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Urban challenges in Dammam metropolitan area: the oil capital of Saudi Arabia

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Sustainable Development Goals (SDGs) form one of the internationally recognized frameworks that guide sustainable urban development. In line with Saudi Vision 2030, the Saudi government aims to increase the livability of Saudi cities. The aim of this study is to assess the current status of the SDG 11 key factors at the local government level in Saudi Arabia. Thus, Dammam Metropolitan Area (DMA) was selected as a case study. A questionnaire survey and a purposive sampling technique were utilized to assess the SDG 11 key factors. The Relative Importance Index (RII) was utilized as a technique to analyze the collected data and establish the most significant challenging factors within the city level based on feedback from public sector stakeholders. The study found that the most challenging SDG 11 key factors in DMA are first, SDG 11.1 Access to safe, affordable, accessible, and sustainable transport systems for all, with RII (0.845); second, SD G11.7 Universal access to safe, inclusive, and accessible green and public spaces, with RII (0.809); and third, SDG 11.1 Access to adequate, safe, and affordable housing and basic services and slum upgrading, with RII (0.787). This study offers insight into their combined efforts toward achieving inclusive, resilient, and sustainable urban development for policymakers, scholars, and practitioners. Additionally, it promotes SDG 11 by highlighting avenues for further study, knowledge sharing, and cooperation.

KEYWORDS

SDG 11, sustainable urban challenges, Saudi Arabia, Dammam metropolitan area (DMA), urbanization, stakeholder perspective

1 Introduction

The twenty-first century is referred to as the urban century, with more than half of the global population living in urban areas. In the last 40 years, the world population has nearly doubled, while metropolitan areas have increased by more than 150% (Melchiorri et al., 2018). The critical population density that facilitates agglomeration economies also enhances chances for reflexivity, information and knowledge exchange, cultural interactions, and more efficient delivery of services, especially in health and education. These are fundamental components for social growth, the progress of civil society, improved wellbeing, cultural consolidation, transformation, and cosmopolitanism. However, significant urban expansion has resulted in the increased consumption of natural resources and ecosystem services, thus intensifying constraints on finite resources and presenting a variety of urban situations that offer unprecedented environmental, social, and economic challenges for policymakers and planners (Almulhim and Cobbinah, 2023). Indeed, this can be considered a global phenomenon. In 2015, the General Assembly

of the United Nations developed 17 Sustainable Development Goals (SDGs), which aim to ensure that by 2030, no nations are left behind in achieving sustainable urban development (United Nations, 2018). Furthermore, SDG 11 aims to "make cities and human settlements inclusive, safe, resilient and sustainable". In addition, within SDG 11, the aim is to cover key factors that relate to a wide variety of urban issues from access to services, infrastructure, and affordable housing to cultural and natural heritage (Nabiyeva et al., 2023). Given the importance of cities, SDG 11 is central to all SDG processes.

SDG 11 specifically aims to address the challenges of the environment and promote fair and inclusive urban development in a way that ensures social justice and the equal distribution of ecological benefits and burdens. In such cities, individuals would have equal access to services that are affordable, and this allows their participation in the different aspects of life in the city. According to Mishra et al. (2024), SDG 11 serves as a platform for monitoring as well as directing urban development, ensuring equity, fostering socio-economic development, and guaranteeing the protection and inclusion of the environment. Given the increase in urban populations, it is more important than ever to translate these elements of SDG 11 into regional plans and policy efforts, which call for local governance structures built on a shared framework and understanding across local authorities (Biggeri et al., 2023). In this vein, Hansson et al. (2019) emphasized that achieving a localized framework for local governments to implement is vital, though challenging, especially regarding the availability of data. However, there is a gap in the procedures to examine and assess the implementation of the SDG 11 key factors. According to Vaidya and Chatterji (2020), it should be recognized that the lack of constant data collection and of a well-known method and procedure to implement SDG 11 has resulted in inconsistences and gaps in the knowledge required to achieve certain factors. In addition, according to Nabiyeva et al. (2023), even though SDG 11 is recognized as a landmark step to achieve sustainable urban development, significant questions remain regarding its implementation. Thus, it is crucial to assess the implementation of the SDG 11 key factors from the perspective of local government actors. Therefore, this research was conducted to gain a better understanding of the achievement and implementation of SDG 11.

Research on SDG 11 has been conducted in different international contexts. However, Saudi Arabia faces specific urban issues, including environmental pollution, urban sprawl, housing affordability, and traffic congestion, which have made the achievement of SDG 11 targets a particular issue. Nonetheless, since 2016, the Saudi government has established objectives in its Vision 2030 to elevate the level of its cities to rank among the world's best. One objective for Vision 2030 is for 20 Saudi cities to be ranked among the top 100 most livable cities globally (Saudi Vison, 2030, Saudi Vison 2030, 2016). Furthermore, in accordance with the 2030 Agenda for Sustainable Development, member states reached an agreement on the development of the 17 SDGs. The objectives are engineered for integration and indivisibility and to equilibrate the different aspects of sustainable development. These goals aim to tackle urban issues and enhance sustainable development and urban lives (Alharthi et al., 2019).

