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Unlocking Walkability in Car-Oriented Cities: Assessing Built Environment Features Affecting Walkability in Riyadh's Neighborhoods

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Abstract: Enhancing walkability in urban settings, particularly in regions characterized by hot, arid climates and car-oriented development patterns, is increasingly recognized as a pivotal factor in elevating the quality of urban environments. Despite historical underemphasis in urban planning discourse, the imperative of pedestrian-friendly spaces is garnering heightened attention due to its intrinsic link to urban sustainability. This manuscript endeavors to synthesize existing literature on walkability within urban contexts, explicitly focusing on extrapolating these insights to the urban context of Riyadh's residential neighborhoods, Saudi Arabia, a domain where previous studies underscored deficiencies in pedestrian infrastructure and a prevalent dependence on automobiles for travel behavior. This study aims to highlight the efficacy of the Humanization of Cities Initiative, a strategic directive outlined within the framework of Saudi Vision 2030, by defining the urban features that determine walkability and pedestrian behaviors in residential neighborhoods. The study highlights the enhancements to walkability within the Al-Falah district, selected as the pilot community for this initiative. Through a comprehensive analysis, including the outcomes of the Humanization of Cities Initiative and insights gleaned from previous studies, this research seeks to develop a robust conceptual model for advancing walkability standards and propose recommendations to improve pedestrian friendliness within Riyadh's urban context.

Keywords: Car-Oriented Cities, Built Environment Features, Walkability, Factors, Humanization of Cities initiative.

1. Introduction

Walking behavior is influenced by lifestyle factors and the complex relationship between walking and the built environment. In addition, various perceptual qualities, including the landscape, have significantly impacted walking behavior. Numerous earlier studies demonstrated that the built environment's design influences neighborhood residents' physical activity. Thus, one strategy to preserve public health could be to create a physical environment that encourages walking (Borst.H. et al. , , 2008) (Ernawat. J,2016). Riyadh is believed to be one of the fastest-growing cities in Saudi Arabia. According to the General Authority for Statistics, Riyadh has a population of over 7.8 million (GASTAT, 2024). Its neighborhoods are geared towards providing housing to cover this pace of population growth(Mubarak, Faisal A,2004), resulting in rapid development without a human

dimension in these residential neighborhoods and no interest in developing the built environment there (Aldegheishem,2023). Ultimately, it led to urban environments oriented only toward the use of automobiles, which did not meet human needs. As a result, its residents rely primarily on private transportation (UN-Habitat, 2018) without any ties between the residences and the surrounding environment, which has increased travel times, traffic jams, and pollution, as well as a decrease in physical activity among the residents, which is reflected in their lifestyle and behavior. Regretfully, there is still no empirical data that supports and identifies the key factors and characteristics of the built environment's aspects that influence walkability in Riyadh. Thus, the purpose of this research is to close this gap and pinpoint the elements that make the residential neighborhoods in Riyadh enjoyable and more walkable by investigating the role of planning and design urbanism in shaping neighborhoods' urban environment within the framework of humanizing cities in line with Saudi Vision 2030 (Saudi Vision,2016) Which focuses on improving the quality of urban life and enhancing Livability in Saudi cities.

Three methods deal with walkability criteria: path morphology assessments, the built environment and pedestrian infrastructure quality measurements, and access to destination measurements (Manaugh, K., & El Geneidy,2011) (Duncan, D. T.,2013) This paper only evaluates the second category, which focuses on the built environment and pedestrian infrastructure quality measurements. Creating a walkable community has recently received great attention from designers and urban planners for its various benefits related to sustainability, public health, and socioeconomic aspects (Speck, J. 2012). Therefore, there is a rising need for research, knowledge, and investigation into the walkability and walkable communities of the urban built environment (Barnes, G. & Krizek, K. J.2005).' Walkability' was most likely introduced to the urban design field (Bradshaw, C. 1993). To grade the walkability of neighborhoods.

The issue with walking, in general, is that, according to urban design theories and discourses, the design elements that are frequently mentioned as encouraging walking or producing "pedestrian-friendly environments" are commonly based on physical urban features (Bereitschaft, B .2017). This research defines and determines the appropriate indicators and variables influencing walking in residential neighborhoods by refining the methods and measures used to analyze the relationship between walking behavior and the physical environment (Speck, J. 2012).

2. Literature review

In urban design and planning, walkability has been outlined and recognized in the literature and by many researchers as an instrumental feature in reaching sustainable urban planning strategies. It can promote social connections and physical activity and reduce pollution and noise. Additionally, walkable neighborhoods may have higher property prices, economic growth, and better public health. (Bhadra, S. et al.,2016) (Gallin, N. 2001) (Gallined, MAA,2016) Numerous studies have shown that the relationship between walkability and physical health is positively correlated. For example, a study by Frank et al. (2010) discovered that residents of more walkable communities are typically more physically active, which lowers the risk of several chronic diseases (Frank, L. D.2010). Walkability has been studied and defined in various research studies. Definitionally, walkability refers to using non-motorized modes of transportation and active mobility (Bödeker, M., et.al.2018)((Michael, Y. L.,2006). In urban environments, walkability can be defined as the suitability of the environment for pedestrians. This includes factors such as pedestrian comfort, safety, the efficiency of connections between different destinations, and the visual interest and attractiveness of walking routes throughout an urban network. Various sources define walkability as the quality of a built environment that prioritizes pedestrians and encourages urban life and socioeconomic interaction (Lima F.T. et.al., 2021). The physical characteristics of the built environment are essential for integrating physical activity into daily life (Zuniga-Teran, A. A. et.al.2017). According to the literature, the physical environmental elements may be tools for improving a neighborhood's walkability (Aldegheishem,2023) (Owens, P. M. 1993). These physical characteristics naturally promote social cohesion by encouraging more pedestrians to participate in activities on the street. However, walkability is a multi-dimensional concept that considers other factors such as safety. A study by Knuiman et al. (2014) found that neighborhoods with better street lighting, low traffic volumes, and pedestrian crossings are perceived as safer by residents, which encourages

them to walk more frequently (Knuiman, M. W, et al. 2014). In addition to that, accessibility, access to public transportation, comfort, condition of sidewalks, pedestrian rights-of-way, traffic and road conditions, land use patterns, and building accessibility can also promote accessibility. (Abdullah, W. S, &Al-Qemaqchi, N.T,2020) (El Helou. M.A. 2018) (Bentley, I., et.al.1985).A study by Marans and Stimson (2011), found that walkable neighborhoods with mixed land uses, interconnected streets, and public spaces promote social interactions among residents, leading to a stronger sense of community and belonging (Lund, H. 2002) (Marans. R, J. Stimson. R. 2011) Many other qualitative aspects influence walkability. They relate to visual interest, attractiveness, and enclosure on walking routes throughout the built environment and its aesthetic aspects and attractiveness, such as green spaces and well-maintained streets (Kim, H.M., &Babiano.I.M, 2018). By comprehending these intervening variables, we can better grasp how the built environment's physical characteristics influence walking behavior (Ewing. R, et. al,2006). Urban planners and designers should prioritize creating walkable neighborhoods with safe, accessible, and inviting public spaces to promote a healthy and vibrant community.

3. Materials and Methods

This paper investigates the relationship between the built environment's urban features and walkability. It identifies key factors influencing walking in residential areas, especially within the context and circumstances of residential neighborhoods in Riyadh City, where the research will evaluate and assess walkability conditions in one selected neighborhood.

