Sustainable Neighbourhood Evaluation Criteria – Design and Urban Values (Case study: Neighbourhoods from Al-Mafraq, Jordan)

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Abstract

A sustainable neighbourhood is critical in preserving the environment for future generations, as various societies are suffering from increasing reliance on vehicles and low social interaction. This study aims to compare two neighbourhoods in terms of implementing the sustainable neighbourhood criteria. This study is based on eight sustainable neighbourhood evaluation criteria related to design and urban values are: regional issues, compacted form, mixed land-use, connectivity, pedestrian-oriented building, public sphere of the neighbourhood, relationship with transit, and walkability. University District and Jordan Villa Compound newly developed residential neighbourhoods located in Al-Mafraq city in Jordan were chosen as a case study to evaluate the sustainable neighbourhood criteria. The primary and secondary data were obtained from various resources, including; previous studies that related to the topic, site surveys and personal interviews. The results show that The University District is more sustainable and walkable than the Jordan villa compound; due to several reasons as the grid pattern of planning and the high population density. The importance of this study comes from implementing the sustainable neighbourhood evaluation criteria to develop communities to become more sustainable and walkable.

Keywords: neighbourhood, sustainable neighbourhood, walkability.

Introduction

People have tended to live close together in fragmented areas. They share a place for practical, economical, sociological, and psychological reasons and form a neighbourhood. The clustering of these neighbourhoods has created towns, villages, and cities (Kohon 2018).

The neighbourhood is a social, economic, and physical environment; The social dimension includes residents' daily needs, a variety of housing types and tenure patterns, and social diversity such as; age, income, and cultural background. The economic dimension includes the availability of several house' prices and various services and amenities. And the physical dimension includes design and planning values (Abbas and Najat 2019).

A neighbourhood is the crucial planning entity in modern residential planning theories. Recently, the goal of urban planning and housing projects has been to provide an appropriate setting for people to live now and in the future that is environmentally, socially, and economically healthy; a place that is safe, well planned, and built to last which forms the concept of a sustainable neighbourhood (Butera 2018).

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Urbanisation and industrialisation produce several communities' troubles; many communities are challenging the growing dependence on vehicles, resulting in low-density development and sprawling development patterns. The most significant theories in urban planning are by Clarence Stein and Henry Wright. In an illustration of the town plan called "A Town for the Motor Age" they highlighted that the primary purpose was to construct a town for the automobile age (Sharifi 2016).

Globally, climate change is another problem resulting from urbanisation due to decreased dependence on walkability and high reliance on vehicles. As a result, people realised that there is an urgent need to use sustainable approaches to dealing with the climate change phenomenon, as in most city centres, the focus is on the streets and traffic movement, which means pedestrians are limited on the sidewalks (Butera 2018).

Several initiatives to solve the problems of urbanisation; UN-Habitat (2013) proposes a method that examines existing sustainable urban planning theories in order to build a sustainable relationship between urban inhabitants and urban space. It is built on three pillars: vibrant street life, walkability, and affordability. The fundamental characteristics of a sustainable neighbourhood include social sustainability through having good environmental potential, such as garden provision and proximity to parks (Choguill 2007, Al-Hagla 2008, and Hong 2011). Sustainable communities' components include governance, transport and connectivity, services, environment, economy, housing and the built environment, sociology, and culture (Al-Haggle 2008, Review 2004).

The main objectives of this study are to:

1. Determine the sustainable neighbourhood criteria related to the design and urban values.
2. Evaluate the chosen case studies in terms of applying the sustainable neighbourhood criteria.

The study relies on relevant literature on sustainable neighbourhoods such as UN-Habitat (2013), Elgadi and Ismail (2016), Jasim et al. (2018), Abbas and Najat (2019), Al-Hagla (2008), Azmi and Karim (2012), and Knapskoga et al. (2019) to develop an evaluation model. A physical survey was conducted to assess the sustainable neighbourhood indicators for Jordan Villa Compound and The University District in Al-Mafraq City, Jordan, by field observation at the site.

Literature Review

Neighbourhood Planning

From unplanned housing design to the industrial revolution, the concept of neighbourhood unit was influenced by suffocating traffic, the regression of the city environment, high overcrowding, the distance from basic community facilities, and the insecurity of children going to school (Kohon 2018).

Clarence Perry's model, which he developed in 1929, provided explicit recommendations for the spatial allocation of houses and community services. Perry proposed the neighbourhood concept as a means of addressing transportation issues; accessible from the place of residence to the community centre and elementary schools are considered basics. Residents can obtain appropriate access to community services such as adequate shared play spaces, an elementary school, retail shops, and facilities in the neighbourhood.

According to Clarence Perry's model, the neighbourhood unit occupies about 160 acres with a population of between 5,000 and 6,000 people. This improves the low-density dwelling district with10 families per acre population. It is expected that the children walk from their houses more than one-quarter mile to the elementary school, which has between 1,000 and 1,200 students (Singhal 2011, Azmi and Abdul Karim 2012). Perry's determined six essential elements of good neighbourhood design:

1. For a safer environment, the main street should form the neighbourhood's boundaries; consequently, it should not run through the residential areas.
2. For low-volume traffic movement, cul-de-sacs are used to plan the internal streets that permeate the residential area.

3. The population should be sufficient to sustain the elementary school in the neighbourhood.
4. The neighbourhood's focal point is the elementary school, which is placed parallel to the neighbourhood's boundaries with other services;
5. The neighbourhood's maximum radius should be no more than a quarter-mile, which is the maximum distance a child can walk to any elementary school;
6. The shops should be located at the significant traffic crossroads at the edge of the neighbourhoods.