To the best of the author's knowledge, no empirical study has been conducted on the realization of SDG 11 from the perspective of Saudi local government practitioners. Thus, this study aims to examine the key factors affecting the achievement of SDG 11 with regard to the practice and implementation of local government in Saudi Arabia. Dammam Metropolitan Area (DMA) was selected as a case study. This study is both important and relevant, first, because paragraph 29 of the 2030 Agenda advises member states to "conduct regular and inclusive reviews of progress at the national and sub-national levels, which are country-led and country-driven" and calls for "follow-up and review mechanisms" for the SDGs (Abubakar and Aina, 2019). Second, it highlights and assesses the current challenges to SDG 11 key factors, which require action to enhance efforts towards achieving the SDGs. Thus, the current study is significant for policymakers, local government authorities, and urban planners.

2 Literature review

Cities expand in a process that involves the removal of significant portions or the entirety of the original vegetation to accommodate buildings, roads, and other needed infrastructure (Youssef et al., 2020; Khair et al., 2020). This process is sometimes characterized by disorderly and escalating growth and the expansion of urban areas, with a low density of population and with changes that are distinguished by the speed of growth of built-up areas exceeding the population growth (Schiavina et al., 2022). This phenomenon, known as urban sprawl, occurs as a part of the urbanization process and is led by a high urbanization rate and the high concentration of people in urban areas. This, in turn, influences the sustainability of the cities; it affects the quality of life of the communities and is reflected in several urban issues.

Within the different international contexts and based on diverse socio, economic, political, environmental, and cultural aspects, urban issues vary from one city to another. Cities are considered not only as centers for human activity but also as places where environmental, social, and economic issues are exacerbated (Rubiera-Morollón and Garrido-Yserte, 2020). Where rapid urbanization occurs, it can become a significant issue, as it intensifies economic inefficiencies and has environmental repercussions. According to Bartniczak and Raszkowski (2022), to align the process of development in cities, it is important to meet the needs of vulnerable groups in urban areas, as these groups act as the driving force for rapid urbanization. This can be achieved by providing them with medical care, educational services, recreational facilities, and transportation. However, it is a challenge for cities to provide food, shelter, transportation, and education, and some serious environmental, social, and political problems can be encountered (Auwalu and Bello, 2023).

Furthermore, rapid urbanization has led to a decline in the vital functions that render an area livable; issues include difficulties in waste management and resource allocation, deficiencies in atmospheric quality, health complications, congestion, and an inadequate, deteriorating, and antiquated infrastructure (Hamamurad et al., 2022). In addition, according to Dadashpoor and Ahani (2021), intra-urban social inequalities, economic inefficiency, general environmental impacts, access to basic infrastructure and utilities, spatial development, multi-level governance, and institutional capacity are challenges that cities face with regard to sustainable development. As part of a global effort to enhance the progress of urban sustainable development and

improve the quality of life for individuals and communities, the aims of SDG 11 go beyond considering urbanization as merely a result of population growth and a demographic phenomenon; instead, it may be viewed as a revolutionary process that can accelerate several facets of global development. It offers a comprehensive reference model to achieve sustainable development, which addresses a number of interconnected urban challenges with an emphasis on sustainable urban development (Vaidya and Chatterji, 2020). It attempts to strike a balance between social inclusion, environmental preservation, and economic development (Leal Filho et al., 2019).

To consider the aims of SDG 11 in more detail, making human settlements "inclusive" refers to ensuring and providing access to environmental goods and services, such as sustainable transportation, basic housing, and urban green spaces, "particularly for women and children, older persons, and persons with disabilities", or with careful consideration of vulnerable groups' needs (Thomas et al., 2021). In this context, "safe" refers to more than just the reducing the incidence of crime and violence; it also involves eliminating poverty, fostering a sense of self-worth, and protecting cities from the threats posed by environmental contamination (Abubaker et al., 2020). Also, the meaning extends to protecting the cities from the danger of high levels of pollution that present serious health hazards, including early mortality (United Nations, 2018).

Furthermore, "resilient" refers to the ability of a city to recover its functions and structures after manmade or natural disasters (Abubaker et al., 2020). A resilient city is a city that can bear several burdens; these can be divided into two types: (a) "slow-burn" or yearly pressures on cities, such as resource consumption, aging populations, pollution, unemployment, climate change, and infrastructure deficit; and (b) unexpected events with immediate effects including bankruptcy, earthquakes, significant infrastructure disruptions, and extreme weather disasters like floods and droughts. A city's ability to create long-term plans, its management procedures, and the efficiency of its urban system in demonstrating tenacity during crises and catastrophes are important indicators of local resilience (Zeng et al., 2022). "Sustainability" refers to the capacity of the environment to fulfil the needs that are considered fundamental to living and non-living environmental components, economic structures, and sociocultural components. It is essential to recognize and plan for the current and future requirements of these elements. In other words, sustainability is the capacity of the environment to maintain itself (Almulhim and Cobbinah, 2023). According to Auwalu and bello (2023), a sustainable city strives to lower or eliminate the impact of unplanned urbanization and to avoid issues of inadequate sewage and garbage disposal; these have a negative impact and lead to an environmental crisis, which in developing countries, costs local governments 30%–50% of their annual budgets.

This review shows that SDG 11 aims to make human settlements "inclusive", "safe", "resilient", and "sustainable"; adopting this as a normative vision for sustainable urban development can help developing countries address a number of urbanization challenges. For the global goals outlined in SDG 11 to be implemented effectively and to significantly impact people's daily lives, they must be integrated with the local development agenda (Franco and Tracey, 2019). Thus, SDG 11 serves as a guide for urban local bodies and other urban governance-related institutions on integrating the SDG 11 objectives into local planning and governance structures. Although SDG 11 lays out broad aims, it is necessary to localize and integrate the universal goals into local development processes to actually improve people's lives. In this regard, urban local bodies play a critical role. Through local urban planning development and budgetary priorities, the targets of SDG 11 must be harmonized and benchmarked with the infrastructure delivery process in order to make time-bound progress toward achieving sustainability goals.