The research was based on analytical reasoning approaches consisting of three main stages. The first dealt with a study of previous literature concerning walkability behavior within the influence of the built environment to determine the indicators that affect walkability in residential neighborhoods in general and within dry, hot areas. The second stage

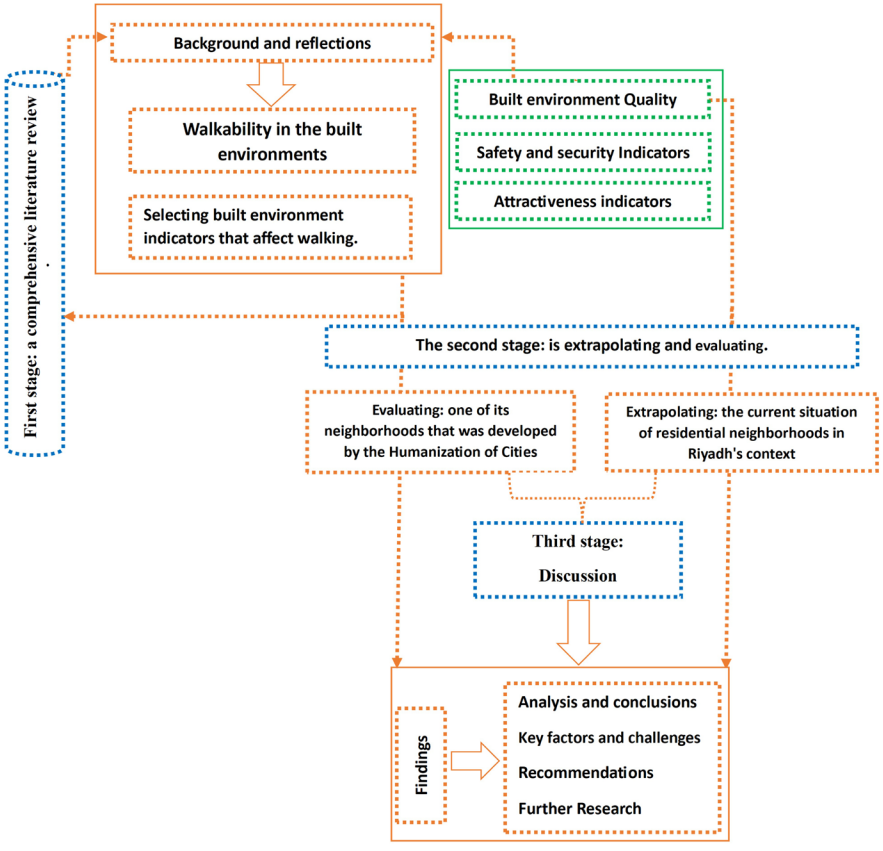

Figure (1). Methodology process. (Author)

deals with analyzing and evaluating the current situation of one of the residential neighborhoods within the city of Riyadh using a mixed-method approachadopting field observation methodologies and qualitative analyses that adopt field observation methodologies and qualitative analyses of semi-structured interviews.

The field observation methodologies based on descriptive analysis, studies, and site visits by the researcher to identify and assess the characteristics, features, and patterns of the built environment that the responsible authorities have developed within the initiative of city humanization applied in the selected neighborhoods in terms of its effects on walkability

The (semi-structured interviews) with neighborhood residents targeted for the study to gain in-depth insights. To do so, detailed, semi-structured interviews with residents were used to produce reliable, comparable data while offering the flexibility to ask follow-up questions to gain rich, detailed insights into residents' perspectives and experiences. This method will help the researcher stay on topic and avoid distractions.

The third stage was oriented toward analyzing the interviewers' responses using qualitative coding software (grounded theory) and combining these results with the results of field observations to generate insights that allow the researcher to have a deeper understanding of the research topic. The search ends with a set of results, conclusions, and recommendations to enhance walkability for pedestrians in residential neighborhoods in Riadh City.

As with all research, this study has certain limitations. Firstly, the study focused exclusively on a single residential area, the Al-Falah neighborhood, which the Riyadh Region municipality selected for the Humanization of Cities Initiative. Secondly, the study did not account for the effects of climate despite the well-known impact of summer heat on people's willingness to walk. Additionally, effective research requires careful consideration of several factors: the scale of analysis (whether at the section or neighborhood level) and the key variables and standards of the built environment that influence walkability.

To sum up, the research strategy intends to mix the author's field observations on the site with the interview results. This type of mixed-methods analysis of the neighborhood provides not only rich information about the built environment characteristics but also offers unique insights into how the selected neighborhood in Riyadh has evolved because of the introduction of city humanization initiatives.

4. Defining the Indicators of Walkability in Residential Neighborhoods with hot and dry Contexts

Determining the indicators of walkability in residential neighborhoods is a complex endeavor due to the subject's qualitative and often subjective nature, as well as the diverse range of studies that have addressed this issue. However, a comprehensive literature review reveals that many walkability indicators are widely accepted among researchers and scholars. The indicators and their associated variables, briefly summarized below, have been employed to establish a conceptual framework for assessing walkability in the designated case study. This study adds to the body of existing research about how walkability is impacted by the built environment, emphasizing residential districts in Riyadh. The chosen indicators fall into two primary categories: microscale and macroscale indicators. Planning-related variables like the walkability network, block length, spatial integration, and built environment quality are included in the category of macroscale indicators. Microscale indicators, on the other hand, focus mostly on aspects of urban design features, such as security safety, and aesthetic appeal. These metrics are specifically designed to mirror the unique circumstances of Saudi Arabian towns and are intended to alleviate locals' worries about walkability. The next part will go into more detail about each category

4.1. The Macroscale category: Planning Form and Built Environment Quality Indicators

Walkability in a built environment is measured using built environment quality indicators, which can significantly impact walkability. People of all ages and abilities can benefit from a , well designwell-planned form, and well-designed built environment that makes walking more attractive and feasible. In contrast, a poorly designed built environment can make walking hazardous, unpleasant, and difficult (Robertson. Kent. A, 2007). Streets network and pedestrian pathways, street intersection densities, and the distance between services and residential buildings are some of the variables that are related

to the Planning from built environment quality indicators, which can be clarified as follows:

4.1.1 Street Intersection density, connectivity and permeability.

Concerning the number of streets per neighborhood and their diversity in terms of the types of streets and their widths. A neighborhood with more major streets tends to have less pedestrian access than one with more minor or local streets (Saelens, B. E., et al., 2003). Street networks with more intersections make walking easier and offer more destinations within walking distance (Ledraa, T. A., 2012). Connections between public transport stops and neighborhood streets are also an important indicator of the street network connectivity.

Permeability is a crucial metric for evaluating the quality of urban areas and street network connections.(YAVUZ, A., & KULOĞLU, N., 2014) It is influenced by block size and the existence of alternate routes. "The extent to which an environment allows people a choice of access through it from place to place" is Bentley's (l985) definition for this indicator.(Bentley,1985, Butina-Watson, G., & Bentley, I. 2007)Diversity, pluralism, and accessibility are all related to permeability. Additionally, permeability has been linked in numerous studies to the state of the pathway's sides and their air and light transparency, which is highly related to the building block length and size in the neighborhood (Ewing, R. & Clemente, O. et al. 2013).

