of human, infrastructural, social, and entrepreneurial resources (Giffinger & Gudrun, 2010). Investments in human, infrastructural (environmental, organizational, transport, and ICT), and social capital support sustainable economic growth and a high standard of living through participation in governance and the prudent management of natural resources (Caragliu et al., 2011). In definitions where sustainability is not explicitly included as a strategic aim, a smart city is one that uses ICT to make essential infrastructure more interactive and efficient (Azkuna, 2012).



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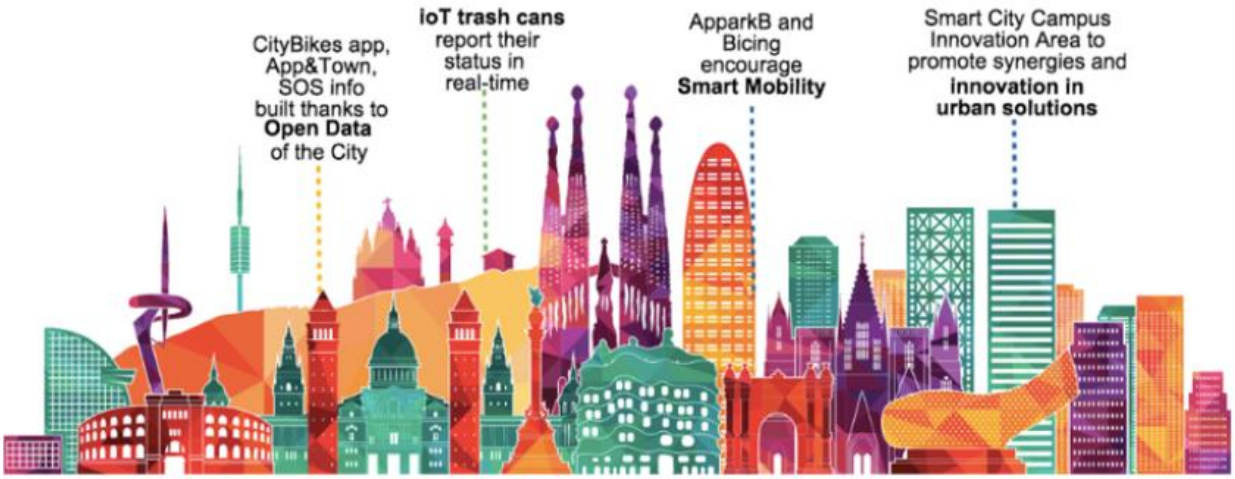
E-ISSN: 3041-8992

**Figure 1**

*The city of Barcelone is one of the most advanced in terms of smart city*




Smart cities aim to improve urban administration and services by fostering an innovative social environment, with the ultimate goal of enhancing the city's sustainability and livability (Toppeta, 2010). By integrating human capital and technology, smart cities can influence urban services, interactions among local actors, and overall quality of life, thereby enhancing the social aspects of urban environments (Heydari & Bakhtar, 2018; Heydari et al., 2018). Based on the discussions above, we define Sustainable Smart Cities following the Brundtland definition: A smart sustainable city meets the needs of its current residents without compromising the ability of future generations to meet their needs, while remaining within local or global environmental limits, facilitated by ICT (Khormian Tusi et al., 2019; Toppeta, 2010).

However, not all stakeholders and perspectives prioritize the concept of smart, sustainable cities. For some, the concept of a sustainable city alone is sufficient. From the perspective of the ICT sector, it might be argued that businesses focus on smart solutions, while sustainability lies outside their scope. Both viewpoints have merit, but from a comprehensive perspective, the concept of smart sustainable cities is necessary, as it bridges these views (Shayan et al., 2020).

Assessing internal readiness for smart city adoption can provide an overview of the local government's current state and serve as a guide for establishing the prerequisites for adopting the smart city concept. This assessment facilitates the smooth implementation of a smart city strategy or plan, addressing a variety of urban challenges. Globally, there is a growing trend toward using ICT platforms for public service reform, making e-government an essential tool for enhancing organizational efficiency. According to Coleman (2006), e-government can be defined as the integration of information-based electronic services with participatory elements. However, e-government is often conflated with e-governance, both of which describe the adoption of IT by organizations, whether public or private (Dwei et al., 2018).

