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Article

Assessing the Efficiency of Smart Cities of COVID-19 Response Measures from a Comparative Perspective

Rania J. Qutieshat

Planning and Project Management Department, Al-Balqa Applied University, As-Salt P.O. Box 19117, Jordan; qutieshat@bau.edu.jo

Abstract: Most cities worldwide have witnessed major disruptions and imbalances resulting from the COVID-19 pandemic, which began in 2020, and its effects are still present now. This research aims to assess smart cities' response levels when exposed to a major health pandemic such as COVID-19 by following a methodology that focuses on qualitative research to identify the areas in which smart cities respond to the Pandemic. The research assumes that smart cities respond better to Pandemics, acknowledge their ability to sustain urban functions, and achieve the well-being of their residents. The research applied these domains to two cities in different development levels, Amman in Jordan, a developing country, and Chicago in the USA, a developed country, as two case studies and compared their response to COVID-19. The research interviewed 12 experts to validate the literature review assessment domains. This research aims to assess smart cities and identify the flexibility of responding to the Coronavirus pandemic that has stormed the world for three difficult years using mixed methodologies. The research used the descriptive analytical approach, using qualitative methods, such as interviews with experts, decision-makers, and those responsible for managing the crisis. Additionally, the research collects and analyzes statistics, data, and technical reports from different agencies for both cities. The researcher concludes that smart cities can respond effectively once significant cities are exposed to such a pandemic of spread and contagion. There are consequences related to the extreme use of technologies in smart cities, especially regarding violating privacy and increasing the digital divide between sectors of society, especially senior residents. More academic debate and research are needed on how smart cities are becoming moral and equitable for their citizens. Finally, the research developed recommendations based on the results concerning municipalities, government agencies, and the private sector.

Keywords: smart cities; COVID-19; epidemics; urban planning; pandemics responds; resilience

1. Introduction

On January 30, 2020, the WHO announced that COVID-19 had been declared at the highest alert level. The World Health Organization no longer classifies the COVID-19 pandemic as an ongoing public health emergency as of May 5, 2023. However, its impact on life remain significant and visible. "COVID changed the world and us," Ghebreyesus (WHO, 2022) said. "This is how things should be. If we go back to how things were before COVID-19, we will not have learned our lesson and will fail future generations." More than ever, emphasis is placed on reducing physical contact and achieving social distancing. Epidemics throughout the ages, such as cholera and the plague, have killed millions of people. The COVID-19 epidemic first appeared in Wuhan, China, in December 2019. More than 7 million people around the world have died due to the coronavirus pandemic.

The virus was first discovered in February 2020 in the United States. Thousands continue to suffer every day from the COVID-19 virus, which presents not only a health crisis but also a global predicament

that has affected all aspects of life. The critical issue lies in how conditions were defined in the past compared to today; these pandemics have occurred during an era known for vast data dissemination, a technological revolution, and advancements in artificial intelligence (Kuzior et al., 2022). In earlier times, urban environments lacked the robust economy and advanced digital technology available todayCook, D. (J., & Das, S. K., 2018). Moreover, the concept of cities shaped by shared and intersecting cultures has expanded beyond previous limits. (Abusaada, H., Elshater, 2020; Connolly et al., 2020). This situation arises from the contradiction between the world's understanding of smart technology's role in globalization and cultural diversity, considering the ongoing COVID-19 pandemic crisis.

A large proportion, up to 60% of the world's population, currently lives in cities. The high population density in cities, in general, greatly increases the risk of spreading infectious diseases.

(Kuzior, et al., 2022; Ezzati M et al., 2018; Neiderud CJ, 2015). In Jordan, the urbanization rate reaches 86% of the people. In contrast, four million people live in the capital, Amman alone, according to the 2018 statistics, with a rate of 42% of the population of Jordan(Greater Amman Municipality. ,2021). . In the USA, the city of Chicago exceeds the 15.46 million inhabitants (Chicago city,2020). Flexible and comprehensive health systems are the first defense against the danger of evolving and re-emerging diseases (Ezzati M et al., 2018).

For her part, Margaret Chan, the former Director-General of the World Health Organization (2020), believes that cities become healthier by introducing procedures that facilitate healthy eating and living a more active life and that cities become safer by reducing traffic accidents or air pollution, Frieden (2022) stresses that the outbreak of infectious diseases is no longer a possibility but rather a certainty for the future. Every country must develop the capacity to prevent, detect, and respond to disease threats. Given these dire conditions, studies indicate that large cities carry significant risks. To mitigate such vulnerabilities, we must leverage modern technologies and applications based on big data, the Internet of Things, and the concept of smart cities to alleviate the alarming impacts of dangerous epidemics that have emerged in recent years. (Hassankhani et al., 2021). On the other hand, countries classified as low- or middle-income, like Jordan, face challenges due to their residents' inability to endure the closure measures stemming from the COVID-19 virus (Cénat J. M.,2020).

After the World Health Organization announced that COVID-19 represented a pandemic in 2020, the response of countries in the world to the epidemic disaster differed according to the differences between countries concerning levels of development, mobilization of local resources, and governance capabilities at the national level (Capano G., 2020), which led to different results on the public health of each country (Serikbayeva B. et al., 2021). In return, there were few studies at the local and city levels in which interest has increased recently. Since the COVID-19 Pandemic, there has been a continual emphasis on the prominence of smart cities (Afrin et al., 2021; Harris et al., 2022; Sharifi et al., 2021); the role of smart cities cannot be ignored in times of Pandemic. Considering the fourth technological revolution (ICT), today's world is heading towards smart cities (Alkhaffaf, M., Almomani, H., 2021). Epidemics are considered dangerous because they constitute an unusual situation. Public health services such as hospitals may collapse due to their inability to accommodate the increased demand, which means massive loss of life. These difficult situations can be dealt with through advanced technology, which was made possible by the Fourth Industrial Revolution, which used huge amounts of data and allowed it to be exchanged easily. By automating it and creating smart applications to combat an unusual situation such as COVID-19(Allam, Z., & Jones, D. S., 2019), where social distancing plays an important role, the workforce can be replaced with automated devices and electronic systems that can monitor, sterilize, and prescribe medications (Palwe, S., Sirsikar, S., 2021). These cities have excellent capabilities based on big data, the Internet of Things, intelligent applications, concepts of sustainability, and accessibility for the population; hence, the critical question arises: "Can Smart Cities, utilizing their tools and policies, respond intelligently if these large human populations are exposed to the spread of highly contagious viruses such as the Coronavirus?

The Municipality of Amman and the City of Chicago are identified as entities tasked with administrating their respective cities and the welfare of their residents. However, the city administration in Amman has struggled to manage the pandemic response efficiently, placing the Ministry of Health and the Jordanian Crisis Center at the forefront of crisis management efforts. In contrast, various governmental and local authorities in Chicago assume responsibility for similar challenges. Consequently, this situation raises pertinent questions regarding the degree of coordination among the municipality, government, and private sector. What tools and methodologies enable effective management of epidemics, and does the city possess spatial and descriptive databases that could assist the Jordanian Crisis Center in navigating a severe crisis, such as the spread of the Coronavirus? Furthermore, what roles do the municipalities of Amman and Chicago, along with their respective government institutions and ministries, play in addressing this crisis? Was there a coordinated effort and a unified plan in place? Do the municipalities and the Ministry of Health in both cities have access to

spatial databases that facilitate easy identification and support for individuals who are highly vulnerable to the virus?

Developed countries produce the term smart city within the context of exploiting the efficiency of digital technologies in managing urban challenges (José R et al., 2024). On the other hand, developing countries consider the concept of smart cities important (Cénat J. M., 2020). Unfortunately, there is a reservation that developing countries import the model of Smart Cities without making appropriate adjustments to fit their cities. Regarding the Covid pandemic, Hassankhani et al. (2021) pointed out that the response of smart cities with their digital technologies was positive, such as accelerating public services and digitization of the public sector (Hassankhani et al., 2021) and city monitoring and data-driven response (James et al., 2020). Others, such as Kogurlu (2021) and Glacimir and Nebelo (2019), have criticized smart cities regarding whether they perform a superior role compared to traditional cities during the pandemic. According to the literature, the smart city has six dimensions: smart governance, smart Society, smart economy, smart living, smart environment, and smart people (Sharifi A. et al.,2021). This research will focus on smart governance concerning policymaking, delivering public services, fostering innovation and creativity in technology use, and enhancing smart living in sectors such as education, health, transportation, and housing, all of which contribute to crisis management. Cities still have limited experience in understanding how smart city strategies and policies can impact the effectiveness of responses to the Coronavirus, the most dangerous epidemic humanity has faced in the twenty-first century. Performance indicators for the COVID-19 response can be formulated. These indicators include several variables: per capita deaths, per capita cases, per capita recoveries, and per capita vaccinations (Sharifi A. et al.,2021;2020). After declaring the end of the pandemic, studies gain credibility because they rely on a completed status. The ability to understand and interpret the circumstances surrounding it has become clearer for evaluation and research. The research highlights resilience at the local level, and the response to pandemics has proven significant at this level (Batty, M., 2020). Furthermore, most studies are performed at national or country levels. There is a lack of specialized comparative studies on how smart cities respond to the coronavirus. Cities are now complex systems that need various mechanisms to manage the concentration of population and activities, particularly during pandemics (United Nations Human Settlements Programme, 2021).In light of the preceding discussion, the research elucidates the following inquiries: In what manner can Smart City infrastructure be utilized to enhance the response to pandemics? Have smart cities effectively addressed the pandemic in a manner that safeguards the lives and well-being of their citizens across the domains identified in the scholarly literature? How has technology been deployed within smart cities to foster transparency, community engagement, and social cohesion? How has technology been harnessed within smart cities to ensure citizens' physical and mental health during the COVID-19 pandemic? How has technology influenced education and urban activities in smart cities? How are Amman and Chicago adapting to COVID-19 with their capabilities? What tools are being used to manage the pandemic? Are there disparities in responses between developing and developed cities?