4.1.2. Convenience and Infrastructure for Pedestrians.

Sidewalk width and height affect pedestrian comfort and safety, sidewalk condition, surface quality, and materials used and maintained (Appleyard D, 1980). When streets and sidewalks are in good condition, pedestrians are less likely to trip and fall, which could provide them with physical and psychological comfort(Wood, L., et al. 2008)

4.1.3. The spatial planning of mixed-use services and their Catchment Distances.

Having residential, commercial, and recreational uses within an area will increase the number of destinations, such as shops, restaurants, and parks, as well as schools, all essential amenities, and bus stops and other public transport facilities. In a neighborhood plan with a variety of land uses, which define an array of amenities and have different arrangements of their locational distribution, it is more likely to be a walkable area and to have an active street life (Ewing, R. & Cervero, R. 2002). For a neighborhood to be considered walkable, it should have good pedestrian connections to the services and facilities in the neighborhood, which should be located within walking distance of houses in the catchment area. (Barton. H, 2000). The distance to amenities is another essential factor in determining walkability, and it impacts the viability and effectiveness of pedestrian systems. In essence, distance refers to the proximity and accessibility of various services from residential buildings. Research has revealed that pedestrians prefer short, direct routes and rarely walk more than 500 meters when accessing local amenities (Brookfield, 2017). However, it is widely accepted that a house should be located within a 10-minute walking distance of local amenities or a transportation hub (Barton. H, 2000). Furthermore, accessibility to mixed-use amenities is essential, particularly for those with disabilities, where features that facilitate accessibility to walking, such as ramps, slopes, and wheelchair crossings, are present.To achieve destination accessibility, it is necessary to provide greater walkability and to move people quickly to required amenities rather than to bring urban activities closer together (Blečić, I., et al., 2020). As a result, mixed-use development should be designed to facilitate access to various destinations, such as retail centers, service centers, recreation centers, etc. However, the lack of accessibility to amenities and mixed-use destinations often prevents large sections of residents from walking

4.1.4. Building Scale and Setbacks.

The scale and setbacks of buildings play a crucial role in defining the context, character, and scale of the pedestrian environment. The building scale discourages pedestrian activity in car-oriented areas due to physical and visual inaccessibility. The buildings in the car oriented cities, typically have large setbacks from the street and are oriented toward parking lots, resulting in longer walking distances and a long continuous built edge or street wall. In car-dominated areas, blocks are larger, streets are less connected, and alleys are usually absent. In contrast, neighborhoods with shorter block lengths, high connectivity, and numerous

local streets exhibit higher walkability rates (Ernawati, J.2016.) The blocks of buildings should have a depth of 35-60 m and a length of 150-220 m. The neighborhood will be more walkable with such block dimensions (Ledraa. T. A.,2012).

4.2. The Microscale indicators: Urban design features indicators.

4.2.1. Security and Safety Indicators.

Safety is a major determinant of walkability since people prefer to walk in places where they feel safe. Safety in the built environment is seen differently depending on several elements, such as traffic safety and security measures. Abandoned lots substantially impact neighborhood security; the existence of more of these lots is generally correlated with a lower level of safety in the neighborhood. When urban form and land-use arrangements help to deter criminal scenes, such as thefts and assaults, adequate neighborhood security can be obtained (Alipour, S.M.H., Galal Ahmed, K.2021). According to Newman (2010), the physical layout of metropolitan centers might enhance residents' options for natural monitoring (Newman, O., & Donnelly, P. G.2010). A Monitoring public areas on a regular basis can help lower crime rates and ease people's concerns about using them. This theory backs up Jane Jacobs's (1961) assertion that a planning system needs to be set up to promote street observation naturally (Jacobs, J. 1961) . Effective physical designs that improve surveillance opportunities include the thoughtful placement of external public spaces, such as parks and playgrounds, to ensure clear sight lines from surrounding streets and the strategic placement of internal public spaces, such as lobbies, elevators, and hallways so that they can be easily observed from outside the building. Sufficient illumination is also necessary to preserve visibility at night.

Furthermore, the presence of safety features within the neighborhood, such as police stations, surveillance cameras, and adequate lighting, is crucial for enhancing overall safety (Humpel et al., 2004) and can further strengthen community surveillance. Numerous factors can influence traffic safety, such as the proper planning and design procedures implemented by addressing street layouts and the availability of the design elements that provide protection for pedestrian crossings, such as the number of potential collision points at intersections, traffic speed limits, and the overall convenience of pedestrians' crossing, as well as adequate facilities to assist pedestrians in safely crossing streets. These facilities may include speed bumps, traffic control devices, protected crossings, crosswalks, and overpasses. (Alfonzo, M., et al., 2008).

4.2.2 Attractiveness and Aesthetic Indicators.

Table (1). The main and sub-walkability indicators,and the methode used for assessment of each one.

Category No.	Selected indicators	Sub-indicators	Factors related to the sub-indicators.	The method used for assessment of each.
The Macroscale indicators: Planning form and Built Environment Quality Indicators:	BEQI Built environment Quality Indicators	**BEQI-1** Street density, connectivity	The number of streets per neighborhood.	Map analysis
			Types of streets and their widths	Field observation Map analysis
			Connections between effective public transport stops and neighborhood	Field observation Map analysis
		BEQI-2 Convenience, Infrastructure for Sidewalk	Sidewalk width height and conditions,	Field observation Simi-structured interview
			Materials, Pavement quality	Field observation Simi-structured interview
			Sidewalk maintenance well-planned pedestrian infrastructure	
		BEQI-3 spatial planning of mixed-use services and the Catchment Distances	Mixed land-use of the neighborhood plan: a wide variety of excellent services and Dispersed service delivery	Map Analysis Field observation Simi-structured interview
		BEQI-4 Building Scale and Setbacks	Building length and setbacks	Field observation Map Analysis
The Microscale indicators: The Urban design features indicators	SSI Safety and security	**SSI-1** Security	Number of Abandoned lots and Avoiding dead-end streets	Map Analysis Field observation
		SSI-2 Traffic Safety	Crossing availability and Calmed road traffic	Field observation Simi-structured interview
			Inclusive traffic-calming and safetymeasures/control devices for pedestrians	Field observation Simi-structured interview
	AAI Attractiven	**AAI-1** Visual appeal	Availability of quality open spaces, landscape and greenery, street furniture along the pedestrian pathways	Field observation Map analysis Simi-structured interview

These indicators evaluate an area's aesthetic appeal; they can significantly impact walkability (Pikora, T. J., et al., 2006). By establishing a welcoming and appealing environment, walking can be made more pleasurable and enticing. This indicator can be achieved by the presence and quality of landscaping (e.g., trees, shrubs, flowers, etc.) (Giles-Corti, B., & Donovan, R. J. 2003). Street furniture design and placement (such as benches, trash cans, and light fixtures), and any other convenience facilities and drinking fountains, are also relevant to the visual appeal and attractiveness (Zayed, M.A.A. 2016), which are related to the architectural style and design of buildings along the pedestrian pathway, as well as the presence and quality of public art (such as sculptures, murals, and fountains).

Each indicator alone may have a lesser impact on walkability in any residential neighborhood in Ryiadh city than the sum of these indicators.

5. Extrapolating the current situation of residential neighborhoods in Riyadh: car-oriented versus walkable.

This section of the paper extrapolates walking activity in residential neighborhoods in Riyadh, where residential use dominates the city and covers roughly 1600 square kilometers. (Sultan, B. et al., 2021).

The city's urban planning prioritizes building setbacks and car movement, leading to streets dominated by vehicles and lacking pedestrian-friendly spaces. This has resulted in dispersed, functionally segregated neighborhoods with wide streets separating residential areas and minimal public transportation, making private cars the primary mode of transport. (Ministry of Transport, 2011) The Saudi Cities Report 2019 (UN-Habitat, 2018) states that roads the way how residential districts' roads greatly impact Riyadh's walkability are now built and equipped for pedestrian access, which is restricted by the lack of unmaintained or inaccessible spaces along these streets. As a result, there are fewer walks and more reliance on personal vehicles (Ledraa, T. A., 2012).

