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Smart Cities: Using GIS Technology in Urban Infrastructure Development at Migration Areas

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Abstract: Technology played a vital role in urban planning and urban infrastructure development. The Geographic Information System (GIS) can help in creating smart cities by analyzing the required issues and present them for local communities. It can improve utilization of existing infrastructure capacity thus improving quality of life, it can also provide a guidance about mobility and the best use for available services. Smart cities promise that with increasing connectedness, services and quality of life can be improved. The intent of smart cities is to make urbanization more inclusive, bringing together public and private sectors, connecting urban centers with periphery, delivering services for all users alike, and integrating the migrants and poor into their community. This research aim at highlighting the advantages of using GIS technology in urban infrastructure development at Migration Areas in Amman the capital of Jordan that welcomes waves of immigration during the last decades which affect its infrastructure, basic services, and socio-economic situation. It focuses on one of the neighborhood and discover the challenges and opportunities based on the infrastructure development analyses using the GIS. The findings of this research confirm the essential need for smart cities with more inclusive plan to help in decreasing the vulnerability of both refugees and host communities thus enhance the social sustainability.

Keywords: Smart Cities, Urban Infrastructure, GIS, Migration Areas, Amman

Introduction

Smart city is the city of tomorrow. It tries to identify a smarter option to maximize the individuals satisfaction and accelerate urban socio-cultural and economic development (Cathelat, 2019). The smart city information system is built on four principles: Planning and engineering, data-driven performance, operational efficiency, and civic inclusion. However, According to Cathelat (2019:41) “the current reality of smart cities is that there aren’t any. At the end of the day, most so-called smart cities are just cities with a few or several standout smart projects”. Still, there are many initiatives in Jordan for a Smart city that are initiated to achieve one or more of the following objectives:

1. Efficiency of Services: Make the best effective use of public resources, and provide a high level of citizen service.
2. Sustainability: Develop the city with considering the environmental, economic and social impacts.
3. Mobility: Make it easy for all users to move in the city, whether by foot, bike, car, public transport.
4. Safety and Security: Improve public safety and security in every-day life, as well as being best possibly prepared for emergencies and disasters.
5. Economic Growth: Attract businesses, investors, citizens and visitors.
6. City Reputation: Constantly improve the city’s image and reputation.

These objectives can be achieved by using various types of technology such as GIS, online forums, online survey, and digital media throughout the decision-making process, these tools connect cities at the national and international levels and foster knowledge exchange among various parties, it also increases the public awareness among stakeholders for the importance of good data management and urban observatory platforms for future.

Since its development in the 1970s, the GIS is used in planning and developing the urban infrastructure, it becomes easier to analyze the collected data and bring many proposals to the ground (Banerjee, 2020). Today, a growing number of cities rely on GIS to model the real world at every stage of planning and development of a Smart City as it can incorporate a huge number of variables. There are various applications of GIS that help in developing the urban infrastructure in a smart way by analyzing the required issues and present them for individuals (Consortium, 2019). It can improve utilization of existing infrastructure thus improving quality of life, it can also provide the best practices for various types of mobility. In urban infrastructure projects the GIS is used based on a number of steps (Consortium, 2019):

1. Creation of the Urban Digital Model that illustrates the components of the urban built and natural environments.
2. Creation of the Sensing Layer that comprises sensors used for monitoring urban networks and infrastructures.
3. Analysis of Data by converting real-time and historical data into operational data that improves the security, efficiency and quality of urban systems.
4. Interactive Visualization of urban components and sensors maps. Users can utilize these maps to access static and dynamic data concerning urban systems.
5. The Control Layer that allows real-time visualization of these devices as well as their status. It could also visualize errors in device command.

Accordingly, this paper provide context on the national refugee situation in Jordan. Then, it highlights how Jordan can transform the migration challenges into spatial and urban infrastructure investment and create smart communities by using the GIS technology throughout planning stages. the GIS technology is used in studying the current condition of urban infrastructure at one of the migrants' areas in Amman, called the Al Hashmi Al Janoubi neighborhood, to help in developing this area in a smart way. Finally, this paper summarizes the urban challenges and opportunities that can be addressed through future development strategies.

Method

The research methodology consists of data collection, literature revision, and field observation. Stakeholders were asked to identify existing challenges in current infrastructure. These were categorized under the four main topics: Natural Environment, Urban Environment, Infrastructure Projects, and Refugee Integration. Moreover, Geographic Information System (GIS) is used to undertake the spatial analysis throughout the proposed plans, and assess the accessibility to public facilities.