2. Literature Review and Conceptual Framework

Tom Frieden (ama-assn. org, 2023), former director of the Centers for Disease Control and Prevention in the United States, assures that every country must be able to prevent, detect, and respond to disease threats. In the field of epidemic prevention, Frieden (ama-assn. org, 2023) identified four foundations from surveillance systems, laboratories, trained epidemic agents, and rapid response teams. Friedenama-assn.org, 2023) stresses the importance of the public health sector, which has had the most significant credit for improving human health over the last 100 years. On the other hand, Dr.Lawrence Carmichael, president of the WHO Collaborating Center for a Healthy Urban Environment, urban health is determined not only by the reality of the environment or the effectiveness of resource management but also by the way individuals and groups use their city, buildings, streets, and neighborhoods (World Health Organization, 2023) . Economic and political factors like migration and population aging can affect health and well-being. Hence, Dr. David Ladlo, a university professor and lecturer on smart European cities (smartcitiesdive.com, 2023), declared that "The environment in which we live, work, and spend our free time has a tremendous impact on our health, where health problems such as obesity, chronic heart disease, stress, and mental health issues are linked to urban environments, which requires effective proactive planning Margaret Chan (2021). Healthy cities are a term used in public health and city design. According to the World Bank (2023), there are three categories to judge urban sustainability: elements of daily life such as clean air, water, and green spaces. Greenhouse gas emissions. Resilience to natural disasters and extreme weather events.

Does the Coronavirus concern us? Yes, it does. The Pandemic has proven that urban planning is no less important than treatment. Allam and Jones (2020). It was found that the outbreak of the virus in the urban environment calls for an effective data system and the speed of its dissemination. The experts

emphasized the importance of utilizing the advent of digital technologies and the plethora of Internet of Things (IoT) devices it brings towards building a broad and standardized multi-sector urban database that helps in advancing efficiency, productivity, and processes in the provision of responsive healthcare services (Alshurideh, M. et al., 2021). Allam et al. (2019) addressed the importance of big data, which forms one of the pillars of smart cities that will help pursue more contextualized, resilient, and sustainable Smart Cities that render more livable urban fabrics. Lii Inn (2020) explored how smart city technologies can contribute to taking on epidemics. He discussed the case of COVID-19 and presented some successful examples of utilizing smart technologies to control the spread of disease and enhancing the health efficiency caring system through informing decisions and responsive policies. He emphasized that the efficiency of smart cities is related to the availability of resources and citizens' needs; therefore, it becomes important to detect what may be available in local contexts to probable logical alternatives. Pratama, A. B. et al. (2023) studied the impact of the urban management of smart cities in developing countries in dealing with the COVID-19 pandemic using data from 75 Indonesian cities. This study found that smart city status has no statistically significant effect on the COVID-19 performance index. Pramanika et al. (2017) argue that combining big data and smart systems can accelerate the healthcare industry. They proposed a framework for a big data-enabled smart healthcare system that offers theoretical illustrations of an intro and inter-organizational business model in the healthcare context. They addressed the importance of smart city systems and big data in healthcare. In Addition, Anisetti et al. (2018) addressed the advantages of employing Big Data Analysis as a service for innovative public health policies in smart cities to help improve Society's welfare. They argue that big data permits obtaining timely responses, allowing frequent interactions with policymakers, and executing several data mining tasks to support the automatic monitoring and evaluation of a given evidence-based policy. Smart cities use big data, which many studies have stated provides a new approach to disaster management and contributes to forecasting, analyzing, and visualizing their data) (Yu, M. et al. ,2018; Abdulla, M.F et al, 2017; Rahman, S.H. et al, 2017). On the other hand, Solanas et al. (2014) introduce the concept of smart health, which is the context-aware complement of mobile health within smart cities. In doing so, they indicated the main aspects of knowledge that are involved in the procedure of building this new concept. Trenche G. and Karvonen (2019) call for shifting the emphasis of smart cities to center on societies. Accordingly, Giles-Corti, B. et al. (2016) investigated the relationship between city planning and disease prevention. They argued that city planning presents a key solution in the face of the global health challenges confronting world societies, considering models that reduce non-communicable diseases and road trauma while also managing rapid urbanization. Ramaswami, A. et al. (2016) linked innovations in the data sciences to advance human well-being and sustainability on a highly urbanized planet. They emphasized that smart initiatives must move beyond city-level data to a higher-order understanding of cities as transboundary, multi-sectoral, multi-scalar, social-ecological-infrastructural systems with diverse actors, priorities, and solutions. Füller (2016) addressed how technologies and laws can be utilized to control pandemic infections nationally and globally. He detailed refined bio-politics, where longstanding mechanisms of social exclusion combined with enhanced forms of social control through architectural, ideological, and intelligence-gathering processes. In another study, Silvaa G. et al. (2016) assessed technologies for monitoring and combating Infection vectors, particularly Aedes mosquitoes. They proposed a solution based on the technologies that have been used, gathering them and using the smart cities concept. Combining these artifacts based on the smart cities approach helps indicate a better infection control solution. Hence, Bigon (2016) addressed the role of different ideologies of planning policies and practices in controlling pandemics. Smart cities include three elements: people, governance, and technology (Figure 1). Siddharth Chandra et al. (2013) addressed the role of geographic variables, particularly population density, in the study of epidemics, trying to estimate the threshold level of population density based on population loss during an influenza pandemic. Daneshpour (2020) calls for a new kind of more responsive urban planning. He also believes that the world needs to revisit local regulations and radically change the political economy of societies to adopt a modified urban and regional planning system that addresses pandemics as part of the planning challenges.

Figure 1. Smart City Response and Recovery from Pandemics (Source): Adapted from The article Siddharth Chandra et al. (2013).

Furthermore, he argues that we need to make changes in our cities before reopening them after the end of the current Pandemic. A Lesson Learned from this crisis in terms of urban planning is "that 'urban hardship' is not only related to climate change and natural disasters but also to viral viruses penetrating and harming human bodies. Accordingly, El-Kholei (2019) discussed how smart cities can respond to hazards and disasters resiliently. He agreed that city planners' capabilities can improve when moving from traditional cities to smart cities. Their plans can enhance the resilience of the city. Weiss et al. (2007) explored methods to study neighborhoods to understand their effects on public health better. They argue that neighborhoods must be identified and outlined in such a way as to optimize the quality and availability of data from each available source. Hence, Freudenberg et al. (2005) called for identifying opportunities for intervention moving beyond describing the health-related characteristics of citizens. (Figure 2).

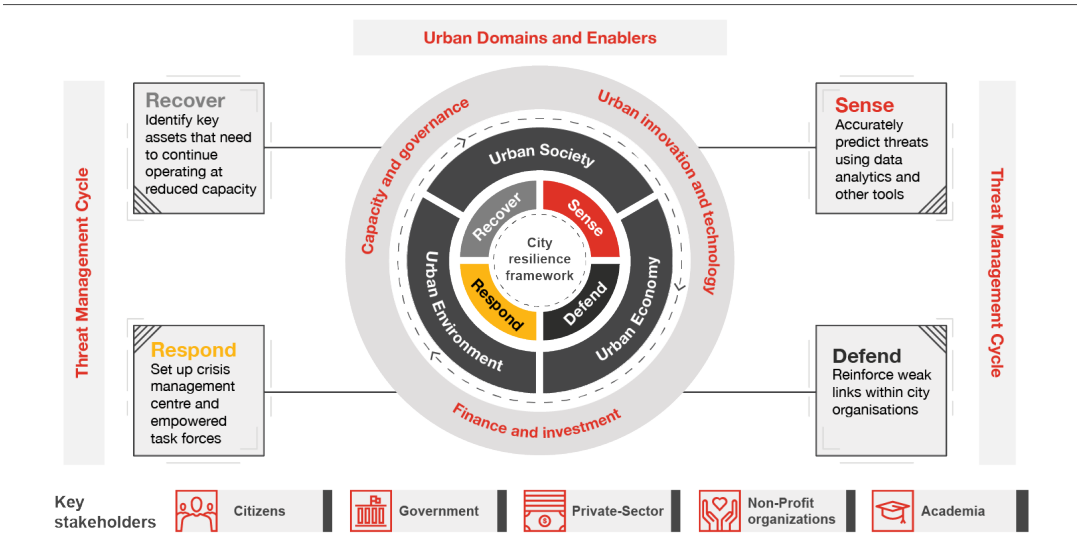

Figure 2. City Resilience Framework. Source: Adapted from the article: Caiaffa, W. et al. (2013).

In another study, Caiaffa W. et al. (2013) developed an abstract framework of urban health for integrating research and evidence into urban policy for health and health justice. They highlighted the importance of integrating health with information linked to geographic, socio-demographic, and environmental data to evaluate health (Urban Health Plan, 2023). Additionally, Boulos and Al-Shorbaji (2014) debate the application of the Internet of Things (IoT) for the cities of Barcelona in implementing its own IoT-driven services to improve the quality of life of its Society. They emphasized the importance of having robust, intelligent geospatial analytics systems to process and make sense of such data in real-time. Consequently, Obinikpo and Kantarci (2017) addressed the integration of smart connected health systems with smart city services. In doing so, they reviewed deep learning techniques that apply to sensed data to expand forecasts and enhance decision-making. While Be'dard et al. (2003) emphasized the

necessity to integrate GIS components and spatial data with knowledge discovery technology for environmental health decision support (Esri, 2023). One of the biggest drawbacks of artificial intelligence and its applications in smart cities is that it may violate privacy. Al-Azzawi and others (2021) predicted the outbreak of COVID-19 seven days before the authorities were officially notified by analyzing Twitter data.