New urban developments have mostly moved northward due to the city's increasing population and urbanization, of creating car-oriented developments with streets designed to allow fast traffic. These new neighborhoods are designed for an area around two kilometers by two kilometers in size (Ledraa, T. A., 2012), with a layout characterized by grid patterns and detached villas. They are divided into sub-neighborhoods by major roads intersecting at their centers, forming the neighborhood center, which includes amenities such as shopping, schools, mosques, and open gardens (Eben-Saleh, M. 2001). These vast streets led to a clear lack of regular level crossings for pedestrians and cyclists, compromising safety and making its users

Figure (2). Photos from Riyadh neighborhoods show the current situation of the built environment (UN-Habitat, 2018)

feel lost. These streets have turned into highways primarily designed to move cars at the highest speeds, sometimes 17 meters wide, tangent directly to the building's lines, with huge spaces used for parking. This model of urban design for residential neighborhoods in Riyadh city impacts individuals' health, safety, and quality of life. Additionally, the lack of trees and plants contributes to reduced living conditions, as do wide, straight streets, which are unsuitable for the region's climate, as well as the absence of streets that are accessible to people with disabilities, with many violations and extreme variation in the external cladding materials, as well as poor physical conditions of the pedestrian infrastructure, and the many unpaved and poorly maintained entrances to the amenities, which hinder accessibility, especially for the elderly and disabled people, resulting in inadequate urban environments and a very low degree of accessibility in Riyadh residential neighborhood, and consequently undermined the level of liveliness there.

5.1. Enhancing Riyadh's Urban Environment: Humanization of Cities Program

The Saudi government realized how important transformation is to sustainable mobility. All the Strategic Urban Transport Policy Directions for Riyadh emphasize the need to improve walkability as a priority strategy (Kim, H.M., & Babiano, I.M, 2018). The developed plans in Saudi Vision 2030 aim to build a sustainable future for the Kingdom (Saudi Vision, 2016). The government has started several initiatives to make Riyadh more walkable. In 2017, the high commission in the region approved five metro lines, a transport network with parks, pedestrian cities, bicycle lanes, and ten bus lines for placement in Riyadh (Saudi Vision, 2016). This vision provided several goals and initiatives to enhance the population's livelihoods and quality of life to build a vibrant society (Saudi Vision, 2016). The Humanization of Cities Program, launched in 2020 by the Saudi Ministry of Housing, seeks to improve the lifestyle of the individual and the family to create a society with a balanced lifestyle (UN-Habitat, 2018)This program included several principles for developing the residential environment and increasing the quality of life in cities. This will be done by creating pedestrian walkways and green spaces to make residential areas sustainable by facilitating safe pedestrian movement, providing social activities, and rehabilitation of public spaces. It also adapts public spaces in Riyadh into pedestrian-friendly ones and fewer car-dependent ones. Additionally, it focuses on upgrading the urban design and environmental context to give residents higher access to daily services and jobs. The program also aims to improve the road network and connect it to public spaces. The program will also contribute to eliminating many manifestations of encroachments on sidewalks, random parking of vehicles, and driving at high speeds inside neighborhoods, in addition to its effective contribution to giving an identity to each neighborhood (UN-Habitat, 2018). Creating walkable areas that promote interaction and dialogue among cultural groups in Riyadh, as a city with a multicultural population, can enhance its cultural diversity. In addition, it enhances community cohesion to promote progress and foster dialogue between diverse nations and cultures, thus achieving mutual respect and understanding among multiple societies.(M. N. Ahmad Taha , D. A. Abdelfattah,2023). Two residential neighborhoods have been selected for Riyadh's "Humanization of Cities" pilot project initiative. The Riyadh Municipality has completed 75% of the first neighborhood targeted within the program, the "Al-Falah" neighborhood, with plans to continue working in other neighborhoods (RCRC). This study was therefore applied to the Al-Falah neighborhood to assess the results of this initiative by measuring and assessing the walkability factors that have been developed in the Al-Falah district. An important tool to assess walkability in urban areas is the Walk Score tool, which was established in 2007 in the USA in order to promote walkable neighborhoods and to make evaluating walkability and transportation options easier for individuals (Hall . M, Ram. Y,, 2018). As the Walk Score tool is tailored to assess walkability macroscale measures in specific urban contexts, it cannot be used locally in the KSA, where The assessment of walkability conditions in Riyadh is still primarily dependent upon the guidelines and regulations concerning the urban design of residential neighborhoods, which were qualitative in nature, and focused on specifications of pedestrian walkway widths, safety measures, and detailed street cross-sections with furnishings, and these are often considered microscale indicators of walkability. However, the macroscale walkability indicators, which relate to pedestrian network design, neighborhood morphology, and neighborhood planning, have

not been updated and have not received similar attention. Accordingly, the paper will assess the walkability conditions in the selected district according to the method described previously in paragraph 3.

6. The selected Case study: Al-Falah Neighborhood Walkability Assessment

This study will evaluate the quality of Al-Falah's built environment, the conditions of walkability there, and the improvements made under the initiative of Riyadh's municipality.

6.1. Describing the Al-Falah neighborhood

Several tools were used to determine the location of the chosen neighborhood, as well as its services, main facilities, population, primary residential types, and street hierarchy. These tools included Geographic Information Systems (GIS), GPS technologies, and the Riyadh region's spatial portal, an e-service offered by the High Commission for the Development of Arriyadh that allows users to view a unified digital map of the city's building and land-use systems. Based on those tools, the Al-Falah neighborhood is in Riyadh's north, and it provides many types of services and facilities for its residents with a length and width of (2.0*2.0) km, approximately a total area of 353.000 m2 (RCRC). It has a strategic location between northern neighborhoods and proximity to numerous prominent landmarks throughout the capital. Several residential neighborhoods are adjacent to the AL-Falah neighborhood, including Al-Wadi and Al-Izdihar. Many important main roads pass through the neighborhood, including the Eastern Ring Road and, to the south, the Northern Ring Road. Moreover, it is located on Prince Muhammad bin Salman bin Abdulaziz Road and Othman bin Affan Road.

The neighborhood has a mixture of residential buildings, primarily villas. It has many services, educational facilities, health care facilities, and green spaces. The table below shows the facilities included inside the AL-Falah neighborhood.

The new concept of planning" the grid pattern and detached villa houses" was used in the selected neighborhood and was planned around a peripheral road and subdivided into sub-neighborhoods by major highways that intersect in the center, forming an area that comprises all necessary community

Table (2). The table shows the facilities included in The Al-Falah district(RCRC).

Number of Mosques	Number of Health facilities	Number of streets	Number of educational facilities	Number of commercial facilities	Number of lands	Number of Parks	The total area	Al-Falah Niegberhood
20	0	184	15	359	2857	5	2m3992557	

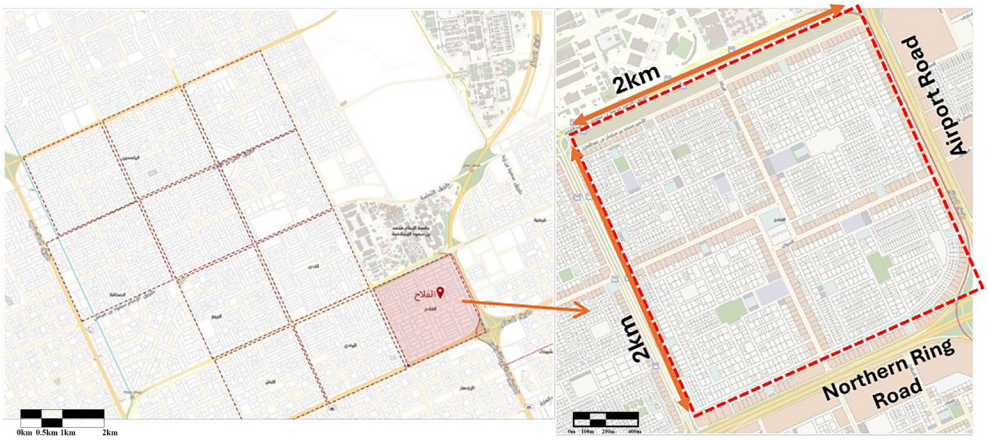

Figure (3). Maps showing the selected district within Riyadh and its dimensions, with the main surrounding streets (Author)