Several studies have investigated SDG 11 in different international contexts. For example, in Spain, Martínez-Córdoba et al. (2020) used secondary data available from government agencies and found a positive trend towards achieving SDG 11, though with differences depending on the government; where citizen participation increases, progressive governments are concerned with inclusive and sustainable urbanization, while conservative governments prioritize slum upgrading and safety in inclusive and accessible public spaces. Ionescu et al. (2024) similarly accessed government agencies to obtain secondary data; their study showed that most European countries exhibit a positive trend toward SDG 11. Meanwhile, in Japan, Yamasaki and Yamada (2022) conducted a survey and found that a level of urbanization was associated with both the fiscal capacity index and a high quality of life/satisfaction since urbanization entails the development of public facilities and transportation networks in the area, and population expansion brought on by urbanization raises both the quality of life and the fiscal capacity index.

In contrast to the benefits, there are disadvantages. For example, urbanization also results in increased air pollution. These intricate trade-offs between indicators show how important it is to take local government-specific urbanization issues into account when creating sustainable urban planning and development policies to meet the SDG 11 targets. In Hainan Province in China, a study by Zhang et al. (2021) collected secondary data from several government agencies; their study revealed that where the local government has not yet implemented integrated development planning, overall implementation of SDG 11 has been low. In Nigeria, Abubakar and Aina (2019) conducted a desktop study and found that the implementation of SDG 11 improves the possibility of meeting a number of targets by 2030. Given the importance of local government implementation, the aim of this study is to examine the key factors affecting SDG 11 targets at the local government level in Saudi Arabia, in the case study of DMA.

3 Methods

3.1 Study setting

DMA is situated between latitudes 26° 06′N to 26° 30′N and longitudes 49° 40′E to 50° 15′E along the Arabian Gulf (Figure 1); it borders the Ad-Dahna dunes and spans approximately 380,000 ha (Alqahtany et al., 2022). The area has a dry hot desert climate, receiving sparse rainfall, averaging 86 mm, which generally occurs between December and April (Abdelkarim, 2020). In the summer months, the average temperature is 34°C but the temperature often reaches as high as 50°C, thus increasing the rate of evapotranspiration. While the summers are long, humid, and dry, the winters are dry, windy, and cool with temperatures

FIGURE 1
Dammam metropolitan area. Source: (Dano et al., 2023).

going as low as 5°C (UN-Habitat, 2019). A prominent characteristic of DMA is its coastline along the Arabian/Persian Gulf, which stretches from the southern to the northern regions along the eastern and northeastern borders, creating a unique waterfront (Abdelkarim, 2020). Dammam, Khobar, and Dhahran are the three major cities that form DMA. Dammam has services at the regional level where there are major regional-level administrative institutions. The commercial center of the province is located at Khobar, while Dhahran is the oil hub, with a research cluster and a cultural centre; it also hosts the headquarters of Saudi Aramco and the King Abdulaziz Centre for World Culture (Abdelkarim, 2020).

With regard to transport, the metropolitan area is well connected nationally and internationally through highways, railways, and sea/air ports. It is linked to the rest of the world through King Fahd International Airport, King Abdulaziz Seaport for imports and exports of crude oil and petroleum products, and the 25 km King Fahd Causeway linking Khobar with Bahrain (Figure 1). It is 80 km from Jubail Industrial City, 150 km from Alhasa, and 400 km from the capital Riyadh. It is also connected to other Saudi cities by a railway line and the Gulf Cooperation Council Road, which connects DMA to the states of Kuwait, UAE, Qatar, and Oman. Therefore, this facilitates domestic, regional, and international cultural and economic exchange.

3.2 Data collection and analysis

The method this study adopted comprised two steps. First, a desktop study using secondary data helped to identify key findings within the study context. Second, a quantitative approach with a questionnaire was utilized to collect data for this study, since it is considered the best strategy for learning about the attitudes and actions of a large number of participants. Additionally, such an approach helps to explore and assess expert opinion and the views of urban local government practitioners about the challenges SDG 11 key factors face with regard to urban sustainability in DMA. The questions were developed based on analogous research and previous literature. The questionnaire was evaluated for clarity and precision by research colleagues prior to its distribution to urban governance stakeholders. A preliminary pilot survey was performed to enhance the instrument's reliability.

Closed-ended questions were utilized; these allow the respondent to choose from pre-determined answers. The questionnaire survey consisted of three main sections. The first section was concerned with data on the demographic variables of the participants, such as job sector and job ranking. The second section evaluated SDG 11 key factors from urban governance stakeholders' perspectives. The third section allowed participants to highlight and add any additional comments. A Likert-type scale ranging from 1 to 5 was used to measure the relative importance of the sustainable factors in DMA as follows: (1) is "strongly disagree", (2) is "disagree", (3) is "moderate", (4) is "agree", and (5) is "strongly agree". SPSS software was utilized for data entry and analysis.