Many studies, such as the study (Asmorati et al., 2021), have agreed on the necessity of Coordination between the different levels of government, from the national to the regional and local levels, at the city level and at the neighborhood level, in efforts to combat the virus. According to Moon (2020), Korea's experience represents a success in quickly responding to efforts to combat the virus. Despite the availability of speed, flexibility, transparency, and popular participation in government policies

Governments often use different interventions and measures to respond to public problems (Neiderud CJ., 2015). Policy mix theory provides more specific information about the government's efforts to overcome the health crisis caused by the COVID-19 pandemic (American Medical Association., 2023). Policy mix combines policy instruments or instruments through which governments achieve policy objectives (Sewerin et al., 2022). Other labels offered by policy scientists also appear in the literature, such as "policy packages" (Milkman et al., 2012) or "policy packages" (Givoni et al., 2013). In the case of COVID-19, Goyal and Howlett (2021) comparatively examine and describe variations in policy responses. Their topic modeling technique runs on 13,000 policy documents worldwide, systematically comparing the mix of COVID-19 policies taken by 190 countries worldwide. The theme model showed that 16 core responses were categorized as the main instruments of the COVID-19 crisis policy mix, as shown in (Table 1) (Goyal and Howlett, 2021, p. 253). Strict policy instruments, such as curfews and lockdowns, border controls, quarantine mandates, and business regulations, dominate the overall policy mix. The policy mixes also included a variety of other tools such as information management measures, guidance and warnings, government services management, and the provision of testing ("track and trace") and treatment (N. Liao and M. Nawaz,2024).

Sewerin S. et al. (2022) talked about different measures to respond to crises, represented by the theory of the mix of policies adopted by the government to overcome health disasters such as the Corona pandemic. Others, such as Goyal and Holt (2021), collected 13,000 documents from 190 countries in the world related to the policies that were followed by governments during the Covid-19 pandemic, analyzed and classified into 16 responses, represent the main tools that have been relied upon to combat the Pandemic around the world, according to Table 1 and the relationship of each response to the concept of smart cities. A study by Yang and Jung Z.(2021) found that increasing the volume of investment in smart city projects improved the response to the COVID-19 pandemic in some Chinese cities. In contrast, we find countries such as Italy considered a bad example and were among the European countries most exposed to the epidemic (Capano G. et al., 2020; Connolly, C.et al., 2020) as the study indicated the poor design and arrangement of state institutional policies, and this appeared to a lesser extent in Canada and Sweden, and in the United States of America, where the federal system prevails. Clark E. et al. (2021) indicated that the response to the COVID-19 disaster was not at the required level, and in general, several studies found that increasing investment in Smart city infrastructure can enhance the flexibility of these cities and their ability to plan. However, it is not necessarily linked to their performance during the Pandemic (Sharifi A. et al., 2021).

By searching the citation articles of the Web of Science (WOS) database in April 2023 using capability and vulnerability, more than 14 thousand results were found. These words are directly related to the scientific literature on health disasters, which have occurred in the year with a high frequency during previous years. The United Nations Office aims (UNISDR) to enhance capabilities to reduce disaster risks (M. Hagelsteen et al, 2013). Although there are differences in views around the world regarding the definition of disaster management capacity, they agree that it is the strength of flexibility in institutional, financial, and technical leadership that stakeholders need to implement emergency measures, which are greatly affected by potential risks and uncertainties (Houdijk, R. 2010). Disaster preparedness can be improved by including capabilities in public health emergency response (T. Avin (2011); (2012) proposed an ACU framework that links Assessment of events, Consequences, and Uncertainties that are key to increasing the capacity to respond to public health disasters. Hudek (2010) believes capacity represents potential factors that may positively affect crisis response. Under the United Nations Development Program for Disaster Reduction (DPDR), the capacity-focused assessment and resilience analytical tool have become a standard approach in disaster detection, including its use in the public health sector (Jahanmehr N., et al.,2015; American Health Organization 2011; World Health Organization (WHO). 2007).

B. Aguirre (2020); T. Eric T., (2013); Z. Liu, R. Ma and H. Wang (2021) built the assessment using a vulnerability and capacity framework to explore regional resilience in the context of public health disasters and develop corresponding risk mitigation strategies. Therefore, capacity analysis aims to know

which aspects are most vulnerable to risks and the main factors affecting vulnerability (World Health Organization, 2023). These results can be effective in making decisions and developing strategies to reduce risks and mitigate the devastating effects of disasters. Therefore, combining the two concepts has become common in risk management. Flexibility and the ability to find solutions include continuity and identifying weak points. It is also possible to quantitatively analyze safety threats in public health disasters. Rufat S. et al. (2015) focused on identifying the factors that affected the ability to confront risks and identified that the demographic, social, economic, and health situations are considered basic factors and drivers of weakness or strength. The National University of Colombia (2005) developed indicators for managing different types of disaster risks and applied them to several geographical regions

3. Research Methodology

This research seeks to understand the contexts and factors that influenced the response of the cities of Amman and Chicago to the COVID-19 pandemic by delving into the mechanisms and technologies of smart cities and how they can be used to increase cities' resilience and ability to respond within different cultural and governance contexts between cities in the developed world and cities in the developing world. The results of these case studies can also be used to enhance the efficiency of cities in the future. This research is considered exploratory and comparative because it examines a relatively new topic related to how smart city technologies and tools respond to the coronavirus pandemic by comparing two smart cities in two different societies. The research identifies two cases classified in the IMD index as smart cities (IMD, 2023). Chicago, located in Illinois (IL) (Chicago. gov, 2024) in the United States of America, is a metropolitan city of three million people in a country classified among the world's developed countries. Amman in Jordan is also a metropolitan city of 4.5 million people in a country classified among the developing countries. The case study strategy involved an in-depth examination of the procedures implemented in response to the COVID-19 pandemic in Amman and Chicago. This analysis included various aspects and assessed both cities' challenges in their pandemic responses. The two cities were also compared regarding their methodologies for response mechanisms, governance, and outcomes related to the COVID-19 pandemic. These initiatives are not necessarily the best in the world, but they are evidence of the changes in these cities because of the social and economic response to the COVID-19. The research was conducted in 2024, after the end of the COVID-19 pandemic. It is considered cross-sectional because it dealt with secondary and primary data collected during the pandemic, i.e., 2020-2022.

3.1. Sample Selection Strategy

The research used the intended sample by selecting Amman and Chicago as two case studies from different communities. Amman, the capital of Jordan, has a diverse geographical, social, economic, and cultural environment different from Chicago. Despite both cities being classified as Smart Cities. The research also included interviews from 12 experts specializing in urban planning, smart cities, crisis management, and health pandemics, including academics, managers, decision-makers, and consultants from the two countries' public and private sectors. The interviews aimed to identify key axes for the study area in both cities based on previous studies and to verify these selections through existing literature. Additionally, it examines the main challenges facing the two cities in responding to the pandemic as smart cities.

3.2. Data Collection Methods

The research gathered secondary data from documents such as government reports, policy documents, and academic articles discussing smart city projects and pandemic responses in cities, especially for Amman and Chicago, during this period. The research reviewed news articles and press releases to identify public communication strategies during the pandemic. Additionally, the research utilized publicly available information on COVID-19 vaccination rates, case numbers, and resource allocation. Then, through interviews with experts, they possess qualitative insights into the response to the COVID-19 pandemic, including the challenges addressed and how they were managed using smart city technology, mechanisms, and principles. The researcher used this to validate the four domains of the study and analyze the documents of the two case studies.

3.3. Data Analysis Techniques

Previous studies identified the most important domains to research in each city. Researchers have referenced these domains in earlier case studies or to identify disaster response methodologies, ensuring that the axes selected for this research have documented references, as shown in Table 1. Content analysis

uncovers patterns and trends by examining textual data, including policy documents and media reports. Qualitative methods, including content analysis (Du & Tan, 2022), interviews (Yan & Cao, 2022), and qualitative comparative analysis (QCA) (Mena et al., 2022; Shi et al., 2022), were applied to determine the factors affecting urban resilience. he researcher verified the data obtained from secondary resources through specialized Interviews conducted with 12 experts, including urban planners, municipal officials, academics, and government representatives involved in the planning and implementing smart city initiatives. A list of experts was prepared, and they were contacted by phone. The purpose of the interviews was to provide an overview of the research and obtain their consent while ensuring complete confidentiality of their personal information and responses, which would only be used for scientific research purposes. Notably, the group consisted of 12 experts: four academics specializing in urban planning and smart cities, four municipal managers from departments focusing on urban planning and crisis management, three private sector consultants, and two individuals from the Crisis Management Center. They were interviewed at various times during 2024, with each interview lasting between 20 and 30 minutes through electronic communication (Okoli, C. & Pawlowski, S. D., 2004). The research adhered to ethical guidelines for qualitative research, including obtaining informed consent from interview participants, ensuring the confidentiality and anonymity of participants, and transparently reporting findings without bias. The researcher asked each expert to address questions regarding Amman and Chicago as smart cities, their responses to the COVID-19 pandemic, their use of technology, the challenges and difficulties faced, the initiatives implemented, the success of these initiatives, and the interplay between the public and private sectors, alongside community participation in planning and implementation. Research uses Coding as an inferential approach to manage and analyze the primary data collected from secondary sources. Additionally, this research employed qualitative analysis to identify recurring themes from document reviews and interviews, such as urban planning, smart city applications, and mental and physical health. Conversely, quantitative analysis, which included descriptive statistics, utilized statistical tools to interpret public health metrics (e.g., infection and vaccination rates). Furthermore, the research employed comparative metrics to develop efficient indicators (e.g., response time and resource utilization) for comparing the two cities. Simultaneously, cross-case synthesis was adapted to compare the findings of the two case studies and identify similarities, differences, and lessons learned (Babbies, 2010).

After Applying the above methodology, the researcher can identify four main domains with subdomains for each main domain seen in (Table 1) and the reference in the third column from the literature review. the researcher obtained and identified this domain since these articles used and identified these domains in their methodologies and findings :

A. Urban Planning and Smart City Applications
B. Mental and Physical Health
C. Learning and Work
D. Transparency and Social communications.

Table 1. The main domains and sub-domains retrieved from Literature Review.