facilities, like shopping, schools, and mosques. Each sub-neighborhood has detached houses, schools, a Jami Mosque, and a garden. This pattern was widely used in Riyadh, and it was car-oriented, with wide and straight streets, rectangular blocks, and square plots, with a low population and land-use density (Eben-Saleh, M. 1998). The urban form of the neighborhood is composed of 4 clusters positioned around the neighborhood centerseveral having a local center within each of the clusters (Fig. 2). Each regional center is supposed to incorporate several amenities in accordance with under the size of the section it belongs to. Accordingly, a park or a pocket garden, a mosque, and a certain number of shops and amenities are, or expected to be, provided in every local center. The Al-Falah neighborhood's constructed environment was initially inappropriate, with extra-wide streets that lacked sidewalks on most of them, few pedestrian crosswalks and street furniture, and few trees and street furniture. Despite being a residential neighborhood, Al-Falah's roadways were not designed with pedestrians but with cars in mind, with minimal adherence to the standards-based design for urban streets. Five locations were selected to evaluate the walkability conditions and the pedestrian infrastructure quality within the AL-Falah neighborhood; locations were located along mixed residential streets, beginning with the four main streets of the Al-Falah district, a field assessment of each point in the study area was conducted based on the leading indicators discussed in the theory section. Fig.4. Below are the selected points.

Moreover, the distances between the centers of each site and the nearest facilities were calculated to examine their distribution pattern. This was done to determine whether the facilities were systematically clustered or dispersed across the study area. The distribution and location of facilities are considered to determine how walkability activities in the neighborhood are affected.

7. Assessment of the walkability conditions in the selected case study based on the field observation

To assess and evaluate the walkability conditions in the selected site, based on the research methodology, the first step is based on site observation, as mentioned previously in paragraph 3, through the author's field exploration, considering the main research indicators explained in paragraph

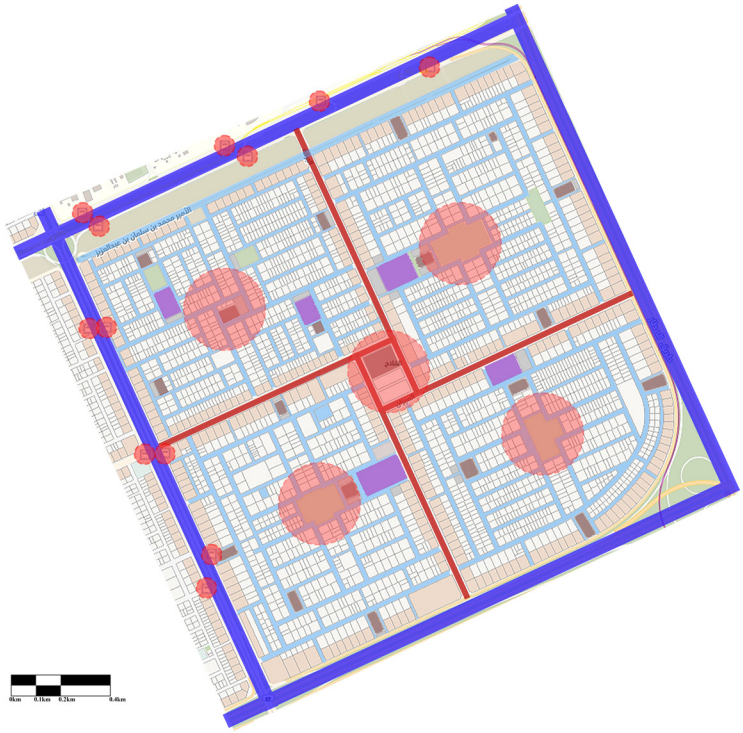

Figure (4). The locations of the selected sites to evaluate from the Al-Falah Neighborhood (Author)

4. To do such an assessment, the author conducted five field visits from March to April 2024. These visits were conducted by walking pre-defined routes across five zones within the neighborhood. Fig. 4 shows those main zones, which included diverse land uses, such as commercial parks, mosques, etc. The distance from the center of each selected site to the nearest mosque is between 200 and 500 meters, with the most distant mosque positioned within this range. Additionally, these sites comprise gardens and green spaces that have been developed as part of the Cities Humanization Initiative to benefit the local community. The proximity of each site to nearby commercial services varies, ranging from 300 to 500 meters. Furthermore, the distance from the center of each selected site to surrounding schools falls within a range of 500 to 800 meters. Each observation session covered an average walking route of 1-2 kilometers. The author recorded pedestrian infrastructure conditions through photographs, notes, and distance measurements. The primary aim of the in situ (on-site) observations was to gather real-world data about the physical environment's walkability. This includes evaluating the physical infrastructure, built environmental features, and overall urban design elements (the macro and microscale indicators) that support or hinder walkability. These observations allowed the research to directly assess how conducive the built environment is to walking and whether it meets the basic requirements for safe and convenient pedestrian movement.

7.1. Assessing the (Macroscale indicators) Planning form and Built Environment Quality Indicators:

7.1.1. Street Intersection Density,connectivity and permeability:

The approach used in the Al-Falah district is the contemporary, vast neighborhood structure. This design has had the opposite effect on pedestrian access and walkability because the neighborhood connectivity was related to the availability of highways, collector roads, and major roads surrounding it, which increased automobile traffic but hindered pedestrian movement (Ledraa, T. A., 2012).

According to the maps and data available by the "RCRC" Two main types of streets are available inside the neighborhood, Type R and Type M, which are classified by the Riyadh Royal Commission based on their functional characteristics as mixed residential roads (Type "M") and residential roads (Type "R") (UN-Habitat, 2018), which will be mainly analyzed in this research because they were the main priority in the improvement of the humanization initiative program. There are about 184 streets of the two types (M, R) (RCRC), which makes the density in the neighborhood logical and well-designed regarding internal connectivity. However, the street length and the failure to adhere to the speed limits for cars, in most cases, within the residential neighborhood, did not encourage residents to walk within the neighborhood.

This planning system has had the opposite effect on pedestrian access and walkability because the neighborhood connectivity was related to the availability of highways, collector roads, and major roads surrounding it, which increased automobile traffic but hindered pedestrian movement (Ledraa, T. A., 2012).

The Field Observations also affirmed the lack of integration within the district and its surroundings, mainly due to the wide and high-speed peripheral streets separating the district. This has made movement between the selected district and its adjacent neighborhoods extremely difficult without private vehicles, which makes the percent of neighborhood integration very low with the other surrounding communities.

7.1.2. Convenience and Infrastructure for Pedestrians:

The field observations affirmed the availability of this indicator at the selected points of the site, where the pedestrian pathways provided convenience and less stress.

At the selected site points, sidewalk widths ranged from 13 to 17 meters with a 15 cm height. They were covered with interlocking hardscape elements, see Fig 5, which had a gray color and well-defined appearance with good physical condition. It provided pedestrians with a safe walking environment, allowing them to walk comfortably, and the large width of the sidewalks provided a good opportunity for diversifying options of mobility for the pedestrian and thus helped improve walkability and bike-ability conditions and helped in regulating access to the destinations around the five selected main points,

Figure (5). Photos showing the width of the pedestrian pathways in the Al-Falah neighborhood's main center. (Author)

Figure (6). Photos showing the accessibility for special needs surrounding the main center in the Al-Falah Neighborhood (Author)

A 1:12 access ramp has been added at the entrance to most buildings and at each ground-level pedestrian crossing. The sidewalks, which were wide between 1 and 4 m, were very difficult to walk on, especially when they included some planting elements along them. Fig. 6 shows some examples of the accessibility measures added to the main sidewalks in the district.