Arnold Whittick (1974) defined a neighbourhood, as "an integrated and planned urban area related to the larger community of which it is a part, and consisting of residential districts, schools, shopping facilities, religious buildings, open spaces, and service industry", a neighbourhood as a scheme of arrangement for the family life community (Kohen 2018).

A neighbourhood means a physical environment in which essential community facilities are within walking distance; a setting in which residents can easily walk to a shopping centre and children will not have to cross crowded streets on their way to school, where employees can find the appropriate transportation to and from work. It is a residential area with a playground nearby where children can play in a safe and healthy setting (EngelYan et al. 2005, Azmi and Abdul Karim 2012).

A playground is a gathering place where residents socialise and children play. Every dwelling unit should be within a quarter-mile to a half-mile of it. While the shops should be located on the main streets and near the intersections of primary or secondary thoroughfares; to be easily accessible by both pedestrian and vehicular traffic, the average walking distance of the service area is between a quarter-mile to one mile (Sharifi 2016).

Nowadays, there are several contemporary neighbourhood's movements, such as.

A. The Compacted City is one of the contemporary residential neighbourhood concepts based on the self-sufficient residential neighbourhoods concerning their daily needs. Walking to the centre takes about 10-15 minutes. The local centres with mixed land-use are connected with other centres by public transport. The main goal is to reduce the use of cars and rely mainly on public transportation (Abbas and Najat 2019, Hamdan et al. 2021).
B. Urban villages, the concept of urban villages is based on independent communities grouped around a defined high-density centre in order to achieve a balance between housing, work and urban life. The scale of the urban villages provides ease of walking and emphasises mixed land-use, which provides an enjoyable and visually rich urban environment through a variety of building styles and attractive facades. This pattern offers a friendly pedestrian environment that calms the traffic movement and enhances the priority of pedestrians over cars (Abbas and Najat 2019, Hamdan et al. 2021).
C. The New Urbanisation Movement was called the "livable neighbourhood". It focuses on designing neighbourhoods based on a human scale and achieving the inhabitants' social needs (Sharifi 2016, Abbas and Najat 2019). The term 'new urbanisation' includes a range of ideas related to the residential neighbourhood, such as: Traditional Neighbourhoods and New Traditional Neighbourhoods.

   Traditional Neighbourhood seeks to create compacted neighbourhoods; containing different types of residential units, a friendly pedestrian environment, mixed land-use, and a well-defined identity that encourages citizens to take responsibility for the preservation and development of the environment. Thus, the daily activities are within walking distance as the residential units are near transport stations, connected to networks of streets and close to commercial and institutional activities (Carmona 2015, Abbas and Najat 2019, Sqour et al. 2022b).

   New Traditional Neighbourhood seeks to design small towns returning to the traditional patterns of small towns that are walkable and have a clear urban structure, a combination of uses and seve-

ral types of housing units. Moreover, it is characterised by a harmonious design of its buildings and spaces. It strives to provide a physical environment that encourages the social interaction and street patterns that allow for walkability with a collective sense of a traditional town (Abbas and Najat 2019).

D. Pedestrian enclaves are defined as a balanced mixed land-use within a half-mile radius, or five minutes walking distance from the transit station, which is smaller than the town and contains housing, offices, retail, and daycare shops. It creates an environment that provides a variety of transportation options. Thus, the other features of the pedestrian enclaves come from giving an equilibrium distribution of jobs, housing and services (Stanislava and Chin 2019).

E. Transport-Oriented Development, Caltrop Peter applied the idea of urban planning and design in traditional neighbourhood development into a regional context by connecting existing places and new communities along transit corridors using light rail technology. Thus, each transit station can stimulate a mixed land-use, a high-density planned neighbourhood within a radius of 400-800 meters, organised around pedestrian-friendly streets, squares, and parks (Walters and Luise 2004).

F. Smart development, which aims to create an active and compacted neighbourhood, serves as a critical component in reducing urban growth and conserving the local environment by emphasising the development of mixed land-use, various transportation options, and several housing types, as well as adopting effective locations that increase the population density around centres to reduce the distance from the daily activities, thereby lowering the infrastructure cost and conserving the open spaces (Quan 2019, Antwi-Afaria et al. 2021).

Sustainable Neighbourhood

Sustainability is known as a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Nowadays, neighbourhoods are constantly implementing adjustments to become more sustainable. There are a variety of sustainable approaches to neighbourhood application, such as the social approach, which understands the neighbourhood as a 'community' (Choguill 2007, Al-Hagla 2008). The ecological approach emphasises on neighbourhood's particular site attributes. It describes the neighbourhood as an ecosystem environment that creates its own microclimatic conditions while providing the essential local habitat for humans with enough comfort and sustenance (Butera 2018).

The major goals of the sustainable neighbourhoods are to reduce greenhouse gas emissions by reducing dependency on automobiles, creating a healthy environment by promoting an active lifestyle (especially walking), increasing street safety by reducing vehicle/pedestrian collisions, increasing accessibility and freedom of choice by making more facilities accessible locally, equity and social inclusion by offering a diverse selection of facilities within easy walking distance, increasing the value of local community by facilitating accessible social networks, and increasing local self-determination by increasing inhabitants control (Al-Hagla 2008, Hong 2011).