While smart cities offer numerous advantages, they also present significant challenges that must be addressed. One critical issue is the need for public servants to facilitate extensive citizen participation. Effective smart city governance requires close cooperation between the private and public sectors and local communities, ensuring that all stakeholders can positively impact their neighborhoods. For smart city initiatives to be successful, they must be transparent and accessible to the public, ideally through platforms like mobile apps or open data websites. These platforms enable residents to interact with data, perform personal tasks such as bill payments, find efficient transportation options, and monitor household energy consumption (Poorahmad et al., 2018).



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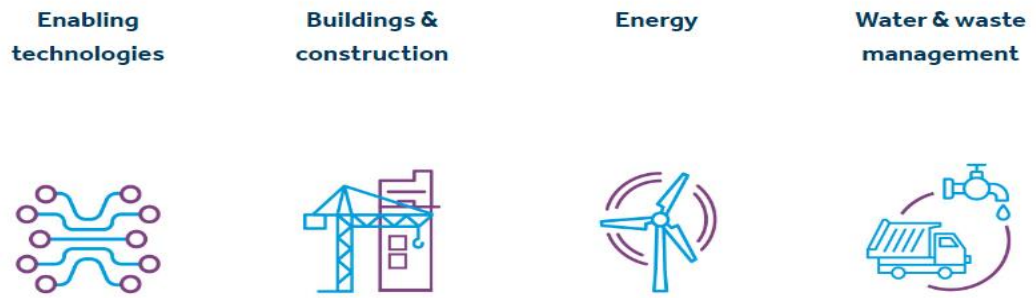
**Figure 2**

*Four infrastructure investment opportunities*




The implementation of smart city technologies demands a robust and secure method for data collection and storage to prevent hacking or misuse. Additionally, data generated by smart cities must be anonymized to address privacy concerns. Connectivity remains one of the most significant challenges, given the need for dozens, or even millions, of IoT devices to communicate and collaborate seamlessly. As demand increases, connectivity will facilitate the integration of services and continuous improvements.

Beyond technology, smart cities must consider social factors that contribute to a sense of community and belonging, particularly in newly developed cities that need to attract residents. Creating a strong cultural fabric is essential for fostering a sense of place among inhabitants (Gheisari & Esnaashari, 2017; Toppeta, 2010).

Comparing the findings of this research with recent studies in smart city governance reveals that this study contributes significantly to the existing body of knowledge. Various research groups have explored different aspects of smart city governance, with publications in reputable journals such as IEEE/ACM Transactions, Elsevier, Inderscience, Springer, and Taylor & Francis. These studies have provided valuable insights, and this research builds upon them by focusing specifically on the municipality of Saqqez. By analyzing the risks and threats to smart city governance in Saqqez and employing the Collective Leadership Approach (CLA), this study enhances the understanding of the challenges and opportunities within this context.

This study is motivated by the growing importance of smart city governance in addressing the challenges posed by urbanization. As the first reviewer suggested, it is essential to underscore the motivation behind this paper. The rapid growth of urban populations and the associated complexities necessitate innovative approaches to urban governance. This study aims to analyze the status of smart city governance in Saqqez Municipality, Iran, to identify the factors influencing governance and potential threats, thereby contributing to the development of effective and sustainable smart cities. The establishment of appropriate technical infrastructure in various urban areas has been a key factor in the success of technology development in Saqqez. The municipality, as a crucial component of urban management, plays a significant role in advancing urban intelligence. The successful implementation of smart city initiatives in Saqqez depends on organizational management functions, particularly the ability to leverage knowledge, people, culture, processes, and technology. Saqqez City is recognized as a pioneering city in Iran for urban intelligence, and its municipality faces significant challenges in technology, external environment, and risk management, which may impede the city's sustainable development planning.