National Context: Refugees in Jordan

Since its independence in 1946, Jordan has been a safe paradise to approximately 4 million refugees including Circassian, Palestinians, Iraqis, Syrians, and Yemeni, and others. Today, Jordan is hosting 89 refugees per 1,000 inhabitants (UNHCR, 2018). These refugees have become an important part of the country’s population and social fabric. The extraordinary numbers of refugees from surrounding countries have significantly affected Jordan throughout its history, and played a vital role in shaping the country’s politics, economy, community, and urban characteristics (Zalloom, 2020).

Figure (1) illustrates the refugee population density based on the nationality, indicating the highest refugee presence for Palestinians, Syrians, and Iraqis at the Amman city (UN-Habitat, 2022). This analysis supported the selection of the neighborhood that has been affected by the refugee influx.

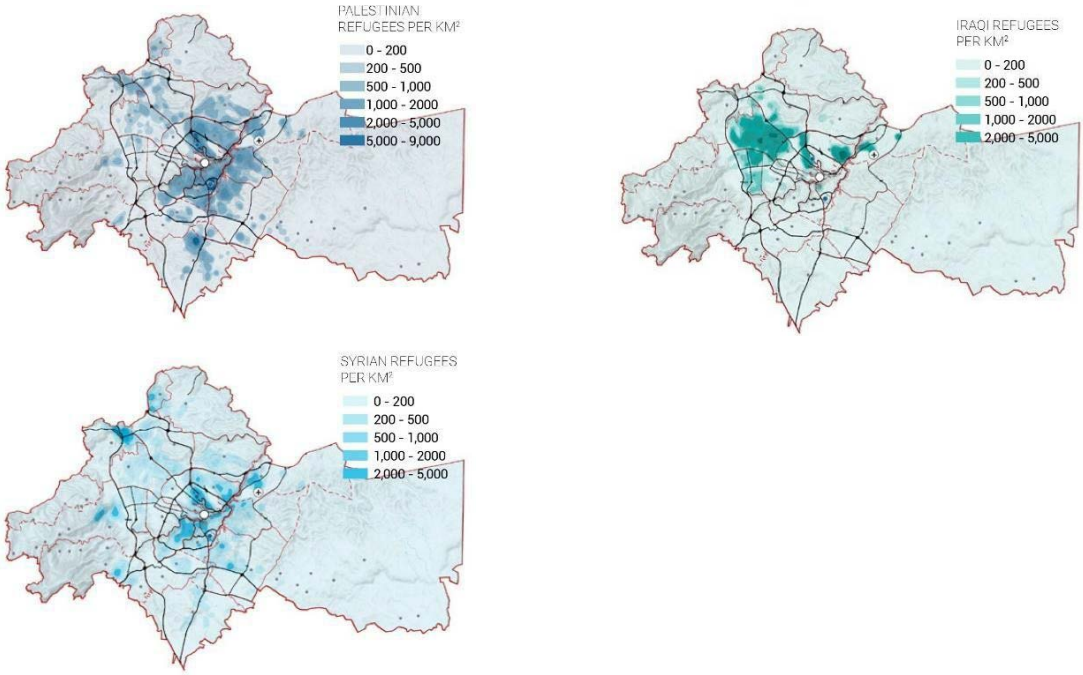

Figure 1. Refugee population density in Amman city (Source: UN-Habitat 2022)

After ten years of the Syrian Crisis and their immigration to Jordan, it becomes clear that the infrastructure, basic services, and economies of Jordanian cities are affected. The need for a more inclusive plan that help in decreasing the vulnerability of both refugees and host communities and provide longer-term sustainable solutions is appeared (Government of Jordan, 2020). Accordingly, national and international efforts are made to cope with this urban transformation, and to improve access to services and socioeconomic opportunities for displaced and host communities.

Applying GIS Technology in a Migrants' Area in Amman

Since 2011, municipal services in Amman, the capital of Jordan, have been significantly affected by the Syrian refugee crises. The waves of refugees from camps to urban areas has a major impact on the capacity of infrastructure and public facilities, such as education, health, public space, transportation, and natural resources (United Nations Jordan, 2021). The rapid displacement of populations to urban settings had major spatial, economic, environmental, and social impacts, which maximize the challenges that facing Amman Municipality such as, the lack of access to acceptable basic service infrastructure, the lack of affordable housing. These challenges affecting the refugees as well as the host communities. The urban sprawl and inefficient urban planning have led to the insufficient distribution and access to services and infrastructure which may cause critical issues. This negatively impacts their economic and social sustainability, thus, has resulted in the inefficient use of valuable resource and has left communities facing increased long-term problems, a lack of self-reliance, and insufficient access to urban services. Therefore, studying and analyzing the areas where migrants come and live is very essential.