A sustainable neighbourhood is a safe, well-planned, and long-lasting environment in which people can live at the present time and in the future that is environmentally, socially, and economically healthy (Elgadi and Ismail 2016; Kohon 2018). Greening the environment, reducing greenhouse gas emissions, and allowing people to live comfortably by providing secure neighbourhoods that minimise resource exhaustion, cultural disruptions, environmental degradation, and social instability are all strategies that could be used to achieve sustainability (EngelYan et al. 2005, Jiboye and Ogunshakin 2010, Antwi-Afaria et al. 2021).

The sustainable neighbourhood is socially cohesive and diverse, with a mix of housing types and employment opportunities, and it gives priority to walking, cycling and public transit. Also, it encourages energy efficiency. At the same time, residential areas are located near recreational and commercial facilities with pedestrian and bike networks (Hong 2011).

According to Al-Hagla (2008), the community perspective of a sustainable neighbourhood includes; the social provision that improves access to facilities, built space, and open space, economic sustainability, such as job opportunities and economic buoyancy, social sustainability that contains health, community safety, and equity and choice. While there are two perspectives on applying sustainability, they are: global ecology and natural resources. The global ecology dimension includes climate, stability, energy in transport, energy in buildings, and biodiversity. And the natural resources dimension provides air quality, water, land, soil, and minerals.

Sustainable Neighbourhood Criteria

One of the initiatives is to design a neighbourhood that improves the inhabitant's walkability, which means that the planning and design desires will be enhanced toward a more sustainable life (Al-Hagla 2008).

Al-Hagla (2008) evaluated the sustainability performance as combining three separate green space typologies: parks and gardens, children's play areas, and sports facilities. Al-Hagla (2008) identified three key characteristics of open space in the sustainable neighbourhood: space management, space function, and the role of items inside areas. Accordingly, he concluded a parameter for assessing the performance of the sustainable community.

Another study was conducted to measure the willingness to buy houses in sustainable neighbourhoods in Malaysia. It concludes that the house buyers are ready to buy houses in a sustainable community, so the governments are responsible for putting a vision and guidelines for the sustainable neighbourhood (Hong 2011).

Azmi and Karim (2012) investigate the link between walkability and a sustainable neighbourhood. They created a model that incorporated three key elements: neighbourhood design, neighbourhood walkability, and the applicability of sustainable concepts. Neighbourhood walkability promotes facility accessibility, measuring the distance to community facilities and assessing the willingness to walk before deciding to drive. Moreover, the adaptability of a sustainable neighbourhood includes several principles, such as location and clustering of community facilities, for example; local shops, playgrounds, and schools, react to places such as hot climate conditions, which affects walking, and diversity, which affects the safety and convenience while walking.

UN-Habitat (2013) proposed an approach to promote sustainable urban development by establishing livable and efficient neighbourhoods. This approach is based on five principles that support three key features of a sustainable community: compact, integrated, and interconnected.

1. Adequate space for streets and an efficient street network. The street network should occupy at least 30% of the land and at least 18 km of street length per km^2.
2. There is a high population density of at least 15,000 people per km^2, which means 150 people/ha or 61 people per acre.
3. Mixed land-use, at least 40% of floor space should be allocated for economical use in any neighbourhood.
4. Social combination, the availability of houses in different price ranges and tenures in any given neighbourhood, 20% to 50% of the residential floor area should be for low-cost housing; and each tenure type should not be more than 50% of the total.
5. Limited land-use specialisation, this is to limit single function blocks or neighbourhoods; single function blocks should cover less than 10% of any neighbourhood.

Sharifi (2016) traced the evolution of the 20^{th} century planning movements to see how the principles have changed and how successful they have been in addressing the requirements of sustainable development. Sharifi studied Garden City, Neighbourhood Unit, Modernism, Neo-traditionalism, and Eco-urbanism, respectively.

Elgadi and Ismail (2016) reviewed the sustainable neighbourhood indicators and development. They found that the sustainable neighbourhood indicators for several countries are generally similar and only differ depending on their regional climate characteristics.

A comparative study was accomplished to analyse the sustainability of six residential districts. The study relies on six architectural and planning criteria are; diversity, compactness, residential density, mixed land uses, transportation network efficiency, and permeability; the criteria were identified as sustainable factors for appraising the residential neighbourhood (Jasim et al. 2018).

Jasim et al. (2018) concluded the main features of the sustainable neighbourhood that are transportation network efficiency, including two indicators: transportation network area, which must be sufficient, convenient, and not less than 30% of the neighbourhood area, and transportation network length. The neighbourhood's population reaches 5,000 people per square kilometre for each community, equivalent to 150 people per hectare. Arrange mixed land-use by allocating no less than 40% of the neighbourhood's area to economic uses. Improve social unity, which means 20-50% housing units must be provided to low-income people, and each type of tenure should not exceed 50% of the total housing units in the neighbourhood. And the area of any use must be not less than 10% of the area specified for the neighbourhood (Jasim et al. 2018).

Abbas and Najat (2019) proposed several principles to achieve the development of the residential neighbourhood, including integrating the social, economic, and environmental aspects with the principles of the sustainable neighbourhood. They concluded that the sustainable residential neighbourhood model contains components of regional development as well as sustainability qualities.

Knapskoga et al. (2019) measure walkability in several neighbourhoods. They proposed several criteria for evaluating walkability that is divided into three groups: infrastructure and traffic, urbanity, and surroundings and activities. These criteria may be used to develop cities and areas to become more walkable and sustainable.

Based on the previous literature review, there are eight Sustainable Neighbourhood Criteria, namely, regional issues, compacted form, mixed land-use, connectivity, pedestrian-oriented building, the public sphere of the neighbourhood, relationship with transportation, and walkability.