Domain	Sub-Domain	Reference
Urban Planning and Smart City Applications	Reducing the population density Indoor ventilation, air quality, Smart technologies Deployment of Technology And Innovative solutions: Smart mobility, Resource allocation, medical supplies, and food using IOT systems	Zandvoort, M et al. (2019); Fernández-Güell, J.-M et al.,(2016); Acuto, M. et al.(2020); Cheshmehzangi, Ali et al. (2024); Fletcher -Lartey, S et al.(2016); Harris P.et al.(1022); El Azzaoui A et al.(2021); Margarita Angelidou et al.(2017); Wu S., Wang C., Zhang L. (2021)
Mental and Physical Health	Maintaining social connections and facilitating social interaction	Johnson et al. (2021); Nitschke et al. (2021); Poortinga et al. (2021); Tokazhanov et al. (2020); Velarde et al. (2007) Wei, E.; et al.(2020,) Diop, S.et al. (2021)

	Access to the green and natural environment Sensors and IoT E-Health Data sharing systems Location tracking systems Dashboard systems to monitor	Zifeng Yang, e. a. (2020) James P(2020) Pineda, V.S.; Corburn, J.(2020)
Learning and Work	Decentralization, Economic recovery by creating jobs Promoting local business Self-sufficiency Adaptability Flexibility Diversity Multi-functionality Modularity Connectivity Redundancy	Toseroni et al. (2016); Zandvoort, M et al. (2019); Fernández-Güell, J.-M et al.,(2016) Salama, S. M. (2020) Kang, M, et al.(2020) Lii Inn, T. (2020) Troisi, O,(2022) horfuzzaman, M,(2021)
Transparency and Social Communication.	Social distancing Lockdown and quarantine Digital platforms Policies and regulations for smart technologies use	Zandvoort, M. et al. (2019); Fernández-Güell, J.-M et al.,(2016); Crook, B.(2016); Yates, D.(2019); Levenda, A.M et al,(2020); Kitazawa, K.; et al.(2021); Zandbergen, D., & Uitermark, J. (2019) Permanasari V.Y.(2022) Moon M.J.(2020)

Source by researcher.

Expert Interview's Structure

The interview enhanced the research's focus by identifying the most relevant areas and subtopics. These areas should align with the respondents' experiences and perspectives. The interview was divided into sections to ensure clarity and ease of use. Section one was dedicated to demographic information such as profession, specialization, and years of experience. Section two identifies domains and subtopics extracted from the literature review. Respondents were asked to rate the importance of each domain/subtopic using a Likert scale (e.g., 1 = not important, 5 = very important).In section three, the researcher asked open-ended questions; Respondents were allowed to suggest domains not included in the initial list or make modifications. They were also asked to provide feedback on the feasibility and relevance of the proposed domains/subtopics. In Section Four, Respondents were asked to prioritize the domains/subtopics for the research and to provide any additional insights or recommendations. The results of the analysis were used to narrow down the options and select the final domains and subtopics for the research. The interview questions and anonymized data are available in the FigShare repository.

Coding facilitated a systematic analysis of complex qualitative data gathered from various secondary sources. By organizing the data into manageable categories and identifying relationships among them, coding enabled the extraction of meaningful insights regarding the effectiveness of smart cities in responding to COVID-19. In this research, coding served as a heuristic tool for organizing, classifying, and analyzing primary data collected from secondary sources, including government reports, academic articles, case studies, publicly available databases, official reports on COVID-19 response measures, documented comparative research studies, and smart city initiatives. These sources provided both quantitative and qualitative data on how smart cities managed the pandemic and assessed their efficiency. "Coding" can be defined as a method for identifying patterns or deriving themes, topics, and relationships within qualitative data. This process involves assigning "codes" or labels to segments of the data to systematically classify and analyze them. Initially, the data was reviewed to identify concepts, themes, and recurring patterns. For instance, codes such as "citizen engagement," "digital surveillance," "public communication," and "resource allocation" were established to capture the main themes of COVID-19 response actions.

Subsequently, axial coding was employed to uncover the relationships between codes, aiming to understand how different themes interact. For instance, the connection between "digital surveillance" and "public trust" was examined to evaluate the effectiveness of smart city technologies. The core themes

were then identified and refined through selective coding to determine the effectiveness of smart cities in responding to COVID-19. For example, the primary theme “technology-based efficiency” encapsulated findings related to the use of AI, big data, and the Internet of Things in responding to and managing the pandemic. Inferential analysis was conducted to derive relationships and patterns within the data, leading to conclusions about the effectiveness of smart cities. Thus, coding facilitated the drawing of inferences; for example, by comparing coded data across different cities, researchers inferred the most effective strategies for mitigating the impact of COVID-19. To ensure that the research findings were rooted in current knowledge, the analysis also contextualized the findings within the broader literature on smart cities and pandemic response.
Experts participated through dialogue and discussion to review and verify codes and themes, address any discrepancies, and ensure the reliability of the coding process. Triangulation, which involves comparing the coded data with multiple secondary sources, bolstered the credibility of the findings.

3.4. Methodological Limitations

One major limitation of this research is the availability of data. Access to reliable and comprehensive information can be limited, especially in Amman, where documentation and transparency may not be as robust as in Chicago. Another constraint involves biases in expert opinions; interviews and surveys might reflect these biases, as stakeholders may emphasize success more than failures. Furthermore, the findings may not be widely applicable to other cities due to the specific contexts of Amman and Chicago. It is also important to recognize that a cross-sectional study may not uncover the long-term effects of the COVID-19 response measures. Additionally, analyzing two cities with markedly different cultural, economic, and political settings adds further complexity.

After applying the above methodology, the researcher can identify four main domains with subdomains for each main domain seen in Table 1 and the reference in the third column from the literature review. The researcher obtained and identified this domain since these articles used and identified these domains in their methodologies and findings:

E. Urban Planning and Smart City Applications
F. Mental and Physical Health
G. Learning and Work
H. Transparency and Social communications.

Expert Interviews Structure

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response actions.

Subsequently, axial coding was employed to uncover the relationships between codes, aiming to understand how different themes interact. For instance, the connection between “digital surveillance” and “public trust” was examined to evaluate the effectiveness of smart city technologies. The core themes were then identified and refined through selective coding to determine the effectiveness of smart cities in responding to COVID-19(ASEAN Tech Sec., 2023). For example, the primary theme “technology-based efficiency” encapsulated findings related to using AI, big data, and the Internet of Things in responding to and managing the pandemic. Inferential analysis was conducted to derive relationships and patterns within the data, leading to conclusions about the effectiveness of smart cities. Thus, coding facilitated the drawing of inferences; for example, by comparing coded data across different cities, researchers inferred the most effective strategies for mitigating the impact of COVID-19 (SafetyCulture, 2024). The analysis also contextualized the findings within the broader literature on smart cities and pandemic response to ensure that the research findings were rooted in current knowledge.

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4. Findings

Jordan's experience in responding to the Coronavirus was recognized by its centralization. The government established a central platform, the National Center for Crisis Management (Jordan Times, 2020). Through this platform, private sector operators were dealt with, thus facilitating cooperation between various stakeholders and stimulating innovation and creativity processes to enhance the city's ability to support citizens during the difficult pandemic period and meet their basic needs such as Education, health, food, medicine, and even mental health, improving access to information and narrowing digital gaps using integrated information system, fed, and updated continuously, making data transparent to citizens (Resolve to Save Lives, 2023). After August 2020, the government eased restrictions, but COVID-19 cases rose to large numbers after the parliamentary elections to nearly 8,000 cases per day, which led to a new lockdown to limit the epidemic. In March 2021, a new epidemic wave was more severe than the previous 9,500 daily cases and had a higher mortality rate (Greater Amman Municipality and International Growth Center, 2020).

4.1. Case Studies

I conducted this research in the Department of Regional and Urban Planning. Given my origins in Jordan, I sought to carry out a comparative study between Chicago, located in Illinois, and Amman, the capital of Jordan. Both cities are recognized globally as smart cities (IMD, 2023) and are heavily populated metropolitan cities. During my sabbatical leave at the University of Illinois at Urbana-Champaign in the United States, the comparative methodology of this research provided insights into how smart cities respond to the COVID-19 pandemic, considering that one is in the developing world and the other is in the developed world.

4.1.1. Amman

According to a recently released report, Amman city is ranked 135 out of 141 cities in the Smart Cities Index, indicating room for improvement, with traffic congestion as the major challenge (Jordan Times, 2024, March 26). The Smart Cities Index (SCI) for the year 2023 provides insights into smart city development across various cities worldwide. Zurich in Switzerland topped the index, while Oslo in Norway came second and led in sustainability. Canberra"

Amman is the capital of Jordan and has more than 4.5 million people. It is, therefore, the largest city in Jordan and contains about 45% of the Kingdom's population. It is located northwest of Jordan and is surrounded by an extended urban area and major cities such as Zarqa, Irbid, Salt, and Mafraq. It is considered a mountainous city with a moderate and cool climate in the summer. It has a mixture of indigenous people and immigrants from surrounding countries. It is classified as a smart city within several classifications. However, according to these classifications, it still ranks at a low rank (128) among (141) cities in the world IMD Index (IMD report, 2023) (Figure 3) compared to the city of Chicago, which is one of the largest cities in the state of Illinois . In the United States, with a population of up to 3.5 people of mixed races and genders, in addition to immigrants, the city of Chicago has been classified as a smart city in several classifications, including one in which it is ranked (61) among (145) countries according to IMD index, while Amman was not at 2019 Smart city.