The collection of accurate data helps in planning and decision-making process, thus, allows for achieving sustainable urban development. Developing and implementing efficient and reliable plans requires accurate, comprehensive, and up-to-date data to understand the urban needs of the population. However, inaccurate data lead to spatial inequalities in service supplying, housing, education, and public space development. Unfortunately, the available data at municipalities only considers local citizens, rather than all inhabitants, including the refugees, this may result in inadequate resource provisioning and inequitable services' distribution.

Using the modern technology such as GIS helps in filling these gaps when collecting and analyzing data, and help in creating guidance for the current and future planning of the city, which should be aligned to the Sustainable Development Strategy. It is an analytic tool that spatially integrates and analyzes urban indicators

and attributes at the city levels by creating multi layers (Banerjee 2020, Zalloom 2020). Furthermore, applying the Sustainable Development Goals (SDGs) is essential as it helps in supporting the selected neighborhood to become more inclusive, safe, resilient, and sustainable. Urban planning strategies that built on infrastructure investments aim to benefit migrant communities, enhance the quality of their life, and create better opportunities for economic investment (UN-Habitat, 2022). In this manner, public can participate in decision making process and they involve in all planning stages from the beginning.

Accordingly, a spatial plan is developed for Al Hashmi Al Janoubi neighborhood in Amman. The area of study is one of the most affected areas with influx of refugees, it has an area of 0.43 km2, a total population of 14,100 inhabitants, therefore, a population density is 32,118.4 person/ km2 (UN-Habitat, 2022). Figure (2) shows the land use of the compacted neighborhood, the satellite image was combined with the available data by using the GIS technology. The created figure shows the residential land use within the neighborhood that mainly comprises of types C, type D, and the unplanned zones while the area has no assigned commercial land uses within its boundaries, instead, small commercial shops that are usually on the ground floor of mixed-use buildings are used to serve residents.

The residential types “C” and “D” according to the “Law of Planning of Cities, Villages, and Buildings, No.79” can have up to four floors, with minimum setbacks of 2.5 meters at “D” type and 3 meters at “C”type. This distance allow people to contact daily, thus, have a strong relationship that enhance the social sustainability of the area. Furthermore, the project is underpinned site visits to visually assess the current situation and to interact with the residents in the neighborhood, the field observation for the neighborhood found housing in good condition and structure, but still the existing public infrastructure, the walkways, and street furniture are not acceptable and need maintenance.