1. Regional issues include the development of previously urbanised land, the proximity of the new product to the existing infrastructure, integration with public transport systems, the arranged growth of neighbourhoods in a rational manner within a comprehensive regional plan, and preserving open spaces (UN-HABITAT 2013, Elgadi and Ismail 2016, Jasim et al. 2018, Abbas and Najat 2019).
2. The compacted form includes arranging the neighbourhood around a well-defined centre and emphasising the boundaries of the neighbourhood (UN-HABITAT 2013, Elgadi and Ismail 2016, Jasim et al. 2018, Abbas and Najat 2019).
3. Mixed land-use, which includes multiple types of activities focus activities on focal points, diversity of retail and service activities and integration of residential, economic, administrative and civil uses (UN-HABITAT 2013, Elgadi and Ismail 2016, Jasim et al. 2018, Abbas and Najat 2019).
4. Connectivity indicator includes connection to the traffic network, safe pedestrian movement, providing green pedestrian paths, easy access to activities and residential movement paths directed to pedestrians and bicycles (UN-HABITAT 2013, Elgadi and Ismail 2016, Jasim et al. 2018, Abbas and Najat 2019).
5. Pedestrian-oriented building indicator includes a human scale of buildings, attractive facades of buildings, defining streets and squares by the surrounding buildings and diversity in shapes and styles of buildings (Elgadi and Ismail 2016, Jasim et al. 2018, Abbas and Najat 2019, Sqour et al. 2022).

6. The public sphere of the neighbourhood indicator includes an emphasis on the locations of civil buildings, emphasise public spaces as places to accommodate social interactions, and emphasises on the third place like cafes and restaurants (Elgadi and Ismail 2016, Jasim et al. 2018, Abbas and Najat 2019).
7. Relationship with transportation indicator includes a convenient street for transportation and accessibility to bus stops (UN-HABITAT 2013, Elgadi and Ismail 2016, Jasim et al. 2018, Abbas and Najat 2019).
8. Walkability indicator is divided into three groups: infrastructure and traffic, urbanity, and surroundings and activities (Al-Hagla 2008, Azmi and Abdul Karim 2012, Knapskoga et al. 2019).

Methodology

Study area

Al-Mafraq governorate is located in the northeast of Jordan, 60 kilometers east of Amman. It covers 26552 km^2. It had a population of 58000 in 2017, making up 5.8% of Jordan's population (Sqour et al. 2016, Department of Statistics 2017). The study's area is located in Al-Mafraq's new city centre, which contains two newly developed neighbourhoods, Jordan Villa Compound (Fig. 2) and the University District (Fig. 3). The project provides an integrated environment with services and infrastructure, where roads, sidewalks, the electricity network, government schools, a commercial mall, retail shops, a mosque, public squares, and green open spaces with a total of 1343 housing units. It is located along the Amman-Damascus international highway, opposite the southern gate of Al-albayt University and King Talal Military Hospital (Fig. 1).

The residential units in the neighbourhoods provide several types, including:

- Type A includes independent villas with various areas, a 217 m^2 built-up area, is constructed on a plot of 350 m^2, and a 250m^2 built-up area and is constructed on a plot of 500m^2-600m^2.
- Type B includes attached villas. Each villa has a built-up area of 197 m^2 and is constructed on a plot of 250–350 m^2.
- Type C includes 190 landed independent houses. Each unit has a built-up area of 184m^2 and it is constructed on a plot of 400 m^2.

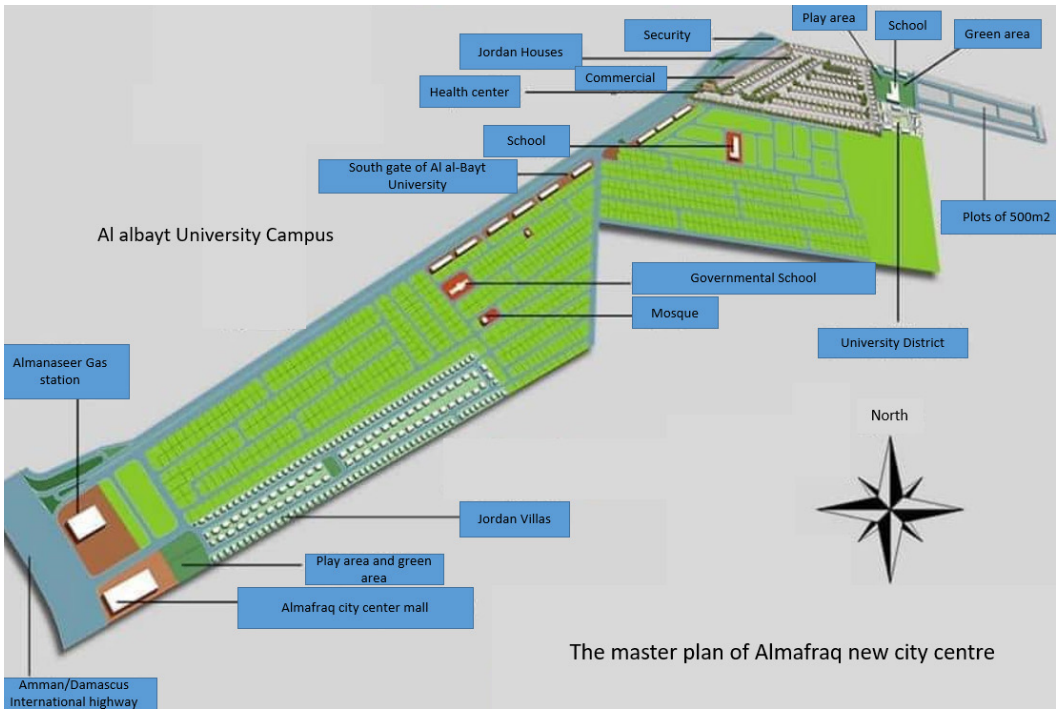

Fig. 1
The master plan of the new city centre of Al-Mafraq

Fig. 2
Jordan Villa Compound

Fig. 3
The University District

- Type D includes 40 flats arranged in 10 residential buildings of two levels. Each building has four flats with a 150m^2 built-up area.
- Type E includes flats built in residential buildings of four levels that offer 930 units with a 150m^2 built-up area.