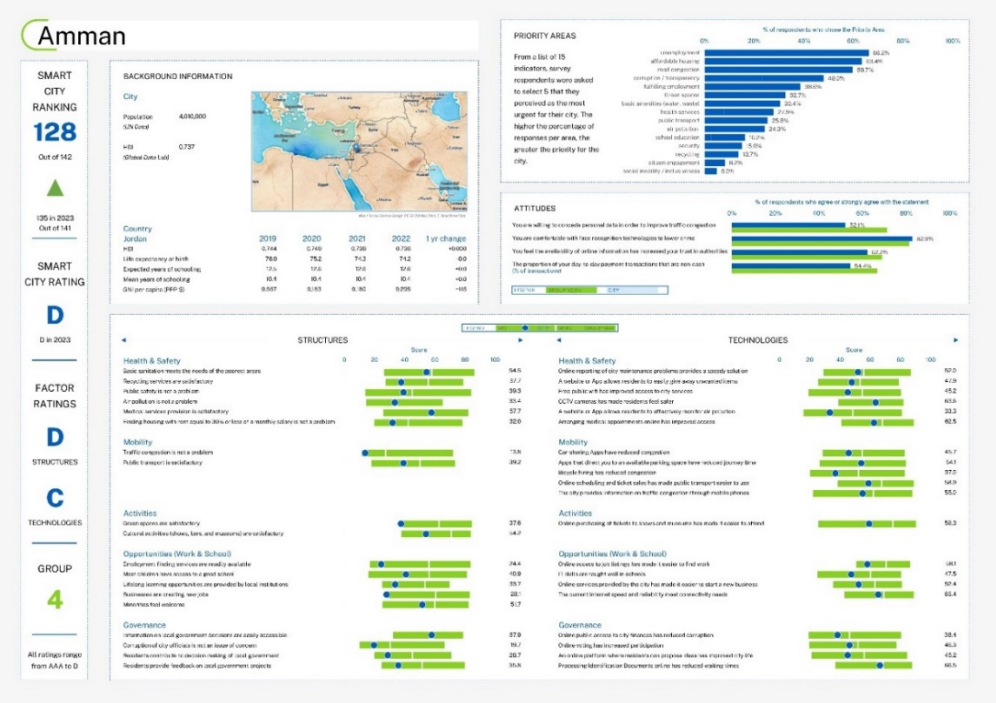


Figure 3. IMD Report for Amman smart city rank 2023 Source (IMD, 2023).

An integrated information system was used, fed, and updated continuously, making data transparent to citizens. Various media outlets, especially social media, were used as platforms to display data and information and inform citizens of decisions and developments. Although the residents of Amman do not suffer from traditional illiteracy, a significant percentage suffer from digital illiteracy, at a rate of at least 25% of the population, according to statistics for the year 2019 (Department of Statistics, 2019).

Consequently, societal groups continued to suffer from digital illiteracy, and older people are the largest percentage of this group, followed by people experiencing poverty and some marginalized groups. During the Pandemic, civil society organizations had a limited role in combating digital illiteracy, which was enforced by ban laws. The curfew was imposed during the Pandemic, and communication was done via the Internet and digital devices, which this group finds difficult to handle (ILO, 2021).

The Experience of Amman as a Smart City in a Developing Country in the Effectiveness of Efforts to Combat the Covid-19 Pandemic

First Domain: Urban Planning and Smart City Applications

The Greater Amman Municipality was affected by the Pandemic due to the decline in its tax revenues, which declined to a 15% rate of its budget. Citizens refrained from paying due to their inability to work. Many of the city's proposed projects were affected or suspended, especially with external funding, Including the BRT Bus Project. (Greater Amman Municipality, 2020).

Responses: The Greater Amman Municipality is launching the Amman Prevention Strategy and Climate Plan to respond to and mitigate the impacts of the COVID-19 pandemic. International Donors and NGOs consider Amman the center of innovations and sustainable solutions. It will greatly influence the smart urban development of the city in the coming years. These plans suggested applying practices in many areas related to the city's transport, energy, and water sectors to achieve Sustainable Development Goals (SDGs) (Greater Amman Municipality, 2020).

Additionally, the new strategic plan of the Greater Amman Municipality is for 2026-2022. To review the structural plan of the city of Amman to be consistent with the development goals and become more citizen-centered and fairer, especially concerning access to health and educational services, green spaces, public spaces, and appropriate infrastructure within the cultural and social diversity in the city, increase attention to children, youth, women and marginalized groups through innovative methods of active participation and activities, to enhance accountability, transparency, and decision-making in the municipality. The rapid growth of the city's IT sector can lead to a positive impact on the modernization of the public sector and achieve better equality through the Urban Observatory, which focuses on partnering with data providers such as the Department of Statistics, academics, international cooperation, and local voluntary initiatives, and then analyzing data and creating guides that help decision makers and

planners of more sustainable and flexible plans. As seen from (Table 2) the strategic goals of 2019-2022 during COVID-19 have good percentages, but the indicator "applying health requirement reached 34 % in 2022 compared to 69% in 2018. As for the goal of" Ensuring a healthy, safe environment," the percentage was (34.67) due to the increase in COVID-19 cases this year. On the other hand, the indicator "Electronic transformation to GAM operation "reached (59.3%) in 2020 due to the COVID-19 lockdown. Additionally, the transportation goals did not exceed the 75% limit. (Greater Amman Municipality, 2020).

Table 2. GAM Strategic Plan Achievements 2018-2022.

NO.	Strategic Objective	Years			
		2018	**2019**	**2020**	**2021**
1	Electronic transformation of GAM operations	70.3%	91.1%	59.3%	84.66%
2	Infrastructure development for information technology systems	67.1%	81.3%	100%	71.59%
3	Improving, maintaining, and developing communication and partnerships with stakeholders	100%	100%	100%	-
4	Providing a supportive institutional environment for development and improvement to raise the quality of services	84.4%	84.4%	72%	81.5%
5	Upgrading the level of financial management to the best practices in the public sector	85.6%	88%	83.7%	92.06%
6	Raising the efficiency of fixed assets and the supply chain	52%	-	-	-
7	An efficient and safe road and transport network according to best practices	77.8%	76%	90%	64.2%
8	Rehabilitation, development, and readiness of the assets and properties of the Greater Amman Municipality	96.7%	91%	84.3%	68.84%
9	Raising the level of traffic safety	89.5%	87.3%	79.8%	73.78%
10	Developing and raising the efficiency of public transport services	69%	69%	74.3%	78.84%
11	Ensure a healthy, safe, and sustainable environment	96.9%	88%	71.8%	34.76%
12	Applying the requirements of Amman Healthy City	93.9%	100%	100%	47.51%
13	Creating and maintaining gardens, parks, and green spaces	90.8%	82.6%	76.7%	77.67%
14	Increasing the percentage of green spaces	75.5%	100%	-	75.13%
15	Planning and organizing a city that achieves sustainable development while preserving the unique identity of the city	90.2%	94%	97.9%	100%
16	Directing and attracting investments to the city of Amman	98.9%	98%	-	-
17	Empowering community members and enhancing a sense of social responsibility and good citizenship by providing inclusive quality programs	100%	94%	69%	79.8%
18	Preserving the cultural heritage and the originality of the city, so that Amman will be attractive for urban tourism	100%	100%	100%	100%

Source: Adpot from GAM 2021 report.

Second Domain: Mental and Physical Health

Under Defense Order No. 2 of 2020, during the COVID-19 pandemic, Jordan enacted the Defense Law to address the crisis. This law granted the government exceptional powers to limit the spread of the virus and implement strict measures, including curfews, lockdowns, and movement restrictions. It encompassed controlling public and private health sectors and imposing mandatory quarantine for travelers and infected individuals. Furthermore, it provided economic support by offering wage subsidies, covering utility bills, and deferring rent payments. It also regulated prices to prevent exploitation, particularly concerning food and medical supplies. Additionally, it mandated wearing masks and restricted gatherings, along with imposing strict penalties on those who instilled fear about the virus and spread misleading information. Despite its effectiveness in controlling the virus, especially in the initial stages of the crisis, it raised concerns regarding freedoms and human rights, not to mention its detrimental effects on the economy, particularly for small businesses and day laborers.

The epidemic has greatly affected the health of citizens due to the inability to treat chronic diseases easily and the inability of citizens to access health services due to closures and the Defense Law (1992). Many services, such as motherhood and childhood, have also been closed, and many foreign organizations have been unable to work during these circumstances ((Greater Amman Municipality, 2020).

Citizens were severely affected during the pandemic period due to their lack of access to basic services and their inability to go to open areas, which also led to negative effects on the mental health of citizens.

In the field of health care and strengthening the response, the government increased the capacity of hospitals, the number of beds and ventilators, and developed a national vaccination program that includes all segments of Society, including refugees and the most affected groups, accompanied by an advertising campaign that motivates people to vaccinate, and mobile vaccination sites have been established to reach all regions, and in the field of monitoring and tracking the disease and developing a strategy to prevent its spread, the National Center for Epidemiology and Infectious Diseases has been established. Instructions for the establishment of the National Center for Epidemiology and Infectious Diseases published in the Official Gazette,) Jordan Times ،2020). For mental health, very little attention is given to this important concept, and many people suffer during the Pandemic from psychological concerns and fairs, especially vulnerable citizens such as aged people and unemployed citizens (Interviews,2023). The Greater Amman Municipality has made a set of initiatives aimed at alleviating the suffering of citizens during the pandemic period, hdl.handle.net,2024) . GAM's initiatives during the pandemic have shown a proactive approach to addressing citizens' needs. By focusing on education, public health, and community engagement, the Municipality has played a crucial role in alleviating the suffering caused by COVID-19 and ensuring the well-being of Amman's residents. Among these initiatives is the "Stay Home" campaign, aimed at reducing people's movement to control the virus by encouraging them to remain at home, utilizing social media, radio, and television for outreach. Additionally, the "My Bread from My Home" initiative deploys mobile units to distribute bread directly to neighborhoods and collaborates with bakeries to ensure fair distribution and increase productivity. It also provides basic food supplies to residents in crowded and remote areas.

The "My Game from My Home" initiative aims to reduce stress and enhance learning and creativity for children during prolonged closures while supporting their mental health by distributing educational and recreational games. Electronic platforms also offer group games and activities to keep children engaged. The "Sports from Home" initiative encouraged citizens to stay active to maintain their mental and physical health by organizing virtual fitness courses, promoting home exercises through social media, and broadcasting healthy medical and nutritional advice. The "Education Basics" initiative supported students and parents in transitioning to e-learning by conducting workshops and distributing educational materials and resources. Electronic platforms helped bridge the educational gap as an alternative to school closures. The "Your Health Matters" initiative involved distributing medical supplies such as masks and sanitizers while raising public awareness and commitment to health guidelines through ongoing public safety campaigns emphasizing the importance of vaccination, social distancing, and handwashing to reduce infection rates. The "Mashlar Management" initiative implemented strict protocols for managing parks, limiting the number of visitors while allowing them to enjoy outdoor spaces safely. The "Summer Club" initiative organized virtual competitions and activities in art, science, and sports during the summer to bridge the educational gap caused by school closures. It also provided various activities and distributed educational materials to assist parents in supporting and educating their children while awarding scientific prizes to participants.