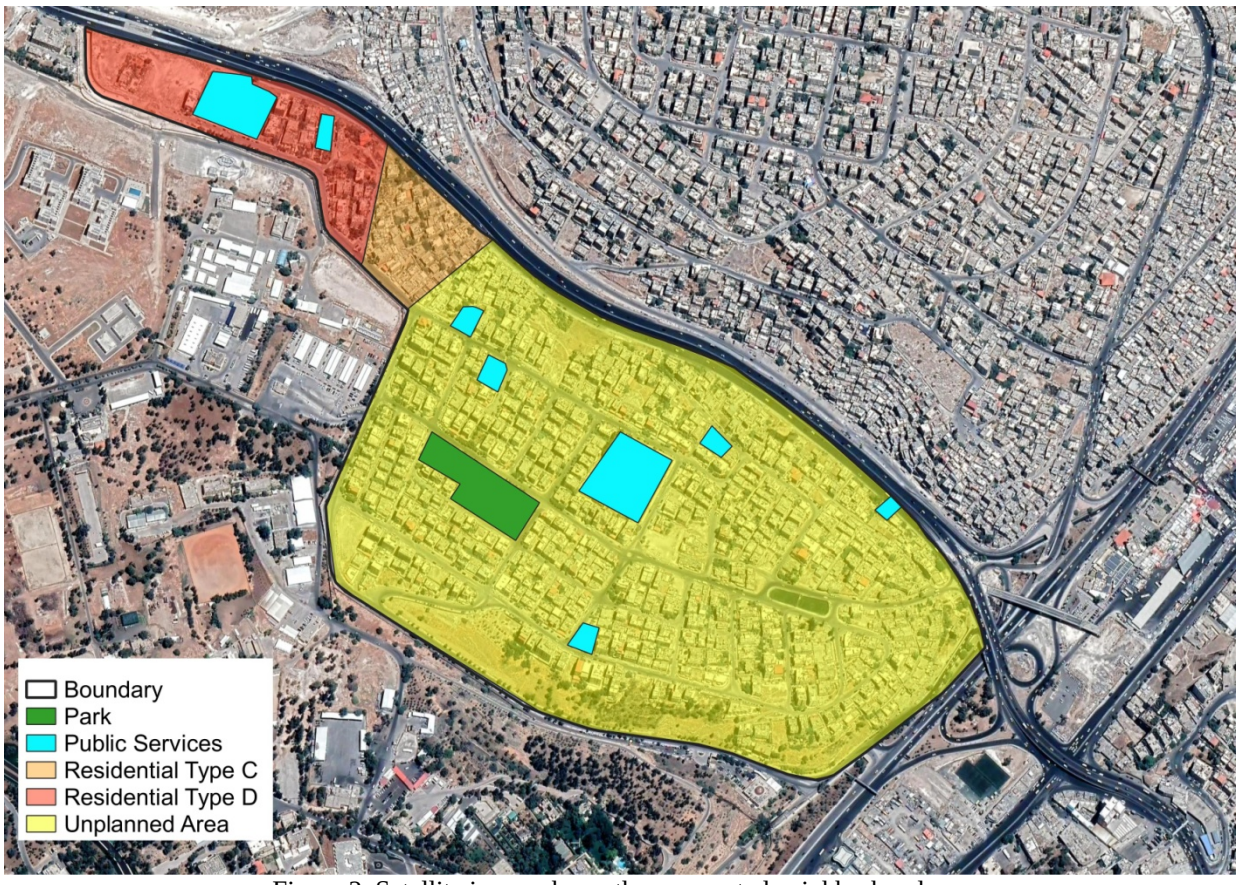

Figure 2. Satellite image shows the compacted neighborhood

Al Hashmi Al Janoubi neighborhood is further analyzed by the GIS program based on its context, refugee presence, access to transportation, access to basic services, and access to public facilities. It was used to undertake the spatial analysis throughout the proposed plans, and assess the accessibility to public facilities within a walkable distance of 15 to 30-minute. The site analysis shows that there are three schools for male and females, four mosques, one public park, and one public health center (Figure 3). The accessibility to these services is very high. Moreover, the street network analysis shows that all services located within a walkable

distance, 40.9% of the population have access to these services within a 5-minute walking distance and 100% within a 15-minute (Figure 4). The preparation of urban planning analyses for the selected area will help in proposing various planning scenarios and arranging priorities that improve living conditions thus enhancing the quality of life; these priorities can be identified, discussed, and converted to actions. It gives a comprehensive spatial understanding of the existing situation as a basis for decision-making. This provides a unique opportunity for stakeholders with different mandates to work together to connect short-term plans with long-term strategies and investments, enabling the development of more inclusive communities.