The Relative Importance Index (RII) was utilized to identify the most significant challenges faced by SDG 11 key factors based on feedback from respondents, such as urban governance stakeholders. Several studies have utilized the RII in ranking SDGs (Marzouk et al., 2022; Alawneh et al., 2024). The RII is significant in this study, as it quantifies the degree of importance of the SDG 11 key factors. It is particularly beneficial for questionnaires employing a Likert scale. In addition, in this study, RII is employed to evaluate the significance of the challenging aspects of SDG 11 key factors in DMA and rank them according to the degree of influence over the sustainable urban development of DMA based on the following formula:

$$(RII) = \frac{\sum w}{A * N}$$

- W = weight was given to each urban challenge by the respondent within the range from 1-5 multiplied by the number of respondents for each challenge.
- A = highest weight
- N = number of respondents

Using purposive sampling techniques, the questionnaire targeted 115 respondents in the DMA urban governance agencies working in the middle and upper management levels. To make it easier for participants to access the survey, an interactive link was added to the email sent to the targeted respondents to increase the response rate. Out of 115 invitations sent to the targeted respondents, 106 surveys were completed and returned, representing a response rate of 92%. Table 1 present demographic details of the study participants. In addition, to ensure the reliability of the study, Cronbach's alpha reliability test was conducted; the overall Cronbach's alpha reliability coefficient was 0.90, which indicates high internal consistency and reliability for the collected data (Hair et al., 2006).

4 Study findings

This section analyzes the assessment of the SDG 11 key factors within DMA local government in meeting six targets of SDG 11 from 10 key factors as presented in Table 2. In this study, the following key factors were eliminated:

- 11.4: "Protect the world's cultural and natural heritage"
- 11.7A:"Support positive economic, social and environmental links between urban, peri-urban, and rural areas by strengthening national and regional development planning".
- 11.7B: "Increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030 and holistic disaster risk management at all levels".
- 11.7C: "Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials".

The justification for eliminating these four factors is because there is no natural cultural heritage within the study area (11.4). Also, there are no comprehensive data that reflect the implementation of 11.7A and 11.7B, while 11.7C is not within the scope of this study.

4.1 Access to safe, affordable, accessible, and sustainable transport system for all

Mode of transportation and traffic congestion have an impact on people's daily urban lives in contrast to Target 11.2: "By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" (Abubakar and Aina, 2019). This study found that SDG 11.2 was identified as one of the top ranked challenging factors in DMA, with 90% of the study participants strongly agreeing and agreeing that transportation and traffic congestion is a challenge. The RII (0.85) and mean (4.226) reflect that the participants' opinions were clustered around agreeing. The city's roads and highways are often congested, leading to long commutes that reduce accessibility and mobility for residents. Congested roads increase the cost and time of transporting goods and services, leading to inefficiency and prohibitive costs of doing business and limited economic opportunities among residents.

Baker and Lee (2019) stated that the challenges of traffic congestion in urban areas are a consequence of poor public transportation systems and urban sprawl. According to AbouKorin et al. (2020), statistics indicate that, as of 2017, the average car ownership per household in DMA was 1.28. The travel mode share was private car (78.8%), taxis (9.17%), and public transport (6.39%), while transport provided by employers and schools constituted the least at 5.74%. This share of public transportation is low compared to the global average of 60% (UN-Habitat, 2019). In addition, a Royal Decree of May 2018 allows women to drive independently and travel domestically or internationally, and women-only driving schools have already been established in DMA, which is likely to increase the rate of car ownership. Thus, there is a heavy reliance on private cars for daily commuting in DMA as a car-oriented society. However, according to Almatar (2023), the current traffic systems designed within DMA are not well established to cater for the rising

TABLE 1 Demographic details of the participants.

Demographic variables	Categories	Number	Percentage
Gender	Female	42	39%
	Male	64	61%
Education Level	PhD	9	8%
	Master	16	15%
	Bachelor	53	50%
	Diploma	13	12%
	High school or less	15	14%
Organization's nature of business	Public	75	71%
	Private	22	21%
	Academic	9	8%
Job Positions	Higher Management	23	22%
	Middle Management	63	59%
	Employee	20	19%
Total	106		

TABLE 2 SDG 11 key factors in DMA.

SDG 11 key factors	Mean	RII	Ranking
Access to safe, affordable, accessible and sustainable transport systems for all	4.226	0.845	First
Universal access to safe, inclusive and accessible, green and public spaces	4.047	0.809	Second
Access to adequate, safe and affordable housing and basic services and slums upgrading	3.938	0.787	Third
Reducing the adverse *per capita* environmental impact of cities	3.742	0.748	Forth
Inclusive and sustainable urbanization and human settlement planning	3.735	0.747	Fifth
Reducing deaths and economic losses caused by disasters	3.273	0.654	Sixth

numbers of private cars. Increased traffic congestion leads to increased accident levels, and has impacts on health as well as other environmental impacts, such as noise and air pollution within the cities.

In late 2022, a bus raid transit (BRT) system was launched in DMA, covering 8 routes with a total distance of 400 km and 212 bus stops. There is a fleet of 85 modern buses equipped with AC, safety measures, and facilities for people with special needs; the buses operate 18 h a day with a trip fare of 3.45 SAR. In 2023, according to Eastern Province Municipality (2023), the total number of users reached 1,617,320, and 24% of citizens and 76% of non-Saudi residents use the BRT system. Also, 84% of users are male and 16% female; 71% use the bus to commute to their work, 11% for shopping, 9% for other uses, 5% for recreation, and 4% for studying. Furthermore, Nahiduzzaman et al. (2021) study identified the social and cultural stigma and barriers embedded in the use of the BRT in DMA, where inconvenience has been identified the highest impact factor, while comfort, fare, privacy, timing, and feeling safe were found to be medium impact factors. Also, Al-Rashid et al. (2020) study found that privacy concerns are the major driver of the stigma against using public transportation, with many residents hesitant to ride with their families since public transport fails to consider gender needs. In addition, wealthy individuals are more stigmatized by this mode of transportation. Because of significantly subsidized and low fuel costs, as well as increased financial affordability, many Saudis utilize private vehicles for everyday transportation. Concerns about privacy, comfort, inconvenience, and schedules as well as the scarcity of (functioning)

public transportation all contribute to the preference for private automobiles for intracity transit (Nahiduzzaman et al., 2021). Thus, for the above reasons, SDG 11.2 is identified as being the top ranked and top key challenging factor in DMA.