The two neighbourhoods in Al-Mafraq, Jordan were chosen by referring to officials of the municipality, the GIS database delivered by the Department of Statistics census and land plots in the Lands and Survey Department were used to identify the demographic features of the neighbourhood.

The reason for choosing these neighbourhoods is the sustainability applicable in the development of the geographical area. The research has two sample schemes; the first sample represents Jordan Villa Compound with private houses of Type A and Type B, and the second sample scheme represents the University District containing landed houses of type C, flats of type D and type E (**Fig. 1**).

Jordan Villa Compound includes 183 units built on 114000m^2; it is characterised by a low population density of 920 residents. While the University District has 1160 residential units constructed on 247420m^2. It is characterised by a high population density of around 5800 residents. The average number of household members is five persons. Most residents work in governmental jobs near the neighbourhoods, such as Al-albayt University or in the private sector in Al-Mafraq.

To make the dwellings affordable for the households, the stone wasn't used to cover the facades. Concrete was used as a building material for the housing units in the two neighbourhoods, and solar panels were used for more energy efficiency in the Jordan Villa Compound; as the units' area is bigger than it in the University District.

Data Collection

This study is based mainly on the literature review to collect the secondary data; eight Sustainable Neighbourhood Criteria were determined: regional issues, compacted form, mixed land-use, connectivity, pedestrian-oriented building, the public sphere of the neighbourhood, relationship with transportation, and walkability. Then a physical survey was conducted to assess the sustainable neighbourhood criteria for Jordan Villa Compound and the University District by field observation.

The physical survey was used to collect the data and test the criteria by observation. Observations can provide and reconfirm important information that can support the survey results. The combination of observation and surveys is a critical methodological approach for this study to observe how the existing conditions of the residential areas (functional, physical, social and psychological) influence sustainability. Notes and picture taking of the residential areas should be the method of recording observations.

Results

According to Hong (2011) and after the field observations at Jordan Villa Compound and the University District, they achieved some dimensions of sustainable neighbourhoods as; they are socially cohesive and diverse, with a mix of housing types and employment opportunities, and it gives priority to walking. Also, they encourage energy efficiency by using the solar energy and sun panels. But the recreational and commercial facilities are not enough and need to improve.

Table 1

Conceptual Model

Sustainable Neighbourhood Criteria	Criteria	Detailed indicators	
	Regional issues	Development of previously urbanised land	
		Proximity of the new development to the existing infrastructure	
		Integration with public transport systems	
		Neighbourhoods growth in a rational manner within a comprehensive regional plan	
		Preserving open spaces	
	Compacted form	Organise the neighbourhood around a well-defined centre	
		Emphasise the boundaries of the neighbourhood	
	Mixed landuse	Various types of activities	
		Focus activities on focal points	
		Diversity of retail and service activities	
		Integration of residential, economic, administrative and civil uses	
	Connectivity	Connected to traffic network	
		Safe pedestrian movement	
		Provide green pedestrians path	
		Easy access to activities	
		Residential movement paths directed to pedestrians and bicycles	
	Pedestrian-oriented building	Human scale of buildings	
		Attractive facades of buildings	
		Defining streets and squares by the surrounding buildings	
		Diversity in shapes and styles of buildings	
	Public sphere of the neighbourhood	Emphasis on the locations of civil buildings	
		Emphasise public spaces as places to accommodate social interactions	
		Emphasis on the third place (cafes - restaurants)	
	Relationship with transit	Provide convenient streets for transportation	
		Bus stops	
	Walkability	Infrastructure and traffic	Street or road character, Pedestrians infrastructure, Crossings, Traffic volumes, Speed levels, Pollution and noise, Traffic safety, Universal design, and Public transport connectedness
		Urbanity	Density, Proximity, Connectedness, Scale, Orientation of buildings, Block size, Permeability, Pedestrian network, Urban structure, Parking lots, Urban space and parks, Green, and Street furniture
		Surroundings and activities	Destinations, Activities, People walking or staying, Facades, Mix of functions, Vibrancy, Maintenance, Experienced safety, and Wayfinding

Based on literature review there are eight sustainable neighbourhood criteria: regional issues, compacted form, mixed land-use, connectivity, pedestrian-oriented building, the public sphere of the neighbourhood, relationship with transit, and walkability (Table 1).

Regional issues include development of previously urbanised land, the proximity of the new development to the existing infrastructure, integration with public transport systems, the neighbourhoods grow in a rational manner within a comprehensive regional plan, and preserving open spaces. All regional issues were considered while planning Jordan Villa Compound and University District except the indicator of integration with public transport systems (Table 2).

The compacted form includes organising the neighbourhood around a well-defined centre and emphasising the neighbourhood's boundaries. Jordan Villa Compound and University District fulfil the two indicators (Table 2).