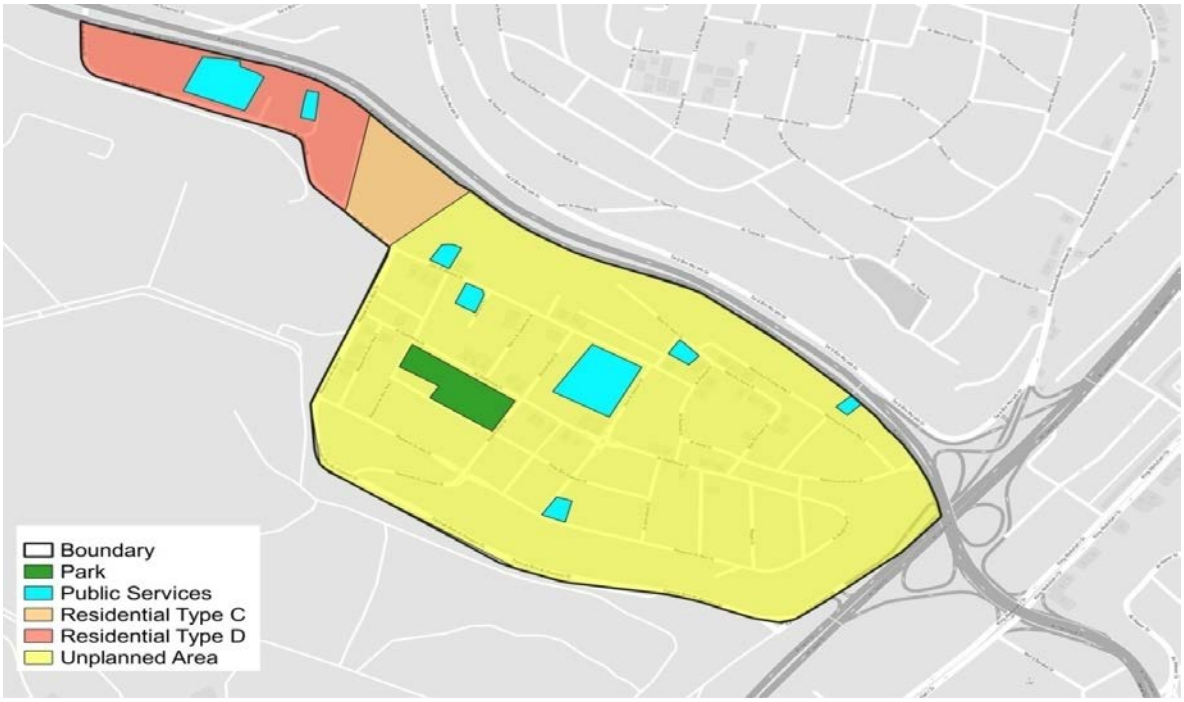

Figure 3. Land use map

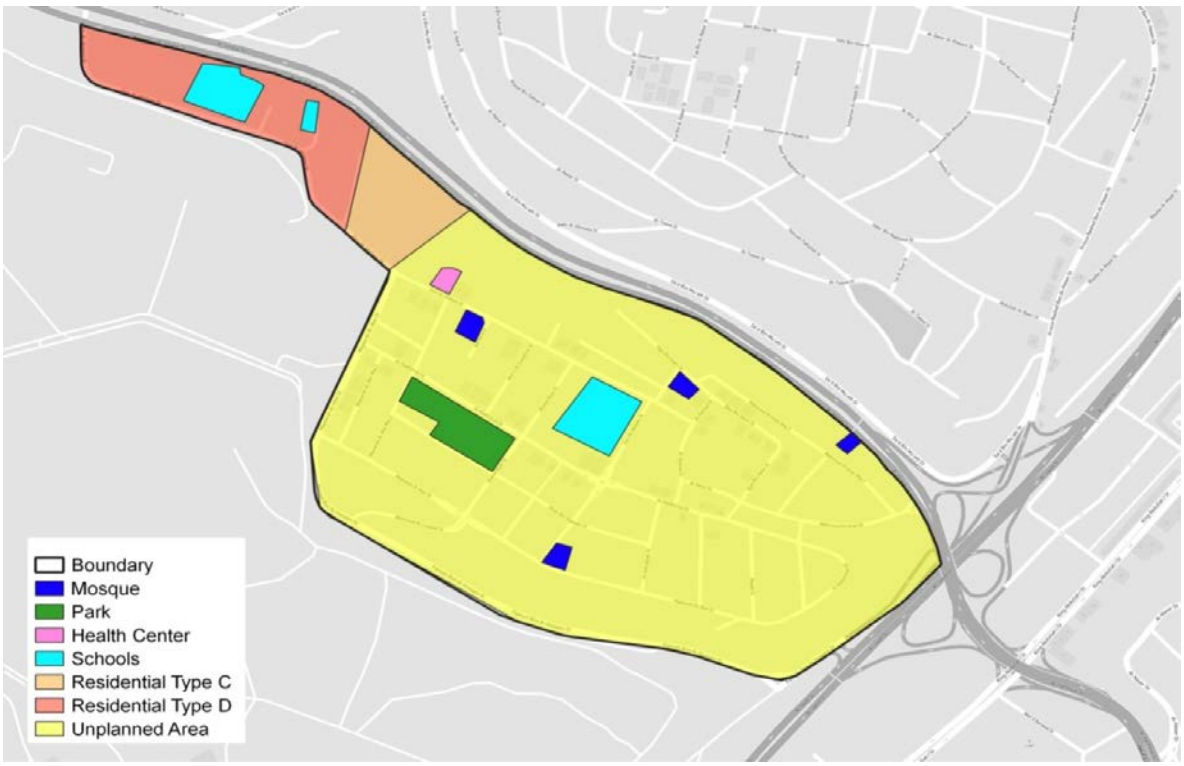

Figure 4. Access to public services

Findings: Challenges and Opportunities

The spatial planning of Amman has revealed various strategic challenges accompanied with the waves of migrations at various levels. At the national level, the major challenge identified is unequal urbanization, whereby weak urban planning practices and influxes of refugees have led to inadequate distribution and access to basic services and public facilities. Accordingly, this rapid urban growth has resulted in urban sprawl that increased the demand on services, thus maximize the pressure on Greater Amman Municipality, who have limited resources to fulfill this gap. This has impacted the quality-of-service, as well as the quality of life for locals and immigrants. Moreover, the lack of affordable adequate housing has become a critical issue due to the inflated prices of land, construction, and energy. Furthermore, inadequate transportation has resulted in major environmental, economic, and social challenges, as public transportation is slow, costly, and time consuming, thus, mainly used by the refugees and locals with low incomes. Refugees and host communities are currently facing outstanding challenges caused by the COVID-19 pandemic, which has resulted in increasing unemployment rates. The Municipality has limited capacity to support local economic development, while also facing constraints to finance service delivery.

At the neighborhood level, it was discovered that Al Hashmi Al Janoubi neighborhood in Amman lack access to health care facilities as it has only one public health center, although it is located within a walkable distance but still not enough to fulfill the residents' and migrants' needs. The neighborhood also has some challenges concerning road maintenance, whereby there is a need for speed bumps, pedestrian crossings, pedestrian bridges on the main roads, safe walkways, street-lighting and furniture.

The neighborhood has no assigned commercial land uses within its boundaries, instead, small commercial shops that are usually on the ground floor of mixed-use buildings are used to serve residents. It is clear that the outdated "Law of Planning of Cities, Villages, and Buildings, No.79", which was established in 1966 affected the land use, the facility distribution, as well as the urban fabric. Furthermore, the area lack of children facilities and it is not designed for people with disabilities, besides the lack of maintenance and rehabilitation of the existing public recreational facilities, and a lack of green elements and spaces. There are also some concerns about the safety of the park at nights as it becomes a men domain and cannot be used by women and children.

Although these challenges specifically affect the achievement of the SDGs goals, but still, there is a significant opportunity to address the challenges associated with migration. At the national level, the Syrian refugee crisis can be transformed into a development opportunity that attracts new investments and boosts the local economy. Amman has a high proportion of youth where more than half of the population are under 25 years old (The Department of Statistics, 2020). This means that there is a growing