While previous studies have explored smart city governance, this paper specifically focuses on Saqqez Municipality in Iran. By examining the implementation of the Collective Leadership Approach (CLA) in smart city governance, this study provides insights into the challenges and opportunities unique to Saqqez and contributes to the limited body of knowledge on smart city governance in this context. The research aims to address the shortcomings of conventional approaches to smart city governance. By clearly articulating the limitations of traditional methods, this study highlights the need for innovative solutions to effectively overcome these challenges. The proposed system



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E-ISSN: 3041-8992

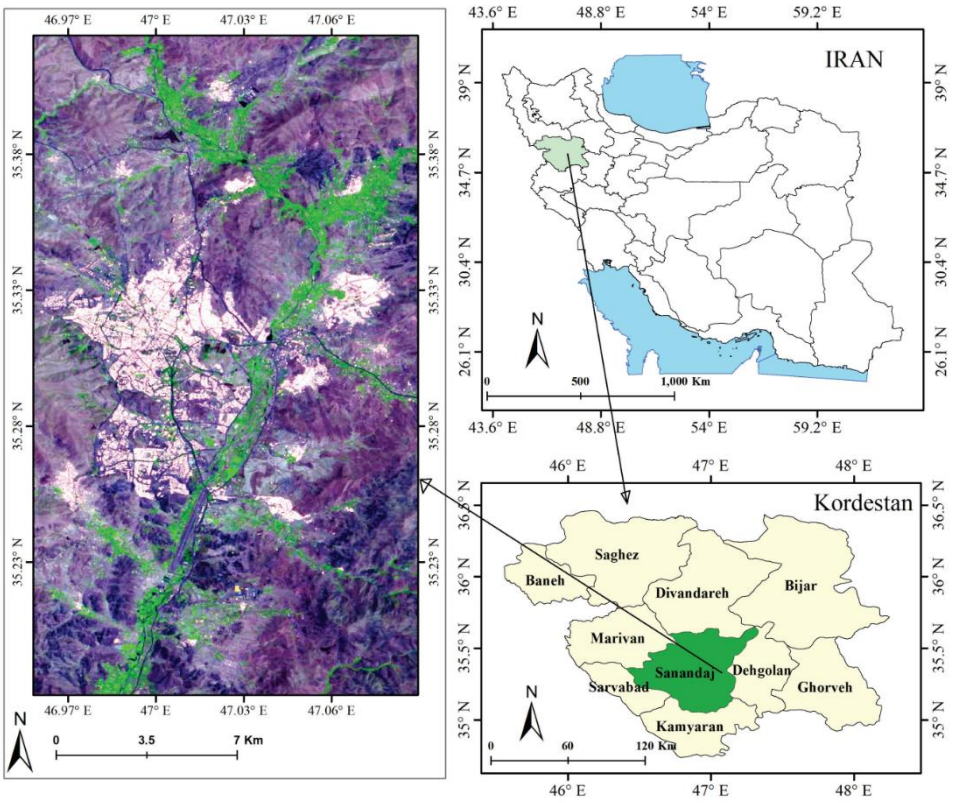
offers a novel and improved framework for smart city governance that is more efficient and sustainable.

The city of Saqqez spans approximately 1,474.8 hectares, located between 46°13′ and 46°16′ eastern longitude and 36°11′ and 36°15′ northern latitude in the northwest of Iran, within the Kurdistan province. According to the 2006 census, the city's population was 135,037, which has since grown to approximately 145,000. The constructed area covers 618.26 hectares, with an average elevation of around 1,496 meters above sea level. Saqqez is characterized by its mountainous terrain, part of the Zagros Mountain range extending from southeast to northwest. As the regional metropolis of Kurdistan, Saqqez holds significant geopolitical importance, sharing a 987 km common border with Iraq. The western border of Iran was established by the Goldsmith Plan in September 1871.

Over more than two decades, from 1976 to 2020, the urban population in Kurdish cities within Iran has experienced significant growth, with the urban population increasing fourfold compared to the rural population. The annual growth rate of the urban population has been 4.3%, while the rural population growth rate has been 1.3%. However, this urbanization has not resulted from the natural evolution of economic and social relations or from a necessity for national development. It cannot be considered an index or criterion of development, as it stems from the broader economic structure (Shafabakhsh et al., 2017).

**Figure 3**

*A View of Study area*




Kurdistan province is one of the least developed regions in Iran, though it is relatively more developed than neighboring Kurdish regions in other countries. Saqqez is the most important urban settlement in the border area, with the nearby town of Bane, located on the frontier, also holding particular significance. Despite efforts made after the Iranian Revolution to support underdeveloped areas, Kurdistan remains underdeveloped compared to other provinces in Iran.

Thus, the purpose of this study is to answer the following research questions:

- What are the main forces influencing the governance of smart cities in Saqqez Municipality?