These initiatives helped curtail the spread of COVID-19 and enforce closure measures. Citizens, particularly vulnerable groups, received basic services, support, and enhanced activities and campaigns promoting health and well-being during this challenging time. Additionally, there were initiatives aimed at fostering a sense of solidarity among citizens. (GAM) on COVID-19 initiatives ،2023).The Dashboard of UN-Habitat shows that Amman has 56% of Responses to the Coronavirus. As seen in (Figure 4).

Figure 4. Dashboard of COVID-19 At Amman in Jordan 2024. Source: (UN-Habitat,2024).

Third Domain: Learning and Work

The Jordanian economy was greatly affected by the COVID-19 pandemic, and the impact on Amman was greater as it contains 42% of the Kingdom's population. When the first positive case appeared in the Kingdom on March 2, 2020, the Jordanian Defense Law was enacted to contain the spread of the virus (United Nations Development Program, 2020). The Prime Minister and the National Center for Crisis Management put strict measures in place that closed shops, markets, schools, air and land borders, and public services. The poverty rate reached more than 40%, and the unemployment rate reached about 25%.

The government has developed an economic recovery program for 2021-2023 by enhancing the ability of the private and public sectors to create job opportunities, improve the business environment and competition, support the affected economic sectors, especially tourism and industry, and provide support to the affected small and medium enterprises, and the pharmaceutical and medical equipment sector has witnessed steady improvement and government support, in addition to stimulating foreign investments and increasing exports of goods and services (National Voluntary Review of Jordan, 2022)

Amman city encourages investment in cooperation with local partners and academics to create sustainable green projects by establishing Amman Vision Company and Amana Investment Company to promote the circular economy (National Voluntary Review of Jordan, 2022(

Fourth Domain: ***Transparency and Social Communication***. The impact on women was great; access to work was difficult, and the income of many families fell dramatically. The Pandemic infected the Tourist sector mostly. Due to the concentration of companies in Amman, a study by the International Labor Organization (2022) showed that many companies were exposed to huge losses, closures, and employee reductions due to the Corona pandemic, especially companies that depend on rent.

Response: The new strategic plan for the (GAM) (2022-2026) focuses on achieving equality between various groups of Society, especially marginalized groups suffering from poverty or refugees, aged citizens, children, and women, by increasing attention to these groups, expanding community participation, and achieving justice by accessing services, activities, and infrastructure, including health care and educational services, and public and green spaces for all groups without discrimination through innovative methods. National Voluntary Review of Jordan, 2022) .

The plan focuses on the goals of sustainable development at the global, national and local levels and achieving the desired equality among citizens in Coordination with partnerships with the sectors that implement infrastructure projects in the city and developing innovative methods for the participation of these groups(National Voluntary Review of Jordan, 2022) .

GAM conducted a survey to measure the citizens of Amman's satisfaction with GAM services during the COVID-19 pandemic, and the result was that 80% of citizens were satisfied with GAM (Greater Amman Municipality, 2020).

4.1.2. Chicago City

Chicago is the third largest city in the USA, with more than three million people. It is located in Illinois, in the North Mid-East of the USA (Smart Cities Dive, 2023). It has a long waterfront on Michigan Lake. It is an environmentally and human-friendly city with a strong path for bicycles used in the city. According to the classification of the IMD index (Figure 5), it is considered a city at level 61 according to the IMD Smart City Index (2023). The Chicago experience was distinguished by creating open platforms by several actors, such as the municipality, government, people in business, entrepreneurs, and civil society organizations, which actively created stakeholder cooperation (Serikbayeva B., 2020). This model is closer to the circular innovation model in which all actors cooperate to achieve the desired

urban sustainability to respond to the Pandemic with all available capabilities and resources, not only by relying on the central institution.

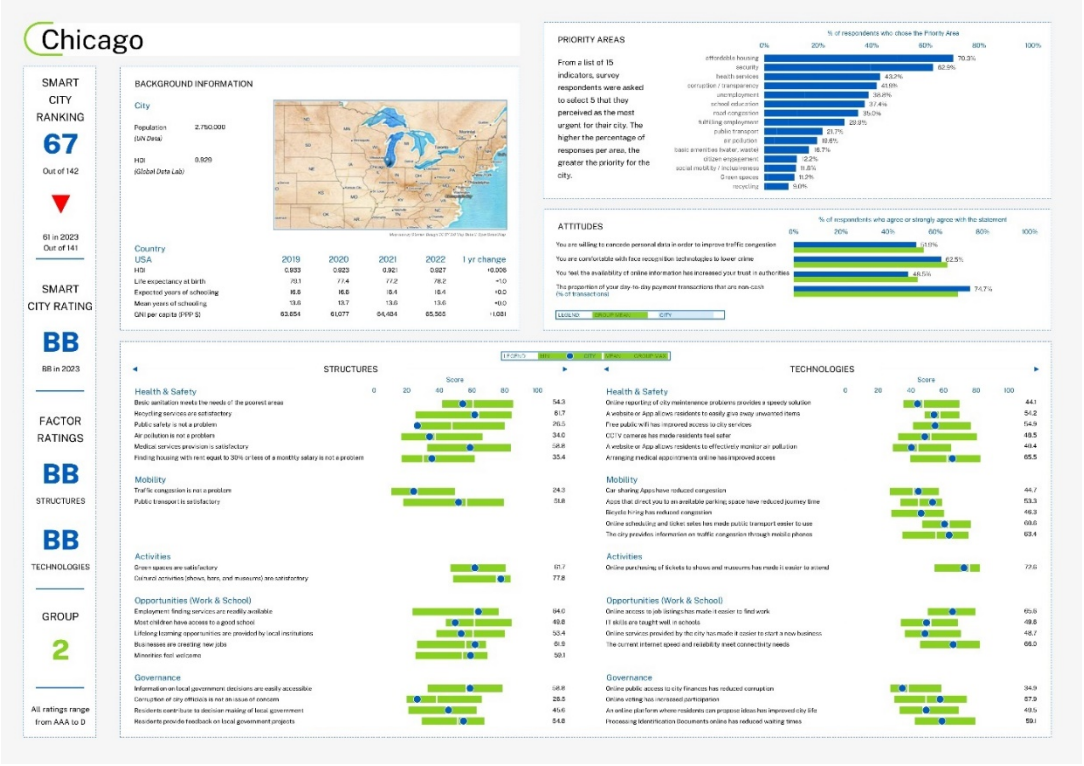


Figure 5. IMD Report for Chicago smart city rank 2023. Source: (IMD,2023).

The Experience of Chicago as a Smart City in a Developed Country in the Effectiveness of Efforts to Combat the Covid-19 Pandemic

First Domain: Urban Planning and Smart City Applications

The City of Chicago received a $1.887 billion package under President Biden's 2021 U.S. Response and Recovery Plan, of which $576 million the municipality allocated to community initiatives (Chicago Department of Public Health, 2024). However, federal guidelines for the grant stipulate that the municipality must fully spend the money by the end of 2026.(Department of Health,2023) (Figure 6).

The Chicago City Government has developed a COVID-19 recovery plan based on fundamental principles of transparency, good governance, and justice that respect human rights, especially children, the homeless, and marginalized groups (Chicagoland Chamber of Commerce, 2024). They provide them with adequate housing and basic needs so that it manages the funds granted to it by the federal government in a clear manner that enables citizens to know all the details and periodically through an electronic platform, Dashboard, which updates its information. (Figures 7 and 8).

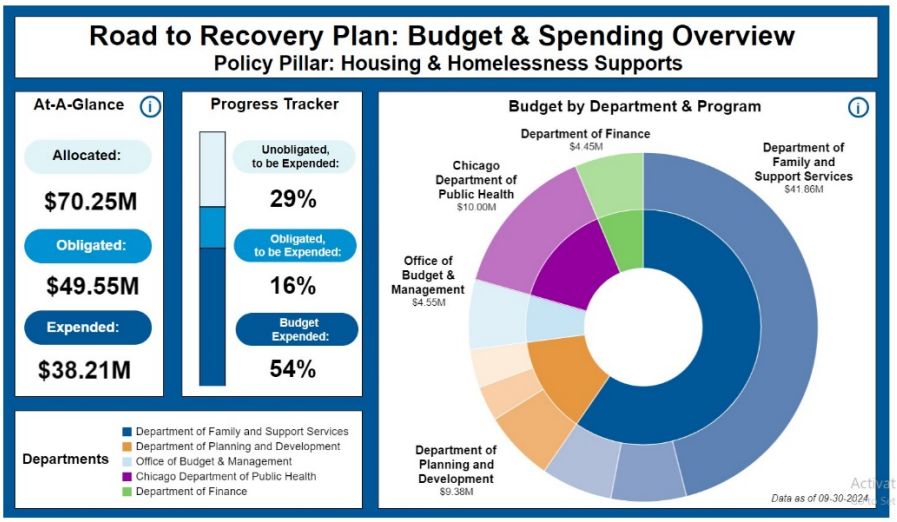


Figure 6. Dashboard of the recovery plan of Chicago City 2023, Source: City of Chicago ARPA Information Hub (arcgis.com).

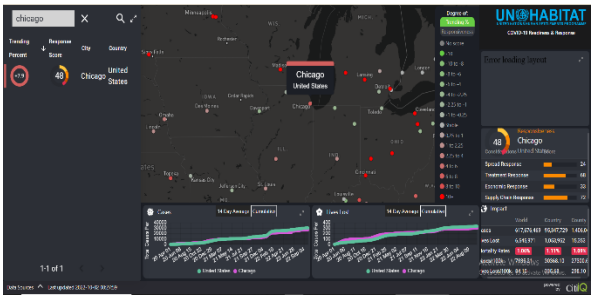


Figure 7. COVID dashboard of vulnerability rate. (Source: UN Habitat ,2024).