4.2 Universal access to safe, inclusive and accessible, green and public spaces

One of the essential challenges of the high urbanization rate is the demand for and efficiency of green and public spaces. SDG 11.7 states, "By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities" (Abubakar and Aina, 2019). In this study, 89% of the respondents agreed that the efficiency of the infrastructure and social services is one of the top urban challenges in DMA, with RII (0.809) and mean (4.047), which shows that respondents clustered around 'agree'. This finding is in line with Abdelkarim (2020) study, which showed that in DMA, there is a low *per capita* green zones rate (3.52 m2/person) and a poor distribution of green zones, with 45 districts having no green area.

In addition, another study found that in DMA, providing social services and green infrastructure is crucial, and that includes enough parks and green areas of different sizes; the distribution of green and public spaces is considered a major challenge, where the growth trend in the outskirts of DMA is rapidly increasing the demand for green and public spaces. Moreover, in DMA, more than 50% of land is allocated to urban activities, which is considered vacant land use (Almatar and Alhajri, 2024). The development of these inhabited areas, especially in terms of infrastructure and public services, is expensive and leads to the problem of efficiency in the provision of overall green and public spaces in DMA. Thus, SDG 11.7 is considered the second top key challenge in DMA.

4.3 Access to adequate, safe and affordable housing and basic services and upgrading slums

Access to housing and basic services is an essential factor in the sustainability of any community. SDG 11.1 states, "By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums" (Abubakar and Aina, 2019). In this study, 87% of the participants agreed or strongly agreed that access to housing and basic services is a challenge in DMA. RII (0.787) places SDG 11.1 as the top third urban challenge in DMA with a mean (3.938) indicating that expert opinion is grouped around 'agree'. The available housing options are obtaining a house through the public housing program or direct purchase from the housing market through bank loans and/or savings. The median household income was SAR 15,000 per month (USD 4,000 based on an official exchange rate of 1 USD = 3.75 SAR), whereas the average cost of an affordable residential apartment was estimated to be SAR 2,045 per m^2, and that of a villa (single-family detached duplex) was SAR 3,253 per m^2 (Alhajri, 2024). Therefore, a typical inexpensive 3-bedroom villa with a floor area of approximately 280 m^2 costs around SAR 910,840 (USD) in DMA, which is more than the 5-year total of the median annual salary, thus indicating the near impossibility of an individual saving to own a house. Not to mention other more expensive types of town houses and villas.

According to Saudi National Housing Company (2021), as of 2021, there were 92,748 applicants on the waiting list for government-provided affordable houses in DMA. Applicants are categorized as bankable candidates based on their purchasing power and ability to repay loans, while un-bankable candidates are those unable to repay loans due to low financial solvency. Out of the total applicants, 57,878 (62%) are bankable candidates, 25,445 (27%) are non-bankable, while 9,425 (11%) are unspecified (Figure 2). A close look at the statistics indicates a sharp gap between the available housing units categorized by cost and the number of candidates on the waiting lists based on their purchasing power in DMA. With only 4,042 housing units available for 57,878 bankable candidates (a ratio of 1 house to 14 applicants), it could take decades to obtain a house under this scheme. Hence, this figure shows a huge deficit in the supply of affordable housing units in DMA where the supply does not exceed 4% of the total demand of affordable housing. Thus, there is a mismatch between the type of housing supplied by the government in DMA and the purchasing power of the candidates.

Homeownership is expensive due to an increasing demand resulting from the high urbanization rate and increasing rate of household formation, as over 60% of the total population are aged between 15 and 26 years (Alhajri, 2022). In addition, there is a cultural traditional effect on people's preference for single family housing units such as villas. Households in Saudi Arabia are unwilling to live in multifamily housing units with shared entrances and joint spaces, or smaller and cheaper units such as apartments, which are considered disadvantageous. Furthermore, the escalating price of residential land, which is considered a sort of investment channel for many local investors, has kept many plots empty in the hope of future price increases (Alhajri, 2022). Also, in DMA, the absence of a mixed social income is one of the most obvious features. According to AbouKorin et al. (2020), in DMA, 90% of approved residential subdivisions are designated for a single type of housing (villa); meanwhile, there is a shortage of affordable multi-family housing units, which are needed by about 80% of DMA residents.

Key factors affecting home purchasing choices in DMA include the geographical location within the city; proximity to essential neighborhood amenities, such as schools, mosques, primary health centers, parks, workplaces, and central business districts; and the primary method of housing financing, that is, a loan, savings, and employer financing. Similarly, realtors focus on newly developed and well-serviced neighborhoods, resulting in elevated house prices that pose a challenge for low-income households seeking homeownership. Regarding the upgrading of slums, there are no identified slum areas within the study context.