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E-ISSN: 3041-8992

- What are the most significant threats to the adoption of CLA in Saqqez Municipality's smart city governance?

## 2 Methods and Materials

This study is applied research in its objective and adopts a descriptive-analytical approach regarding its nature. The research was conducted using a quantitative methodology. Indicators were gathered from various studies in the research process and presented to experts and professionals in Saqqez Municipality. These experts were asked to evaluate the accuracy and relevance of the indicators in the context of Saqqez Municipality. In the technological domain, indicators such as IoT and China Blockchain technology were excluded due to their absence in Saqqez Municipality. Similarly, digital records were omitted due to overlap with other indicators. In the environmental domain, indicators related to food security, national security, and heritage preservation were excluded as they fall outside the municipality's performance scope. Conversely, based on expert recommendations, service management and urban smart displays were added to the technology indicators, and waste management was added to the environmental indicators.

After finalizing the validity of the studied indicators, a quantitative questionnaire was developed, focusing on two dimensions: impact and the likelihood of risks, using a five-point Likert scale (1 to 5). The questionnaire was then distributed to the statistical population. Following data collection, the reliability of the questionnaires was assessed using Cronbach's alpha method, with the results presented in Table 1. The reliability scores for the technological, organizational, and environmental dimensions were 0.913, 0.922, and 0.875, respectively, indicating a high level of reliability for the instruments used.

## 3 Findings and Results

The proposed system offers several advantages, making it a promising approach for smart city governance. By leveraging advanced technologies such as artificial intelligence, pattern recognition, smart sensors, and cybersecurity, the system enhances the efficiency, intelligence, and overall performance of urban infrastructure and services. These technological advancements lead to improved administration, education, healthcare, transportation, security, and public safety, ultimately resulting in better decision-making processes and an enhanced quality of life for residents.

### *3.1 Descriptive Findings*

This study was conducted to identify the main risks and threats to smart urban governance in Saqqez Municipality. The sample included 55 experts and knowledgeable individuals from the study area. Among the participants, 23 individuals (41.8%) were classified as experts, representing the highest frequency within the study sample. These experts were drawn from various municipal departments, including Crisis Management, Fire Department, Services, and Environmental Safety. Regarding work experience within Saqqez Municipality, the maximum experience reported was 25 years, while the minimum was 2 years, with an average tenure of 9.13 years.

### *3.2 The Most Significant Threats*

To identify the most significant hazards and challenges to smart urban governance in Saqqez Municipality, the study employed a structural equation model (SEM) using the AMOS software. The maximum likelihood method was applied to analyze and identify the most critical risks and threats, as well as to assess the structural relationship between the dimensions of technology, organization, and environment within the study sample. Given the absence of established criteria and predictors, the study relied on expert recommendations to determine which indicators best evaluated the model.

Model fit was assessed using various indices, including the degree of freedom, significance level, Chi-square ratio to the degree of freedom, relative indices of root mean square estimation error, adaptive fit index, brevity coefficient index, and adaptive fit index. The results indicated that the model fit indices were within acceptable limits, demonstrating a good fit. The RMSEA index, a crucial indicator, was 0.077, within the confidence intervals of 0.068 to 0.085, indicating that the model was robust.

### *3.3 Technological Variables*

The study's findings on the risk levels and threats to smart urban governance in Saqqez Municipality highlighted the factor loads of key technological indicators. The artificial intelligence index, with a factor load of 0.79, and software, with a factor load of 0.768, were the highest. This suggests that traffic violations, security breaches, and software



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malfunctions are perceived by the study sample as the most critical factors influencing risks and threats to smart urban governance in Saqqez Municipality. The lowest factor load (0.497) was associated with indicators related to system failure, national security concerns, and anomalous social propaganda.

### *3.4 Organizational Indicators*

The impact of organizational factors on smart urban governance in Saqqez Municipality was analyzed by examining the factor weights of key organizational indicators. The electronic transaction index had the highest factor load at 0.820, followed by privacy at 0.760. This indicates that unauthorized access to transaction information, configuration management, the physical protection of government documents and reports, and encryption are viewed as significant organizational risks and threats to urban governance in Saqqez Municipality. Flexibility-related factors had the lowest factor load at 0.601.