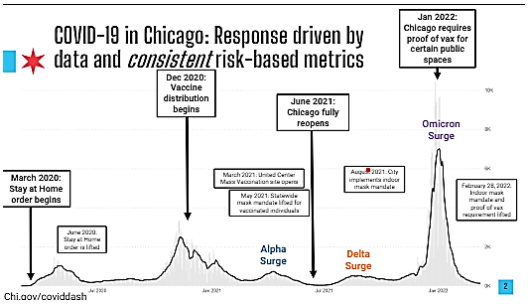


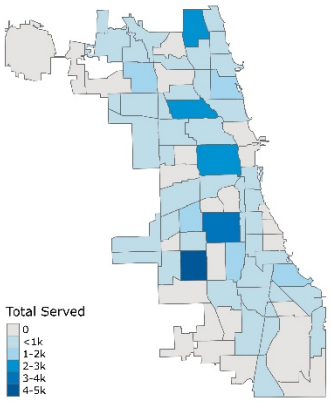
Figure 8. COVID-19 Data in Chicago by date. (Source: Chicago response plan, 2023).

Second Domain: Mental and Physical Health

The city launched initiatives to disseminate the spread of the virus corona and enhance physical health. COVID-19 Vaccination &Community Resource Navigators (Department of Health,2023).

The program aims to protect vulnerable groups through vaccination activities for uninsured or underinsured people, such as those experiencing homelessness and those living in crowded conditions. Regardless of residency or insurance status, vaccination is free for everyone, including people experiencing homelessness. Mental Health Equity Initiative (MHEI), Good Food Fund, and Food Business Incubator (Figure 9) This initiative aimed at securing food and resources for poor and marginalized groups that do not have access to food, and it was supported by more than $ 5 million. The Mental Health Equity Initiative has allowed the Chicago Department of Public Health to build on an existing network of providers to serve more Chicagoans and communities (University of Illinois at Urbana-Champaign, 2024). This Mental Health Equity program is available to all Chicagoans at any time they need it during the COVID-19 pandemic, which has impacted the mental health of residents more

than ever before and beyond, regardless of gender, race, or residency status. It promotes high-quality mental health services for residents who can pay, uninsured or uninsured. Federal and other sources fund the grant and focus on those most in need who have previously been unable to access these services due to their high cost.(Department of Health,2023). (Map 2).



Map 2 illustrates 28,888 persons in one of 56 community areas. Who received mental health services Data as of June 30, 2024. Source **:** Latest Data | COVID19 (chicago.gov)

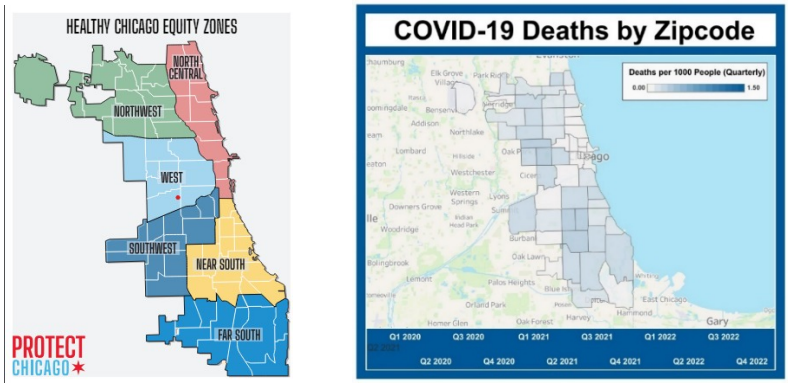


Figure 9. Equity Zones and Dashboard for COVID-19 Deaths by Zip code 2024. *Source:* COVID-19 Deaths by Zipcode | Tableau Public.

911 Alternative Response (CARE)

The 911 Alternative Response (CARE) initiative aims to respond to people who are mentally incapable of communicating information during the Pandemic by working with behavioral health professionals to ensure rapid response in difficult crises.

Family Connects Chicago

This initiative focuses on mothers and newborns, with special attention to marginalized groups such as people with addiction, abusers, depression in black families, and those living in poverty, by partnering with hospitals and community stakeholders to reduce the life expectancy gap in Chicago, especially in neighborhoods with high rates of infant mortality.

Environmental Risk Reduction Program & Environmental Justice (EJ) Seed Grants

These two programs aim to develop policies in partnership with the local community to ensure environmental safety and understand environmental pollutants long-term for the city's residents. They focus on the Chicago ARPA Information Hub (arcgis.com) and the ental and social pressures to achieve environmental justice for the population.

Third Domain: Learning and Work

The city government also used federal funding to replace lost revenue due to the Pandemic, support

health services for residents during the Pandemic, help the unemployed and affected businesses recover from the financial impact of the Pandemic and pay workers' compensation and wages, especially for health workers who bear heavy burdens due to their greater exposure to health risks from the virus and infection. Investing in sanitation, water, and communications infrastructure to improve access to support for vulnerable groups was also important (Illinois Department of Public Health, 2024);(illinois.gov,2024). The Chicago Land Chamber has developed a plan to address the Corona pandemic, which included a set of measures, including: attention to transportation projects to improve accessibility, urban planning, and housing, as well as provide sources of relief in the event of natural disasters. Prepare an integrated transport plan that includes buses and stops, prepare an integrated plan for Education on public safety protocols, promote the use of other sustainable transportation alternatives such as bicycles share cars and electric cars, promote walking culture, invest in infrastructure by modernizing O'Hare Airport worth $8.5 billion, and strengthen Chicago's position as a major logistics distribution center in the United States (chicagolandchamber.org,2024) facilitating access to laptops to support the business community and students by the City of Chicago Chamber of Industry and Commerce and providing staff to train teachers to use online teaching methods voluntarily, strengthening broadband infrastructure to ensure access to all individuals, and supporting the establishment of childcare centers at work sites. Encourage using private capital and reduce risks in using public funds (chicagolandchamber.org, 2024).

Fourth Domain: Transparency and Social Communication

In the recovery plan developed by the city government, transparency and governance was a basic rule in the plan and was represented in the development of many platforms aimed at sharing information, financial statements, and initiatives with the population, especially vulnerable groups, with all available means of communication such as telephone, text messages, the Internet and social media. An example of this is the Initiative 211 system. It is an initiative that facilitates communication between residents through a free, confidential, 24-hour helpline that provides basic needs for callers and their families, including food, medicine, housing, healthcare, and assistance in accessing health facilities. This platform can be used via phone, Internet, or text messages with direct and dedicated agents, which mitigates the exacerbation of social and economic disparities among residents during the Pandemic.

There are many platforms and available data that helped in assessing the general situation in the city, which showed the existence of disparities between the population according to race and location, as the death and infection rate among the population of Latino and black origins increased by more than 50% compared to the rest of the population, as well as the elderly over 65, while the death rate reached ten times among the population over 80. (Chicago. Gov, 2024).

4.2. Expert Analysis Interviews

The experts agreed on the challenges facing smart cities in responding to a health pandemic such as COVID-19, the most important of which, according to the opinion of experts:

1. **Privacy**

trust and violation of human rights, as the city authorities and agencies use many applications that violate human privacy during the pandemic period, such as the geographic positioning system, except that many companies responsible for the shelving can easily access information about the city's residents and patients that many agencies and companies can use in matters that violate privacy such as medical experiments Unauthorized on the drink or medicines.

2. Inclusiveness

Most experts discussed the digital divide, noting that digitization may increase inequality. They examined both the ability to use technology and the lack of access to it. The focus was on the elderly, low-income, and marginalized individuals who may not be well-versed in Internet usage. Consequently, they struggle to access social media or websites easily, which impedes their ability to communicate with official authorities that disseminate advertisements or instructions, as well as their relatives or friends. This gap is evident even in a multi-ethnic city like Chicago, where several experts pointed out significant disparities among races in their experiences during the pandemic, which may stem from their inability to communicate due to the digital divide or language barriers.

3. Political bias and the spread of disinformation

Many experts in cities and professions have found that the smart city delivers information faster. However, there are fears that governments, institutions, and some international companies will use this to spread misleading information that contradicts the original idea of digitization or smart cities, which depends on the demands and needs of the local community. Some experts have talked about inadvertently spreading false information through social media, significantly impacting public opinion and increasing fears.

4. Technical issues

Several experts found that the lack of data or its unreliability leads to wrong analyses and decisions based on it. Many experts disclosed that managers lack the technical knowledge to deal with big data and that local governments cannot afford the cost of data processing.

5. Inefficiency of Education and remote work

Experts found that distance learning and Education have many advantages, especially during the coronavirus pandemic, as digital technology has allowed the continuity of distance education and remote work despite the closures. Some experts expressed their concerns that the digital divide negatively affects the justice of Education, especially in the city of Chicago, where there are several races and refugees with different languages, and distance education lacks the human dimension and direct contact, as there are specialties that need a direct presence in laboratories. While remote work has flexible schedules, it is an advantage for workers, especially mothers, as it improves the balance between work and life and reflects positively on productivity. Some experts pointed to risks related to violating privacy and security of access to information.

Amman and Chicago encounter shared challenges like the digital divide and privacy concerns, yet their underlying causes and effects differ greatly. Chicago grapples with issues linked to social inequality, political division, and high expenses, whereas Amman contends with infrastructure deficiencies, weak regulations, and limited resources. Tackling these issues demands context-specific approaches: Chicago needs policies to close racial and socioeconomic disparities, while Amman needs investments in infrastructure and regulatory frameworks. Table 3 summarizes these differences.

Table 3. Summary of Differences in COVID-19 Smart City Response Challenges Between Chicago and Amman.