Furthermore, in DMA, given the dry and hot climate, water usage stands as a crucial facet of the city's operations, as highlighted by MOMRA regarding the pressure of water scarcity on DMA. While the Dammam municipality oversees city management, the Ministry of Environment, Water, and Agriculture (MEWA) centrally handles the water sector. Despite high national costs incurred by municipal water supplies, the service levels remain suboptimal (Gazzeh and Abubakar, 2018). Within DMA, the water network covers 84.2%, and 15.8% is received and transported by water tank. Also, 284.8 L/day/person, and the average water consumption per person in DMA is 416 L/day/person (Regional Urban Observatory, 2017).

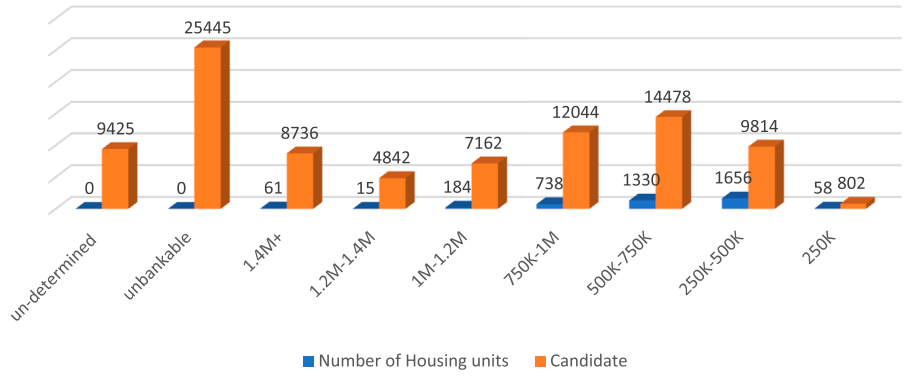

FIGURE 2
Candidates for affordable public housing in DMA based on purchasing power. (Source: Saudi National Housing Company, 2021).

4.4 Reducing the adverse *per capita* environmental impact of cities

The quality of air and waste management has a direct impact on the sustainability of any community. The aim of SDG 11.6 states, "By 2030, reduce the adverse *per capita* environmental impact of cities, including by paying special attention to air quality and municipal and other waste management" (Abubakar and Aina, 2019). This study found that SDG 11.6 ranks lower as a key challenge in DMA where 68% of participants agreed that air pollution is a challenge, and the RII (0.748) and mean (3.742) reflect that participants' opinion clustered between 'agree' and 'neutral'. Alwadei et al. (2022) found that one of the major environmental challenges in DMA is air quality and pollution, which affects the environmental viability of DMA. In DMA, industrial areas and the low cost of fuel are the main causes of air pollution, while the low cost of fuel and a limited public transportation system have led to an increase in the number of private automobiles (Dano et al., 2023). Thus, the air quality in Dammam is among the most polluted and toxic in the country, adversely affecting the overall quality of life of its inhabitants (UN-Habitat, 2019).

Furthermore, Alwadei et al. (2022) study revealed that crustal thickening, sulfate-rich factor, sea salt, nitrate-rich factor, biomass burning, and transportation are the six main causes of PM2.5 levels in DMA. Another study by Tawabini et al. (2017) found that the mean levels of PM10 concentration were approximately 177, 380, and 126 μg/m3 in Dhahran, Khobar, and Dammam, respectively. The PM obtained in Dhahran had a mostly platy and rod-like structure, with a size ranging from 2 to 6 μm. In contrast, the PM collected in Khobar displayed largely irregular shapes, with a size ranging between 2 and 8 μm. The PM collected in Dammam, on the other hand, had a spherical shape and varied in size from 1 to 3 μm. The EDX and XRF analyses reveal elevated weight percentages of carbon (C), oxygen (O), silicon (Si), fluorine (F), and calcium (Ca) in the three cities, whereas sodium (Na), magnesium (Mg), and potassium (K) exhibit decreased weight percentages.

Regarding waste management in DMA, landfill is the dominant form of waste disposal, while the recycling rate ranges from 10.5% to 15.5%, and this is done by informal scavengers (Labib et al., 2021). In addition, the waste management system in DMA means waste is collected for free from community and individual bins and disposed of in landfill sites. However, most of this landfill will reach its maximum capacity within a few years. Also, reuse, energy recovery, and recycling are at an early stage (Zafar, 2020). Furthermore, in 2005, the total amount of waste produced in DMA was estimated to be about 13 million tons in 2013 and was predicted to reach 18.4 million tons in 2025; this issue is exacerbated by the rapid population growth (Labib et al., 2021). A study in DMA found that 54% of respondents showed a positive inclination towards trash sorting, while 26% expressed discomfort with this practice, and 20% admitted lacking knowledge or guidance on the subject (Almulhim and Abubakar, 2023).

4.5 Inclusive and sustainable urbanization and human settlement planning

The SDG 11.3 target states, "By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries" (Abubakar and Alshammari, 2023). In DMA, urban sprawl occurs where rapid urban expansion exceeds the maximum threshold of the city's growth limit, and it is considered one of the major challenges facing the urban area. This study found that 65% of the study respondents agreed or strongly agreed in identifying SDG 11.3 as one of the key challenges in DMA. The RII (0.747) and mean (3.735) indicate that respondents' opinion clustered between 'neutral' and 'agree'. Previous literature identified urban sprawl and land reclamation as an issue with regard to inclusive and sustainable urbanization in DMA.