Mixed land-use is essential to accommodate residents' daily requirements while minimising urban sprawl. Economically mixed land-uses emphasise reducing long commutes, creating of self-sufficient neighbourhoods through the integration of residential, commercial, administrative, and civil services, allowing people to live close to their workplaces and shops (Abbas and Najat 2019).

Mixed land-use includes several indicators such as various types of activities, focus activities on focal points, diversity of retail and service activities and integration of residential, economic, administrative and civil uses. Jordan Villa compound and University district fulfil all indicators except integration of residential, economical, administrative and civil uses as the residential area is separate from other activities (Table 2).

There are multiple types of activities at Jordan Villa Compound and University District, such as a play area, schools, shops and commercial mall, which are focused on focal points and are accessible to the residents of the neighbourhoods (Fig. 1).

Connectivity aims to connect neighbourhoods with their surroundings by using hierarchical street designs (Abbas and Najat 2019). The connectivity indicator includes connection to the traffic network, safe pedestrian movement, providing green pedestrian paths, easy access to activities and residential movement paths directed to pedestrians and bicycles. Jordan Villa Compound and University District satisfy all indicators except providing the green pedestrians paths (Table 2).

The pedestrian-oriented building criterion includes the human scale of buildings (Sqour et al. 2022a) as the residential units vary from one floor to four floors, attractive facades of structures by using a pleasing height and suitable materials, defining streets and squares by the surrounding buildings and diversity in shapes and styles of buildings as there are several dwelling types in the neighbourhoods (Abbas and Najat 2019). Diversity in shapes and styles of buildings isn't available in the Jordan Villa compound as there is a typical pattern of building with various areas (Table 2).

Neighbourhood design should include appropriate public spaces in which buildings and their features are organised to encourage pedestrians to walk and emphasise the relationship of buildings with streets in terms of proper setbacks and the creation of streets and squares with dynamic character. The intensive construction density and mixed land-use should be encouraged during neighbourhood design (Abbas and Najat 2019).

The public sphere of the neighbourhood criterion includes emphasis on the locations of civil buildings, emphasis on public spaces as places to accommodate social interactions and focus on the third place like cafes and restaurants. Jordan Villa Compound and University District satisfy all indicators excluding the indicator of emphasis in the third place (Table 2).

The neighbourhood structure must be adequately connected to public transportation in order to encourage users to use it. Transportation should follow direct and logical routes to various destinations so that the routes work efficiently, and the transit points must be safe, comfortable, and

Table 2

Sustainable neighbourhood criteria and indicators

Criteria and indicators		Jordan Villa Compound	University District
Criterion 1: Regional issues			
1	Development of previously urbanised land	√	√
2	The proximity of the new development to the existing infrastructure	√	√
3	Integration with public transport systems	X	X
4	Neighbourhoods growth in a rational manner within a comprehensive regional plan	√	√
5	Preserving open spaces	√	√
Regional issues score		4/5	4/5
Criterion 2: Compacted form			
1	Organise the neighbourhood around a well-defined centre	√	√
2	Emphasise the boundaries of the neighbourhood	√	√
Compacted form score		2/2	2/2
Criterion 3: Mixed land-use			
1	Various types of activities	√	√
2	Focus activities on focal points	√	√
3	Diversity of retail and service activities	√	√
4	Integration of residential, economic, administrative and civil uses	X	X
Mixed land-use score		3/4	3/4
Criterion 4: Connectivity			
1	Connected to traffic network	√	√
2	Safe pedestrian movement	√	√
3	Provide green pedestrians path	X	X
4	Easy access to activities	√	√
5	Residential movement paths directed to pedestrians and bicycles	√	√
Connectivity score		4/5	4/5
Criterion 5: Pedestrian-oriented building			
1	Human scale of buildings	√	√
2	Attractive facades of buildings	√	√
3	Defining streets and squares by the surrounding buildings	√	√
4	Diversity in shapes and styles of buildings	X	√
Pedestrian-oriented building score		3/4	4/4
Criterion 6: The public sphere of the neighbourhood			
1	Emphasis on the locations of civil buildings	√	√
2	Emphasise public spaces as places to accommodate social interactions	√	√
3	Emphasis on the third place (cafes - restaurants)	X	X
The public sphere of the neighbourhood score		2/3	2/3
Criterion 7: Relationship with transit			
1	Provide convenient streets for transportation	√	√
2	Bus stops	X	X
Relationship with transit score		1/2	1/2

well-designed (Abbas and Najat 2019). The relationship with transit includes a convenient street for transportation and accessibility to bus stops. Based on the site visit, bus stops cannot be accessed by residents at Jordan Villa Compound and the University District (Table 2).

The walkability criterion includes three groups of indicators: infrastructure and traffic, urbanity, and surroundings and activities. The score was arranged from 0-3; if the neighbourhood isn't walkable, it is given 0, if the neighbourhood is somewhat walkable, it is given 1, if it is walkable, it is given 2, and if the neighbourhood is highly walkable, it is given 3. Infrastructure and traffic indicator includes several attributes such as; street or road character that affect pedestrians' walkability, whereas the use of street increases the walkability and the use of road decreases it. The availability of the sidewalks as a pedestrian infrastructure inspires pedestrians to walk. Crossings as barriers and detours decrease the willingness of pedestrians to walk. If traffic volume and the speed level are high, that decreases the walkability. Contrary relationship between pollution and noise and pedestrians' walkability. While high traffic safety, universal design, and connectivity to public transit increase walkability. The highest score of infrastructure and traffic indicator is 27, if the neighbourhood achieves the attributes of high walkability.