labor force, less demand on health facilities, and reduced dependency rates. Moreover, the COVID-19 pandemic and restrictions raised awareness on the importance of spatial planning, the availability of green open space, of investing the vacant lands for green open spaces, urban agriculture to reduce unemployment, mitigate climate change impact, enhance the residents' socio-economic conditions, and achieve food security. Likewise, developing adequate mobility options will give the opportunity of minimizing the environmental impact and increasing the residents' socioeconomic conditions and access to job opportunities. The strategic location of Amman, and the enhancement of affordable and accessible public transport is an important opportunity that can enhance the socioeconomic opportunities. As there are several planned infrastructure projects and investments that will help in promoting sustainability and improving the delivery of services.

At the neighborhood level, the study confirms that there is an opportunity to improve access to healthcare through constructing a comprehensive health centre and upgrading the existing primary health centre within the neighborhood. The mobility of residents could be enhanced through restoring the road infrastructure, adding various means of street furniture such as lighting poles, waste containers and benches, extending a public transport route into the neighborhoods, as well as adding pedestrian bridges. There are also opportunities to encourage diversity in commercial facilities by establishing community centre training centre, and by improving the public spaces, which can host various social activities, bazaars, cafes and restaurants, thus boost the livability of the public areas.

Conclusion

Technology played a fundamental role in urban infrastructure development. The Geographic Information System (GIS) is used to provide a better understanding of the urban context at different levels, it helps in

creating smart cities by analyzing the collected data and transform them into maps. The analyses outcomes are then presented for local communities and stakeholders. This research aim at highlighting the advantages of Using GIS Technology in urban infrastructure development at Migration Areas in Amman the capital of Jordan.

The waves of emigration have played a vital role in shaping the country's politics, economy, and urban characteristics. A specific neighborhood in Amman is selected as an example to understand the impacts of these migrations based on the infrastructure development analyses using the GIS. The findings of this research confirm the essential need for smart cities with more inclusive plan to help in decreasing the vulnerability of both refugees and host communities thus enhance the social sustainability.

Recommendations

It is recomended that the findings of this research considered as a foundation for decision- making when developing the urban infrastructure at the migration areas. The challenges and opportunities identified in this spatial planning for the selected neighborhood can be entry points for future national and international strategies.

Scientific Ethics Declaration

The author declares that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the author.

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