Challenge	Chicago	Amman
Privacy	Robust privacy regulations and public opposition to surveillance	Lack of strong regulations and insufficient public knowledge about privacy rights
Inclusiveness	Disparities in race and socioeconomic status, language obstacles	Deficiencies in infrastructure, limited digital literacy, and challenges faced by refugees
Political Bias and Disinformation	Decentralized misinformation, political division	Consolidated authority and societal skepticism towards official data
Technical Issues	High prices and insufficient technical support expertise	Insufficient data access and aging infrastructure.
Inefficiency of Education and Remote Work	Disparities in access and diminished human interaction in online education	Restricted device and internet access, along with language obstacles.

Source: By Author

5. Discussion

COVID-19 has an important impact in accelerating the transformation towards flexible and smart cities, as cities are located on the front lines of the coronavirus pandemic and can be turned into living laboratories to test effective measures at the state level. It was found that traditional cities struggle to respond to the COVID-19 pandemic, which significantly accelerated this vulnerability (TechRepublic. 2023). As a result, traditional cities seek to transform into smart systems to improve resource management, healthcare, and digital communication, necessitated by the widespread lockdowns in many countries worldwide. This situation has also highlighted the importance of flexibility in urban planning to boost investment in digital infrastructure, care for the built environment, and enhance pedestrian accessibility. Additionally, it has prompted the adoption of innovative solutions for learning and education to address the challenges posed by the pandemic and its consequences. This result is consistent with many studies mentioned in the theoretical framework (Moon, 2020; Asmorati et al., 2021; Alshurideh, M. et al.,2021; Allam et al. (2019) it is not consistent with the study o) (Pratama, A. B. et al.,2023). They studied the impact of the urban management of smart cities in developing countries in dealing with the COVID-19 pandemic using data from 75 Indonesian cities. This research found that smart city status has no statistically significant effect on the COVID-19 performance index. By increasing our reliance on technology to combat the pandemic more effectively, we observe a rise in the proportion of distance education and remote work even after the pandemic has ended. Digital applications and platforms have been successfully launched, even in Amman, which ranks 135 out of 141, according to

the IMD Smart Cities Index. The rollout of e-government services has also accelerated, introducing numerous new offerings. Big data for smart cities has facilitated effective predictions and decision-making regarding combating the pandemic, identifying virus hotspots, and reaching residents through modern technologies and satellites. This includes monitoring all activities, tracking violators, and managing resources effectively. It has also enhanced urban mobility and enabled urban planning to address urban environments intelligently, focusing on improving access to services. A key achievement has been developing a smart health system that uses smart applications to reach patients and the elderly, offering diagnoses. At the same time, they remain in their homes, along with the delivery of medicines and supplies. The experiences of Amman and Chicago serve as examples, highlighting the need to address the challenges posed by the digital divide among residents and the potential infringement on their privacy.

5.1. Differences between Chicago and Amman

The City of Chicago focused on a comprehensive strategy based on significant federal funding covering local initiatives seeking justice for Chicago citizens. The epidemic showed a great disparity between the population according to their places of residence and race, as blacks and Latino suffered from high rates of infection and mortality compared to whites and other races for many reasons, including overcrowded housing, poverty, their inability to provide treatments, and their chronic diseases more than other races, in addition to the need for them to go out to work in jobs that require leaving the house as well as the language barrier for non-English speakers. In addition, disparities in the rates of infections appeared in the age groups, as citizens over the age of 65 suffered from their inability to access electronic services and thus their inability to reach their basic needs. It also suffered in the city of Amman: the elderly citizen, and there were some initiatives to reach these groups, highlighting the issue of digital illiteracy. The city alerted these groups and built strategies to reduce their problems in the future. It relied on reliable, high-quality, and diverse data sources and platforms that are easy to work with in Chicago, with the possibility of building interactive spatial maps throughout the city and even a map of inequality. On the other hand, we see that the city of Amman also suffered from disparities in the rates of injuries among the population, especially between areas where large numbers of refugees and the poor live, which are generally in the eastern areas of the city, and the city has relied on a rapid emergency plan that responded to the disaster at the national level up to the level of the city of Amman, which did not have accurate and comprehensive spatial data regarding detailed geospatial data such as Chicago platforms. However, this data was available statewide. The Greater Amman Municipality has paid attention to the issue of urban planning, the lack of available public spaces, and the weakness of green spaces in the city, which are available at a high rate in Chicago. In addition to discussing how services arrived within a reasonable walking distance because the quarantine lasted longer than in Chicago, there were programs in both cities regarding education and employment afterward, supported by regulatory legislation. Differences in place, population, and socioeconomic capabilities dictate a situation that each city must treat differently. Although it is possible to benefit from the experience of one city to another city, in practice, the same strategies and plans cannot be applied.

5.2. Implications for Policy and Practice

These implications draw from the findings to renovate stronger, more responsive smart cities. The response to the coronavirus in the world was almost uniform. However, there were spatial differences between developed and developing world cities, such as the case of Chicago and Amman in Jordan. The response in the labor market due to the negative effects of the Covid-19 pandemic depends primarily on these markets' nature, flexibility, and social formations. The Pandemic has highlighted accessibility and flexible mobility within the integrated urban planning and organization framework. The Pandemic revealed disparities between community groups, especially marginalized groups such as the elderly and low-income people, and their concentration in certain neighborhoods, who were more exposed to the epidemic, as revealed by the percentages (YouTube, 2024, May 6). Remote Work, Education, and digitization are still gaining great importance despite their different handling between cities. Cities have shifted towards a circular economy and a shift towards environmental sustainability and clean energy, especially with mobility. The Pandemic affected governance and confidence in the political system and differed between cities. Increasing pandemic response capacity requires more flexibility that depends on increased attention to sustainable urban planning. The research noted that the pivotal role of the state in responding to the Pandemic is indispensable to bridge the gap and structural disparities to enhance community participation, support the basic needs of citizens in Education, health, food, energy, and water, and organize the use of digitization for rapid response in emergencies and that responses smart city authorities can divide into short, medium and long-term plans.

The research indicates the need for a deeper understanding of the social and technical transformations that greatly affect the smart urban transformation of the city. The main goal is to benefit from modern technology to create more comprehensive development through cooperation and Coordination between the various stakeholders in the city and taking into account the available human, in-kind, and material resources, which differ between cities, not to mention the institutional capabilities existing in cities as referred in Kitazawa, K.; et al.(2021); Zandbergen, D., & Uitermark, J. (2019) Permanasari V.Y. (2022); Moon M.J. (2020) studies. These studies emphasized the cooperation and coordination between stakeholders in the city. Therefore, what is appropriate for one city may not be appropriate for another. Flexibility in the proposed plans, strategies, and initiatives should not be generalized to smart cities without scrutinizing them and discussing their suitability for the city's environment and capabilities. The research found that Amman and Chicago, as smart cities, responded more flexibly and fairly and contributed positively to the flexible urban transformation. This does not mean that there are no negatives related to the excessive use of technologies in smart cities, especially concerning the violation of privacy and the increase in the digital gap between segments of society, especially aged citizens. There is a need for more discussions and academic research on how smart cities transform into more just and equitable for their citizens. This result is somewhat consistent with what Durose et al. (2019) and Kitchin (2019) revealed in their studies. They found that smart cities should focus more on promoting justice among the city dwellers.

Social transformations can be distinguished from technological transformations. The former are bottom-up, and the latter are top-down. However, in the systematic change in smart cities, this change is carried out through multiple institutional levels that work to meet the different needs of citizens and aim to achieve fair and balanced public services. Therefore, this result agrees with Kitchen (2019), who insists that social transformation is relatively slower than technological transformation.

Finally, the research also recommends and agrees with the study of Abdulla et al. (2020) on collecting and managing data by involving citizens and making them an important part of the planning process.

6. Conclusion

The research assesses how smart cities responded during the COVID-19 pandemic through case studies in Amman (Jordan) and Chicago (USA), highlighting their ability through advanced technologies, such as the Internet of Things, big data, and artificial intelligence, to support urban functions and enhance the well-being of residents. According to experts, the main findings reveal that smart cities managed the crisis more effectively and analyzed data documented from relevant sources through response plans that enabled real-time monitoring, data-driven decision-making, and efficient resource allocation. However, the study also identifies some critical challenges related to privacy concerns due to increased surveillance of residents and the widening digital divide between different segments of society, which particularly affects the elderly, women, and marginalized communities. This means establishing ethical frameworks, bridging the digital divide, and facilitating access to technology at lower costs. The research also emphasizes the importance of collaboration between smart city stakeholders and achieving integrated governance and transparency in crisis management, as evidenced by the coordinated efforts of the public and private sectors and cooperation with the local community in both cities. However, Chicago is ahead of Amman in this regard. Experts also stressed the importance of adopting sustainable urban planning that prioritizes and facilitates access to basic health, education, and food services. The research also recommends strengthening partnerships between citizens, the public and private sectors, investors, and decision-makers, investing in smart infrastructure, and ensuring that data is used transparently. The study concluded that smart cities have significant advantages in responding to the pandemic, but more research is needed on ethical concerns and achieving digital justice without exacerbating inequalities. This work provides valuable insights for policymakers, urban planners, and stakeholders who aim to build resilient, inclusive, and sustainable cities for future crises.

On the other hand, continuous evaluation of processes and strategies for building smart city resilience through multidisciplinary interactions is recommended, as it is not necessary to progress linearly based on a specific method but to evaluate multiple experiences. Additionally, city planners and decision-makers should open doors to interventions and innovations for all parties in the city through an integrated and comprehensive planning approach.

Transparency, governance, and justice are the foundations for designing smart cities to survive and combat any future pandemic or disaster. These standards govern agreements that may be slow, difficult, and complex between the public.

Moreover, the private sector serves citizens best, which can only be achieved through collective effort.

Conflict of Interest Statement

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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- During my sabbatical leave at the University of Illinois at Urbana-Champaign in the United States, I engaged in this research within the Department of Regional and Urban Planning. Given my origins in Jordan, I aimed to conduct a comparative study between Chicago, located in the state of Illinois, and Amman, the capital of Jordan. Both cities are recognized globally as smart cities. This research received support from Al-Balqa Applied University.

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