The urbanity indicator contains several attributes that affect walkability. Population density, proximity and short distance, connected to the city structure, the building scale as small blocks, and the high permeability of the neighbourhood increase the pedestrians' walkability. Other attributes, such as building orientations, where pedestrians' walkability increases if buildings are oriented along the street, while walkability decreases if buildings recede from the road. The urban structure of neighbourhoods affects walkability; the grid pattern increases walkability, and Cul-De-Sac decreases walkability. As well as, the increasing of parking lots negatively affects walkability. However, growing urban space and parks, trees on the streets, and street furniture all contribute to increasing walkability. The highest score on urbanity indicator is 39 if the neighbourhood achieves the attributes of high walkability.

Surroundings and activities indicator contains several attributes that positively affect walkability, such as; multiple destinations, multiple activities, many people walking or staying, a high mix of function, high vibrancy and high maintenance. Moreover, the feel of safe and easy wayfinding rises the pedestrians' walkability. The highest score for surroundings and activities indicator is 27 if the neighbourhood achieves the attributes of high walkability.

Walkability in Jordan Villa Compound

The first group of indicators is infrastructure and traffic; Jordan Villa Compound achieves all indicators except the connectivity with public transportation. The second group is the urbanity indicators, the density is low, and the buildings are close together, so the walking distance is short. The district isn't connected to the city structure, and the urban design is on a pedestrian scale. The residential buildings in the community are oriented along the street and built head-to-head to the sidewalk, which improves walkability. Another relevant indicator is block size, which is small. Permeability is low as the urban design of the neighbourhood is based on the cul-de-sac pattern, so pedestrians cannot choose between routes and take shortcuts. Furthermore, the pedestrian network has a coherent area as no infrastructure creates barriers, and there are urban spaces and parks where pedestrians can stay, socialise, play and spend time. There isn't enough street furniture and there aren't enough street trees because of the desert weather where the district is located (Table 3).

In the last group of indicators, surroundings and activities, there are limited destinations and activities in the Jordan Villa Compound, which decrease the pedestrian walkability and pleasure while walking in the area. Few people are walking or staying in the open spaces; the dwellings have closed facades because of the fences around the villas and similarities in facade patterns. There are insufficient functions, only the play area. Good maintenance and experienced safety are high, and easy wayfinding (Table 3).

Table 3. Walkability in Jordan Villa Compound

Indicators	Attributes	Highly walkability		Walkable	Somewhat walkable	Not walkable	
Infrastructure and traffic	Street or road character	Street	√				Road
	Pedestrians infrastructure	Sidewalks	√				No sidewalks
	Crossings	Defined crossing at the same level	√				Barriers and detours for pedestrians
	Traffic volumes	Low	√				High
	Speed levels	Low	√				High
	Pollution and noise	Low	√				High
	Traffic safety	High	√				Low
	Universal design	High accessibility	√				Low accessibility
	Public transport connectedness	Route connected to bus stops				√	Route not connected to bus stops
Infrastructure and traffic Indicator Score			24				
Urbanity	Density	High			√		Low
	Proximity	Short distance	√				Long distance
	Connectivity	Connected to the city structure				√	Its own structure
	Scale	Pedestrians	√				Vehicles oriented
	Orientation of buildings	Buildings oriented along the street	√				Building receded from the street
	Block size	Small blocks	√				Long/large blocks
	Permeability	High permeability				√	Not permeable
	Pedestrian network	Coherent pedestrian network short cuts	√				Infrastructure as barriers for pedestrians
	Urban structure	Grid				√	Cul de sac
	Parking lots	Few	√				Many, making barriers
	Urban space and parks	Many			√		Few/none
	Green	Street trees, parks et.			√		Non greenery
	Street furniture	Many			√		Few/none
Urbanity Indicator Score			22				
Surroundings and activities	Destinations	Multiple				√	Few or no one
	Activities	Multiple			√		Few or no one
	People walking or staying	Many		√			Few or no one
	Facades	Active		√			Closed
	Mix of functions	High			√		Low
	Vibrancy	High		√			Low
	Maintenance	High		√			Low
	Experienced safety	Feels safe	√				Feels non safe
	Wayfinding	Easy	√				Not Easy
Surroundings and activities Indicator Score			16				
Walkability score			62				

Walkability in The University District

The University District achieves all the attributes of the infrastructure and traffic indicator except the connectivity with the public transportation. Urbanity indicator score is 32, the density is high, the buildings are close together, so the walking distance is short. The district isn't connected to the city structure, and the urban structure is on a pedestrian scale. The residential buildings in the district are oriented along the street and built head-to-head to the sidewalk, which improves walkability. Another relevant attribute is block-size which is small, the permeability is high, and pedestrians can choose between routes and take shortcuts. Furthermore, the pedestrian network has a coherent area as there is no infrastructure that creates barriers, and there are urban spaces and parks where pedestrians can stay, socialise, play and spend time. analyse (Table 4).