7.1.3. The spatial planning of mixed-use services and their Catchment Distances

Through the utilization of map analysis and field observation tools, it could be easily claimed that the neighborhood offers a considerably limited range of high-quality services, housing types, non-car-based jobs, open spaces, and modes of mobility, where the analysis of the available maps

of the spatial portal of the Riyadh region offered by the municipal government of the Riyadh region revealed approximately 359 commercial facilities, located in the main center and the sub-centers, and 15 educational buildings, including one university. Additionally, the neighborhood includes 20 mosques situated at various points. There are also three significant parks within the neighborhood and subsidiary parks (RCRC). Both the map analysis and field observations exposed the availability of good-quality open spaces in the main center of the district, which increases the richness of the main streets' functions and vitality and adds a type of function variety in the main center. All these services along the main streets supported pedestrian accessibility and were well-planned regarding disabilities and can be reached comfortably without interruption ; however, there was revealed limited ability to undertake multi-purpose walking trips to the sub-centers in the neighborhood, where the predominance of residential use of the detached housing type has hindered mixing other retail, commercial, and administrative uses with the residential use that led to the absence of many services and facilities in the sub-centers, and makes the spatial organization of the areas far from the main center lacks appropriate mixed land uses, so the distance between home and service facilities has increased. Mosques are the most widely distributed facilities in the study's area, making them the closest to every single parcel, according to the findings of the field observations. This has to do with the fact that Muslims make up the majority of the population in Riyadh and that going to mosques to worship is a significant aspect of both religion and culture. Mosques must, therefore, be the nearest amenities, accessible by foot, to each parcel. Contrary to mosques, in the suburbs, the average distance between Parcels and the nearest supermarket, pharmacies, and grocery store is about 649 m, which limits the chance to conduct walking trips to these destinations. The map below shows the land use of the selected districts, with the main points for bus stops and

Figure (7). Maps showing the land uses,of the Al-Falah Neighborhood (RCRC,edited by the Author)

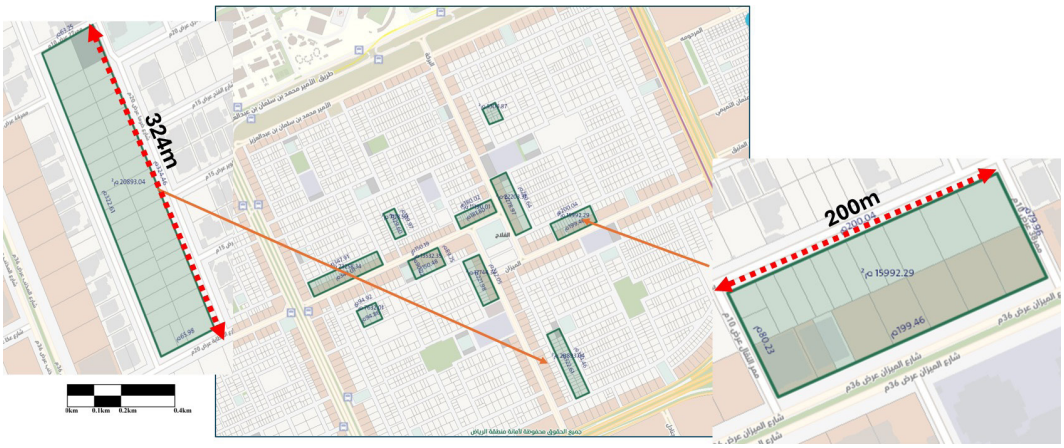

Figure (8). The building length in the selected district (Author)

public transportation points surrounding the district, which were distributed in the region at a very small rate. There were good connection points along the streets from the north and west sides, but there was no connection between the neighborhood and public transportation from the east and north sides, despite the neighborhood being adjacent to major streets (the airport road from the east and the Northern Ring from the north).

7.1.4. Building Scale and Setbacks:

Due to the car-oriented planning system implemented previously in Al-Falah, the average length of each residential unit is approximately 35 meters. The exaggerated lengths of residential units created a continuous street wall, reaching in many areas about 200 meters see Fig.8, because the buildings were built in attached villa style on many district sites, which reduced the district's permeability and affected its walkability. Even though the setbacks were organized along the main streets, they encroached on external sidewalks on many subsidiary streets. As a result, pedestrian sidewalks in those areas became narrower. It is clear from this that imposing a development system on an area previously designed for cars rather than pedestrians was of no benefit to the level of rising permeability in the district. This indicator should be considered during the first residential district planning stage.

7.2. Assessing the (microscale indicators) The Urban design features indicators

7.2.1. Security and safety

The map analysis and field observations revealed that many abandoned lots could impact security, as these areas may attract illegal activities or become potential hiding spots for criminals. These abandoned areas surround the district and within it. see Fig. 9. Which clarifies these abandoned areas in the Al-Falah neighborhood. Therefore, efforts to address abandoned lots and improve visibility in the neighborhood are essential for maintaining a safe and secure environment for residents. These abandoned areas were used in many sites as parking lots, especially those within the district. The map analysis showed the negative effect of the neighborhood's urban form on safety, which has resulted in long walking distances and wide streets, which have prioritized the car traffic and accordingly increased the private car dependency. Despite there being no dead-end streets found in every housing cluster in the neighborhood and the fact that the residents of the neighborhood often belong to the middle/upper social stratum, which leads to low crime rates and gives a sense of security in this neighborhood, but the high ratio of abandoned and undeveloped lots in the district makes it unsafe, especially within the district boundaries. It was also discovered, from field observations, that the urban form, which is

Figure (9). Solid and Void Map showing the ratio of abandoned slots in the district(Author)

Figure (10). The availability of pedestrian Crossing, traffic speed signs, and bumps in the selected district (Author)

spread over two square kilometers, does not also encourage community urban surveillance since people are not encouraged to walk or gather in the streets. Furthermore, windows overlooking streets and open spaces are prohibited by the houseshouses high, solid external walls, which means that active police patrol monitoring is necessary.

After visiting the district many times, it became evident that pedestrian crossings were well-planned to facilitate safe crossing for residents and that traffic-calming measures and control devices were sufficient in all the district streets, and those were added during the implementation of the Humanization of Cities initiative. All areas had well-lit streets to enhance visibility and safety during nighttime hours, and traffic control devices, such as traffic signs and traffic-calming measures, which were more prevalent at the centers and intersections. Fig. 10 below shows traffic measures in the center of the district. Despite the speed limit determined in residential areas being about 30 km/h, this limit was not respected, affecting safety in many neighborhood areas despite traffic-calming measures. While there was limited coverage of cameras in the district, despite the importance of their availability, it was mainly those that residents themselves

7.2.2. The Attractiveness and Asethtic Indicators

The Al-Falah district included different areas with good architectural-style buildings that added to the aesthetic appeal and character of the region, especially those with detached villas, creating a visually pleasing environment for pedestrians, according to (Ahmad Taha M.N 2023). The high economic capacity of the local societies in the modern residential neighborhoods in Riyadh provided dwellings of different types and levels to meet the diversified housing demand, and the effect of Western culture influenced and reflected architectural products and the styles of the architectural formation of the exterior facades of the residential buildings in these areas to identify the level of luxury that each homeowner owns. The good appearance of most houses with their usually well-maintained fences and gates, together with the overall cleanliness of the streets, has created a generally accepted level of visual and psychological comfort for the neighborhood's residents and has been reflected clearly in villa buildings in the selected district, creating an attractive environment and providing visual comfort.