In 2018, the overall average density of the built-up area in DMA was 66 p/ha (Dano et al., 2023), which could accommodate about 2.3 million people, according to the UN-Habitat's recommended density of 150 p/ha for a sustainable city. The low population density in DMA is linked to the problem of urban sprawl, where land conversion is beyond the needs of the current population. According to Almatar and Alhajri (2024), in DMA, urban sprawl is associated with rapid population and economic development, lax enforcement of town planning regulations, lack

of experience of the urban planning authority in controlling and managing urban growth, and land speculation in the real estate market.

The built-up area of DMA increased more than 11 times in just 3 decades, going from 2,200 ha in 1972 to 25,000 ha in 2004, and during that time, the population increased by 4.6 times (Dano, 2022). Between 1985 and 2019, Dammam was considered to have the highest urban expansion intensity in the country (1.51% per annum), followed by Riyadh (0.79%), with the bulk of growth occurring after 1997. Edge development (urban expansion on undeveloped land along the periphery of developed areas) was the most common, while infilling was the least common type of urban expansion in DMA (Aljaddani et al., 2022). According to Abubakar and Alshammari (2023), one of the disadvantages of such low-density development is the prohibitive cost of providing infrastructure and services, especially for a city relying heavily on federal budgetary allocations.

Other unsustainable features of these projects are the exclusiveness, the low density, the single housing type, and the poor connectivity with the surroundings. Five specific coastal areas along the Arabian/Persian Gulf saw substantial reclamation activities over the past 2 decades; 66.5%–100% of the reclaimed areas (6,081 ha), which were previously water in 2000, had been transformed into reclaimed land by 2020 (Alqahtany et al., 2022). This transformation has negatively impacted coastal vegetation, as the reclaimed areas have been repurposed into barren lands to facilitate upcoming development projects. Land speculation on seafront properties to increase profit margins is one of the key drivers of landfilling of the coastline. However, large-scale sea reclamation is among the most disruptive activities for marine resources and coastal ecosystems (Abubakar and Alshammari, 2023).

4.6 Reducing death and economic losses caused by disasters

Flash flooding is a significant natural hazard, since it ranks highly among natural disasters based on the rate of fatalities and number of individuals impacted. The SDG 11.5 target states, “By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations” (Abubakar and Aina, 2019). However, this study found that the issue of flash floods has the lowest rank among the SDG 11 key factors in DMA where 49% of the participants agreed or strongly agreed that this was challenge. The RII (0.654) and mean (3.273) indicate that participants’ opinion clustered around ‘neutral’. This finding contrasts with the study by Dano et al. (2023), which revealed that in DMA, coastal flooding and sea-level rise, despite the short rainfall duration, were ranked as having the most significant impact with a 0.36 weight (36%). The location of DMA near the coast and the insufficient infrastructure for rain drainage, which results in regular floods, can explain this finding.

In addition to its coastal location, DMA has been exposed to sporadic instances of intense rainfall, which have resulted in severe flash floods. For example, a significant flash flood that occurred in Dammam in 2017 caused the derailment of a train, which resulted in eighteen individuals being injured. Heavy rainfall in Dammam in 2018 caused major disruption to the transportation networks, resulting in severe traffic congestion, accidents, property loss, injuries, and damage to the local economy. In addition, homes, schools, and other vital institutions were inundated, particularly those situated in low-lying locations (Dano, 2022; Abdelkarim, 2020).

5 Discussion

SDG 11 aim is to "make cities and human settlements inclusive, safe, resilient and sustainable". This covers key factors that are considered to number among the urban challenges faced by different cities both in developed and developing countries. The above findings show that implementation of the six targets of SDG 11 is still considered challenging within DMA, as discussed below. The study found that SDG 11.2 “Access to safe, affordable, accessible and sustainable transport systems for all” is one of the top key factors that challenges sustainable development in DMA. Despite the recent launch of the BRT, the accessibility and coverage remain limited within DMA, and privacy concerns are the major driver of the stigma against the use of public transportation, which leads to DMA being a car-oriented city. Within the literature, smaller studies have found that SDG 11.2 is a challenge. For example, Abubakar and Aina (2019) study in Nigeria found that SDG 11.2 is a challenge, as most Nigerian cities lack a reliable and secure public transportation infrastructure. Public mass transit buses in certain cities, such as Abuja and Lagos, have been characterized as inadequate, and other significant metropolitan centers face a similar predicament. Also, according to Brussel et al. (2019), the operationalization of SDG 11.2 is exclusively linked to the scheduling of formal public transport systems. However, within the Global South, cities mostly rely on informal transportation systems.

Furthermore, the study also found SDG 11.7 regarding universal access to safe, inclusive, and accessible green and public spaces is the second top key challenging factor in DMA, where the scarcity of green areas has been indicated. This is in line with the finding in Shanghai where due to the high population density, the *per capita* rate for park and green space area was limited, which makes achieving the SDG 11.7 target a challenge (Xu et al., 2019). In contrast, a finding from Chenes et al. (2021) in Switzerland revealed that more than 75% of the population has access to urban green spaces within 5–15 min from their home by motorized mode of transport. Hence, this can be reflected in the urban development policies and regulations. Regarding the SDG 11.1 target, access to adequate, safe, and affordable housing and basic services and the upgrading of slums are considered key factors with regard to achieving urban sustainability in DMA. Nonetheless, despite the different housing policies and programs implemented by the Saudi government to increase access to affordable housing, achieving this target remains a challenge. Similarly, in Malaysia, Ebekozien et al. (2024) found that Malaysia’s low-cost housing

schemes threaten the achievement of the SDG 11.1 target. This conflicts with the finding of Martínez-Córdoba et al. (2020) study in Spain, which shows that local government can enhance access to suitable housing and has a significant involvement in slum rehabilitation with high levels of significance for achieving SDG 11.1.