Table 4
Walkability in the University District

Indicators	Attributes	Highly walkability		Walkable	Somewhat walkable	Not walkable	
Infrastructure and traffic	Street or road character	Street	√				Road
	Pedestrians infrastructure	Sidewalks	√				No sidewalks
	Crossings	Defined crossing at the same level	√				Barriers and detours for pedestrians
	Traffic volumes	Low	√				High
	Speed levels	Low	√				High
	Pollution and noise	Low	√				High
	Traffic safety	High	√				Low
	Universal design	High accessibility	√				Low accessibility
	Public transport connectedness	Routs connected to bus stops				√	Routs not connected to bus stops
Infrastructure and traffic Indicator Score			24				
Urbanity	Density	High	√				Low
	Proximity	Short distance	√				Long distance
	Connectivity	Connected to the city structure				√	Its own structure
	Scale	Pedestrians	√				Vehicles oriented
	Orientation of buildings	Buildings oriented along street	√				Building receded from the street
	Block size	Small blocks	√				Long/large blocks
	Permeability	High permeability	√				Not permeable
	Pedestrian network	Coherent pedestrian network short cuts	√				Infrastructure as barriers for pedestrians
	Urban structure	Grid	√				Cul de sac
	Parking lots	Few	√				Many, making barriers
	Urban space and parks	Many		√			Few/none
	Green	Street trees, parks		√			Non greenery
	Street furniture	Many			√		Few/none

Indicators	Attributes	Highly walkability		Walkable	Somewhat walkable		Not walkable
Urbanity Indicator Score			32				
Surroundings and activities	Destinations	Multiple			√		Few or no one
	Activities	Multiple			√		Few or no one
	People walking or staying	Many		√			Few or no one
	Facades	Active	√				Closed
	Mix of functions	High			√		Low
	Vibrancy	High		√			Low
	Maintenance	High		√			Low
	Experienced safety	Feels safe	√				Feels non safe
	Wayfinding	Easy	√				Not Easy
Surroundings and activities Indicator Score			18				
Walkability score			74				

The last indicator is surroundings and activities; University District has few destinations and activities, which decreases the pleasure of pedestrian walking. Walking or staying outside almost are experienced by few people. The facades of the residential buildings are active facades. There aren't enough functions, only the play area and vibrant street life, good maintenance, experienced safety is high, and easy wayfinding is understood (**Table 4**).

The sustainable neighbourhood score for the University District is 94, which is higher than the sustainable neighbourhood score for the Jordan Villa Compound, which is 81 (**Table 5**). The sustainable neighbourhood score was calculated for both Jordan Villa Compound and The University District by summing all the principles scores (regional issues, compacted form, mixed land-use, connectivity, pedestrian-oriented building, the public sphere of the neighbourhood, relationship with transit and walkability).

Table 5

Sustainable neighbourhood criteria score

	Sustainable neighbourhood principles	Jordan Villa Compound	University District
1	Regional issues	4	4
2	Compacted form	2	2
3	Mixed land-use	3	3
4	Connectivity	4	4
5	pedestrian-oriented building	3	4
6	The public sphere of the neighbourhood	2	2
7	Relationship with transit	1	1
8	Walkability	62	74
	Total score	81	94

Conclusion

A neighbourhood is an area for residents to live, communicate, and get suitable access to community services. While a sustainable neighbourhood is an appropriate environment for people to live now and in the future that is environmentally, socially, and economically healthy; a place that is safe, well planned, and built to last.

The importance of this study comes from employing the sustainable neighbourhood indicators to develop communities to become more sustainable, and producing a parameter that could be applied internationally; thus, it can be used to assess the sustainable neighbourhood.

The present research explores an evaluation process for two newly developed neighbourhoods in Al-Mafraq in the northeast of Jordan. Jordan Villa Compound and the University District were chosen to be the cases in the study.

To begin the research a set of criteria was developed to evaluate the sustainable neighbourhood. Those criteria are grouped into eight components: regional issues, compacted form, mixed land-use, connectivity, pedestrian-oriented building, public sphere of the neighbourhood, relationship with transit and walkability, each of these components has its own attached attributes.

After the physical survey was conducted, the results show that the social dimension is achieved by meeting the residents' daily needs, supporting the variety of housing types and tenure patterns, and supporting the social diversity such as age, income, and cultural background. The economic dimension is achieved by offering several house' prices and various services and amenities.

Moreover, the two neighbourhoods achieve most of the sustainable neighbourhood principles. In spite of the fact that the two neighbourhoods are close together, the sustainable neighbourhood score for the University District is 95, which is higher than the sustainable neighbourhood score for the Jordan Villa Compound, which is 82. The reason is the availability of various house types, such as landed houses, flats of two-story buildings, and flats in four-level buildings. Also, the dwelling facades at the University District were active. At the same time, it was closed at the Jordan Villas Compound as the villas have more privacy and have fences around each unit, which prevent social interaction.

Additionally, the permeability in the University District is higher than in the Jordan Villa Compound due to the urban design; the grid pattern was used to organise the neighbourhood activities at the University Distract while the Cul-De-Sac pattern was used in the Jordan Villa Compound.

University District is more sustainable; as it is more walkable than Jordan Villa Compound due to several reasons; firstly, the urbanity indicator of the University district is higher than Jordan villa compound as the permeability and population density is high, while the population density is low at the Jordan Villa Compound. Secondly, surrounding and activities indicator is higher in the University District due to the high density, thus more people are walking or staying in the public spaces than in Jordan Villa Compound.

Several factors affect the pedestrian's walkability, including infrastructure and traffic, urbanity, and surroundings and activities. The urban design pattern affects walkability since the grid pattern of the neighbourhood increases walkability while the Cul-de-Sac pattern decreases walkability. Moreover, high population density, connection with public transit, and the availability of multiple types of activities are factors that increase pedestrian walkability.

The most critical factor that decreases the sustainable score in both Jordan Villa Compound and the University district are: connected to public transport is unavailable and the green areas are limited due to the desert weather. While the indicator that raises the sustainability score for the two neighbourhoods and encourages the residents to live there are: the proximity to job opportunities, high safety in the neighbourhoods, and availability of essential facilities such as schools, universities, mosques, and government hospitals such as King Talal Hospital and women and children's hospital.

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