The humanization initiative and the green Riyadh initiative are applied in modern residential neighborhoods to increase the ratio of greenery in Riyadh's neighborhood. According to this aim, many open spaces in the selected district have been changed to parks with landscaped several areas of the district; where there were about five parks in the district, one in each center of the sub-neighborhood and one in the main center, as shown in Figs. 7 and 4 above. These parks had well-maintained pathways, which enhanced the walkability surrounding them, and they were fully furnished with sitting elements, trash receptacles, and well-marked biking and disability routes, making them safe and comfortable to walk through (see Fig. 11 below).

In addition to providing opportunities for recreation and community gatherings, these open parks enhance the overall ambiance and livability of the neighborhood. The field observation also discovered. Sub-centersField observation also discovered that high-visual attraction elements, such as landscapes and site furniture, added in the district were promoted in the district's main center and sub-centers, contributing to their overall livability and quality of life in these centers.

However, the other areas, which are far from the centers, had limited street furniture and landscape elements, where there is a lack of sitting benches and shading devices, and landscape weather mitigating elements, besides the extensive use of pavement and concrete blocks in sidewalks inevitably led to physical and thermal discomfort.

Figure (11). Green elements and site furniture along some pathways (Author)

8. Assessment of the walkability conditions in the selected case study based on the Interviewed actors:

Field observation, which was the first step to assess the walkability conditions and pedestrian infrastructure in the Al-Falah district, was used as the basis for the second step mentioned in the research method, semistructured interviews in which physical characteristics, perceptions, and walking behavior are related (Ewing, R., & Handy, S. 2009). Based on that, semi-structured interviews were conducted with residents who were explicitly practicing and using the public spaces in the neighborhood as key actors directly involved in the built environment of the Al-Falah district. The research included 51 participants, drawn from a diverse demographic within the Alfalah district, encompassing a range of ages and backgrounds, to capture a broad spectrum of community perspectives.

These semi-structured interviews provide opportunities for in-depth exploration of complex topics and focus on the research's main objectives. The interviews were done with pedestrians passing through the same zones selected previously for the author's field observation, shown in Fig. 4 above, which includes mosques, supermarkets, and parks. Based on the identified indicators discussed in the literature, interviewees were asked to give a deep insight into the built environment's physical condition related to the district's pedestrian infrastructure and to examine the rate of its development after applying the humanization cities initiation in that district. Pedestrians on the streets were chosen randomly, and the questions in each interview were structured in four parts; with about 20 questions, the interviewees had the freedom to expand or provide additional insights based on their lived experiences in the district. The interviewers were trained on evaluation procedures to ensure consistent scoring and minimize bias, both open-ended, multiple-choice, and probing questions were used to explore attitudes and responses and assess the built environment's qualities,

Throughout each interview, the interviewer took copious notes on the transcripts and recorded the interviews. A spreadsheet was used to arrange the data by the three primary indicators specified in the paper.

The first section of each interview recorded data on respondents' socio-demographics, such as education, current job, length of stay in the neighborhood, and the time they spent daily walking in the neighborhood to determine walking duration

Table (3). The semi-structured interviews questions regarding demographics data [Author].

Interview section	Question Statement	Answer Scale
Section 1: Demographic Information		
DEM-1	Age	18-25 years - 25-35 years 35-45 years- 45-55 years More than 55
DEM-2	Gender	Male- Female
DEM-3	How long have you been living in your district?	0-5 years - 5-10 years 10-15 years- 15-20 years
DEM-4	How many minutes per day do you usually walk?	Less than 10 Min- 10-20 Min 20-30 Min- More than 30
DEM-5	What are the main reasons you walk?	Exercise (walk or run) Shopping Enjoy the outdoors. Going to mosque
DEM-6	What mode of transportation do you use to reach your most visited destination.?	Walking\Own car Public transportation

The demographic shown by the interview results are varied, with somewhat more women than men participating. Most respondents (35) have been able to assess recent developments from the city's humanization effort launched in 2020 because they have resided in the neighborhood for 0–5 years. Most walk for less than ten minutes daily, though some walk longer. Walking for exercise (23 respondents of all genders) and visiting the mosque (30 male respondents) are the two and most significant motivations for walking; shopping accounts for less walking. Due to the long streets in the area and the dispersed location of amenities like parks and markets, private automobiles are the primary means of transit. Not a single respondent mentioned taking public transit. Fig.12 shows the results of the demographic analysis conducted during the interviews.

The second part of the interview questions in each interview were meant to measure people's evaluation of the macroscale indicators, which are related to the quality of the built environment of pedestrian pathways and mixed-land-use facilities.

The analysis of resident interviews regarding the quality of the built environment and its effect on walkability in the Al-Falah residential neighborhood of Riyadh following the city's humanization initiative reveals several insights. Resident evaluations indicated favorable ratings for

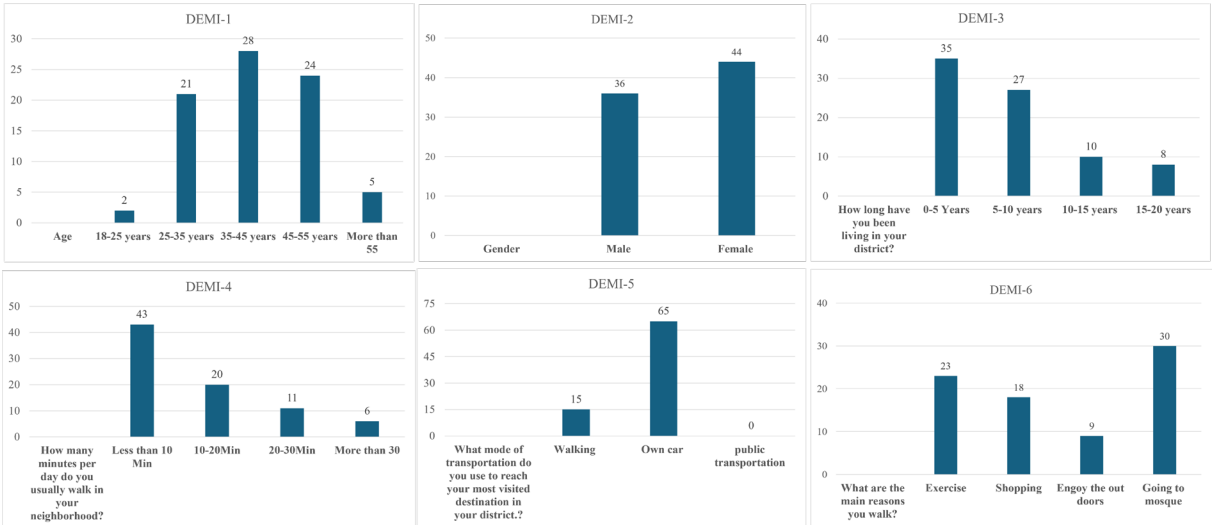

Figure (12). The demographic analysis results were conducted during the interviews in the Al-Falah neighborhood [Author].

sidewalk conditions and materials, with a significant majority rating them as "good" and "very good." Enhanced pavement quality has positively impacted pedestrian activity, notably along the sidewalks adjacent to the neighborhood's approximately five parks. Responses varied regarding sidewalk connections, with "good" and "medium" ratings being most common, which were influenced by each household's location and proximity to the central area within sub-neighborhoods. Disconnected sidewalks in the district posed a significant obstacle, discouraging walking among participants. Other barriers to walking included poorly designed narrow sidewalks, influenced by setback-dependent planning systems in the district. Despite various traffic control measures in central areas, some participants expressed hesitance due to unsafe road crossings and high traffic volume, particularly those residing further from the primary key centers. Some also mentioned interruptions along the sidewalks made by establishments caused by debris from incomplete construction sites

Table (4). The semi-structured interview questions regarding the Built Environment Quality indicators in the Al-Falah district [Author].