### *3.5 Environmental Indicators*

The environmental indicators were also examined to assess their impact on smart urban governance in Saqqez Municipality. The public spaces index had the highest factor load at 0.798, followed closely by energy at 0.795. These findings suggest that disruptions in environmental sensors, security alarms, network issues, lighting systems in public spaces, electricity, and transportation are considered the most significant environmental risks and threats to smart urban governance in Saqqez Municipality.

## 4 Discussion and Conclusion

This study has quantitatively assessed the hazards and risks associated with the ongoing transformations in Saqqez's smart city initiatives, through the distribution and collection of questionnaires among professionals within the Saqqez Municipality. Although the development of a smart city significantly enhances the quality of life and offers numerous advantages, the findings underscore the importance of strategic interventions to mitigate risks or prevent their occurrence. The dynamic and heterogeneous environment of a connected smart city introduces the potential for significant entities to negatively impact the entire network. This study identifies complex conditions, such as traffic infractions, system malfunctions, and security breaches, as crucial technological elements that substantially influence risks and threats to smart urban governance in Saqqez.

In the organizational sector, electronic transactions and privacy concerns received the highest factor loadings, indicating their critical importance. The data reveal that the most pressing organizational risks to smart city governance in Saqqez include electronic transactions, confidentiality, electronic communication, information accuracy, and technical support. The study concludes that the Saqqez Municipality faces significant risks across the technological, organizational, and environmental dimensions. Given the current inadequacies in risk management planning, it is imperative to implement the risk management policies recommended by municipal managers and officials, particularly with regard to the organizational aspect, which presents the greatest risk.

Based on the hazards identified within Saqqez Municipality, the study proposes several recommendations to effectively manage these risks.

Firstly, the integration of risk management organizations is crucial to prevent the fragmentation of risk operations across technology, organizational, and urban environmental domains. It is recommended to unify various risk management entities, such as the Red Crescent, the fire department, and the crisis management organization. This integration will facilitate coordinated efforts and ensure a comprehensive approach to risk management.

Secondly, the establishment of a centralized data collection system is essential for effective risk management. A national crisis management center should be developed to collect and analyze data related to risk-prone areas, including the urban environment, technologies, and organizational structures. This centralized system will provide valuable insights for risk assessment and informed decision-making.

Additionally, ongoing risk assessment is critical. Regular and annual risk assessments should be conducted to continuously monitor and evaluate risks. This proactive approach will help identify potential hazards, mitigate risks, and enhance the performance of risk management practices across the domains of technology, organization, and environment.

The recruitment of risk management professionals is also vital. To strengthen risk management capabilities within Saqqez Municipality and its sub-organizations, it is important to attract and employ professionals specialized in risk management across technological, organizational, and environmental aspects. These experts will bring essential



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E-ISSN: 3041-8992

expertise and knowledge, enabling the municipality to effectively address and mitigate risks.

Furthermore, public awareness programs should be developed to educate the community on risk management and disaster preparedness. Implementing educational programs and workshops will increase public awareness and resilience, ensuring that citizens are better equipped to respond to emergencies.

Investment in smart infrastructure is another critical recommendation. By investing in smart technologies and infrastructure, Saqqez Municipality can improve its monitoring, response, and risk management capabilities. Advanced technologies, such as IoT sensors and AI, can enhance real-time risk detection, analysis, and response, contributing to more effective management of both current and emerging risks.

Finally, strengthening inter-agency collaboration is essential. Fostering collaboration and communication between different agencies and stakeholders involved in risk management will ensure efficient information sharing and coordinated efforts. Enhanced inter-agency collaboration will lead to more robust and integrated risk management strategies.

By implementing these comprehensive recommendations, Saqqez Municipality can significantly enhance its risk management practices, thereby improving safety and resilience in the face of potential hazards. These measures will not only address current risks but also prepare the municipality for future challenges, ensuring the successful development and sustainability of its smart city initiatives.

## Authors' Contributions

All authors have contributed significantly to the research process and the development of the manuscript.

## Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

## Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

## Acknowledgments

We would like to express our gratitude to all individuals helped us to do the project.

## Declaration of Interest

The authors report no conflict of interest.

## Funding

This research was conducted with the scientific and financial support of the Ministry of Economic Affairs and Finance.

## Ethical Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were observed.

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