With regard to SDG 11.3 on reducing the adverse *per capita* environmental impact of cities, the findings of this study reveal that this factor is not among most highly ranked key factors that are challenges in DMA even though several studies found that air pollution (Dano et al., 2023) and waste management (Labib et al., 2021) are environmental challenges in the region. Within the literature, a similar study in Europe by Ionescu et al. (2024) found that air pollution caused by fine particulate matter is a challenge facing urban communities and that this needs to be highly prioritized in order to achieve SDG11 targets. Also, in Nigeria, Abubakar and Aina (2019) study found that one of the main obstacles to achieving SDG 11.6 is the decline in urban air quality brought on by emissions from industry and traffic, as well as environmental damage due to unsustainable waste management methods.

For SDG 11.3 regarding inclusive and sustainable urbanization and human settlement planning, the finding from the study reveals that this factor is among the lowest two factors in DMA although urban development planning in DMA suffers from the challenges of urban sprawl, where the low population density means land conversion is beyond the needs of the current population (Dano, 2022). In addition, large-scale sea reclamation is one of the most disruptive activities to the coastal ecosystem and marine resources in DMA (Abubakar and Alshammari, 2023). This is similar to in China, in Wukang, at the center of Deqing County; Cai et al. (2020) study found that the land use development has failed to meet the SDG 11.3 target. Also, in Zambia, Huang and Ming (2024) demonstrated that urban expansion occurs due to the development of industrial parks; this results in an imbalance between population growth and urban expansion, which threatens the achievement of the SDG 11.3 target. Furthermore, regarding the SDG 11.5 target of reducing deaths and economic losses caused by disasters, the study found that this is one of the lower ranked challenging factors in DMA. Several flash floods have been reported in the literature (Dano, 2022; Abdelkarim, 2020); however, in comparison with the other six SDG 11 targets, this remains the lowest ranked. A similar situation is discussed in the previous literature, where Chang et al. (2023) study assessed natural disasters occurring in Guilin City between 2010 and 2020 and revealed that a comparatively large proportion of the city's population is impacted by disasters, meaning achieving SDG 11.5 is a challenge.

The overall finding of the study is that achieving the target of SDG 11 is still limited within DMA due to the urban issues that occur in the region, as discussed above. This is because it is difficult to efficiently manage the rapid urban expansion that DMA faces, meaning sustainable urban development is challenging because of the tremendous strain that rapid urbanization places on housing, infrastructure, services, and resources. Also, poor land-use and urban planning regulations result in ineffective land use, urban sprawl, and insufficient delivery of essential services. Hence, this study's findings contribute to filling the gap in and the shortage of related SDG 11 studies that contribute to the investigation and understanding of regional planning and policy efforts at the local governance level and implementation of SDG11 across local authorities.

6 Conclusion

The high urbanization level has several impacts on communities, and these include social livability, economic prosperity, and environmental sustainability. SDG 11 provides a guide to solve the different urbanization issues cities face to achieve sustainable urban development in both developed and developing countries including Saudi Arabia. This study has assessed the implementation of six key factors of SDG 11 within the local context in DMA. The study found that in DMA, the top three challenging factors are SDG 11.2 Access to safe, affordable, accessible and sustainable transport systems for all followed by SDG 11.7 Universal access to safe, inclusive and accessible, green and public spaces, and then SDG 11.1 Access to adequate, safe, and affordable housing and basic services and slums upgrading.

Even though achieving SDG 11 by 2030 is challenging, the government in Saudi Arabia aims for rapid transformation to meet the aims of Saudi Vision 2030. As long as there is political will by the Saudi government, then launching an effective governance framework for implementing and monitoring SDG 11 targets; providing sufficient funding, cooperation, and support from all levels of government, society, and other stakeholders; and correctly utilizing potential human and material resources, it will be possible to overcome the obstacles presented by urban issues. In addition, including local government in a comprehensive framework that meets the different SDG 11 key factors at the local level will enhance the effectiveness of urban development policies.

Local government policies should encourage people to utilize public transportation and should develop projects that enhance the coverage and accessibility of public transportation in the overall metropolitan area. Also, developing policies that consider and enhance the access to safe, inclusive, and accessible green and public spaces within local urban development policies will help to achieve sustainability in DMA. In addition, enhancing the provision of affordable housing and improving service accessibility, especially to vulnerable groups, requires particular collaboration between government, private, and non-government organizations. This study has assessed the SDG 11 key factors within DMA as a valuable movement to increase the effort to meet SDG 11 and overcome the challenges represented by urban issues.

However, this study has several limitations, as follows. First, the data that reflect and assess the different SDG 11 factors are not available. Recently, the government established urban observation centers at the local level, which may help address this gap in the future. Second, this study collected data through surveying the opinions of local government public sector stakeholders, where the community and the consideration of segments of society consider as a limitation of this study. Third, that lack of assessment of the other remaining factors within this study is a limitation, and these should be considered in future studies. It would also be interesting to compare the

different government levels of implemented policies that seek to achieve SDG 11. These different limitations can be addressed in future studies.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Instituationa Review Board -Imam Abdulrahman Bin Faisal University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MA: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing.

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