Interview section	Question Statement	Answer Scale
Section 2:The Macroscale indicators: Planning form and Built Environment Quality Indicators:		
Convenience and Infrastructure for Pedestrians BEQI-1	On a scale from 1 to 5, how would you rate the sidewalk infrastructure in your district regarding sidewalk conditions and materials? (1: Poor; 5: Excellent)	1-5
Convenience and Infrastructure for Pedestrians BEQI-2	On a scale from 1 to 5, how would you rate the sidewalk in your district regarding ease and connection? (1: Poor; 5: Excellent)	1-5
Convenience and Infrastructure for Pedestrians BEQI-3	What prevents you from having a walk throughout your district? Select all that apply.	Poorly designed sidewalk Sidewalk is discontinuous Unsafe road crossing Narrow sidewalk Occupied by establishments
Mixed-use services and their Catchment Distances BEQI-4	Which kind of facilities, in your opinion, increase the district's walkability?	Amenities (shops, Supermarkets, restaurants, cafes) Mosques Sport buildings Parks

It was found that parks and mosques were the most favored amenities that could enhance walkability, followed by shops and cafes. Residents in mixed-use neighborhoods reported higher walkability and increased daily physical activity in areas characterized by mixed land uses, in central areas with well-connected streets and a continuous pedestrian sidewalk network. In contrast, residents of outlying areas with solely residential land use reported lower walkability. Hence, diverse land uses in the central district contributed to enhanced walkability in that area. While these results indicate that the neighborhood environment quality has improved, there are still significant obstacles to walkability that need to be addressed, especially in suburban areas that are far from the main center, where it is recommended to combine residential, commercial, and service activities to encourage walking, biking, and public transportation.

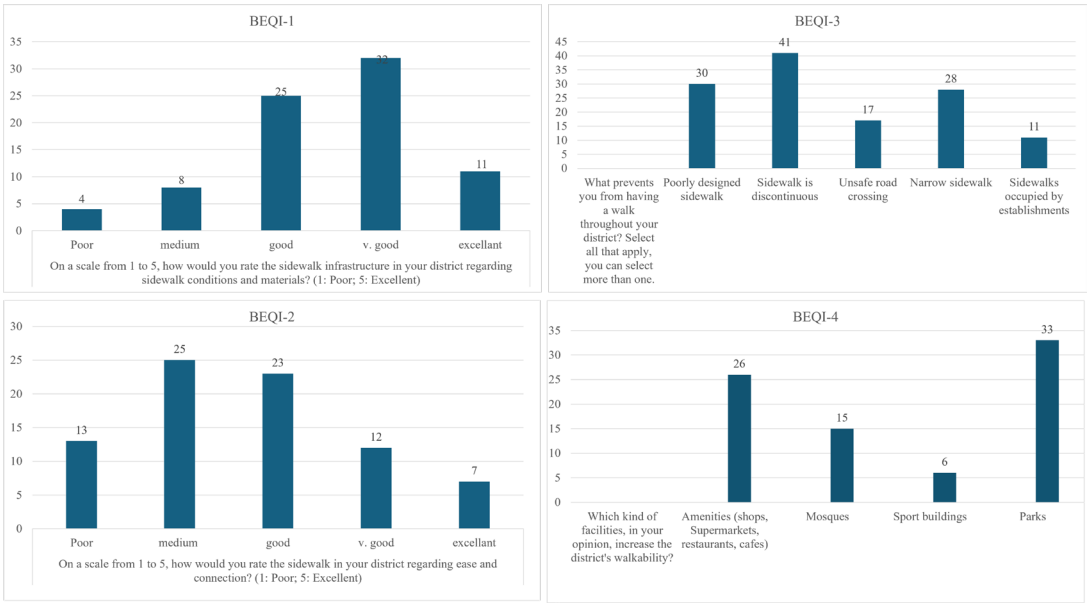

Figure (13). The results of the Built Environment Quality Indicators analysis were conducted during the interviews in the Al-Falah neighborhood [Author].

(Ewing R.2005). Fig.13 shows the analysis results conducted during the interviews regarding the built environment quality indicators.

The third part of the questions in each interview included indicators of the microscale indicator categories, which are related to the interviewee's perceptions of safety, security, and attractiveness indicators.

The Humanization of Cities initiative aims to improve safety and security in residential neighborhoods through measures such as enhanced street lighting, surveillance systems, community policing, and public safety services. The analysis of safety and security indicators in the Al-Falah residential neighborhood of Riyadh reveals varied perceptions among residents. The evaluation of residents can vary based on individual experiences and perspectives. But in general, many residents appreciated the improvements in safety measures and community engagementand agreed that there is a safe and secure environment. In terms of safety from crime and theft (SSI-1), a significant majority of respondents feel very safe; the few who think moderately and slightly safe are the residents of buildings near abundant and empty areas that are distributed to the north and south borders of the district, as shown in Fig. 9 above, which clarifies the state of built and unbuilt spaces in the district. Regarding the safety and availability of pedestrian crossings and traffic measures (SSI-2), the majority rated them as somewhat available and safe. The other participants rated them as poor and unsafe for those living far away from the centers and near the highways surrounding the Al-Falah neighborhood. For street lighting (SSI-3), most respondents found them available and adequate in their areas, which gave them comfort and safety after starting the humanization cities initiative, and this assessment is compatible with the researcher's field observation and assessments.

The community's perception of safety can be positively impacted by neighborhood design and aesthetics, providing neighborhoods with a sense of livability and vitality [42, 43, 44]. In the Al-Falah neighborhood of Riyadh, the AAI-1 indicates landscaping (plants, trees), which respondents rated as the most important but saw as somewhat inadequate according to the results of rating the AAI-2. Despite the neighborhood's implementation of city humanization and the development of its main and more minor centers, as well as the increase in planting and greenery there to make the neighborhood more walkable and appealing, it still needs more green spaces and well-equipped pathways with the significance of offering an extensive selection of well-planned, well-kept, and fully equipped sidewalks. By accomplishing this, the neighborhood's surroundings will be aesthetically pleasing, which will increase the neighborhood's appeal.

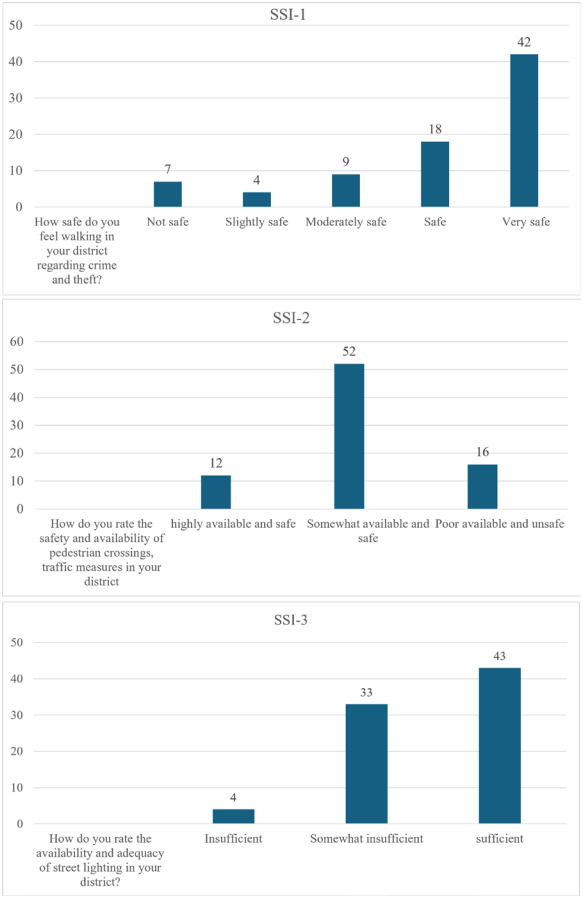

Figure (14). The Safety and Security Indicators analysis results were conducted during the Al-Falah interviews [Author].

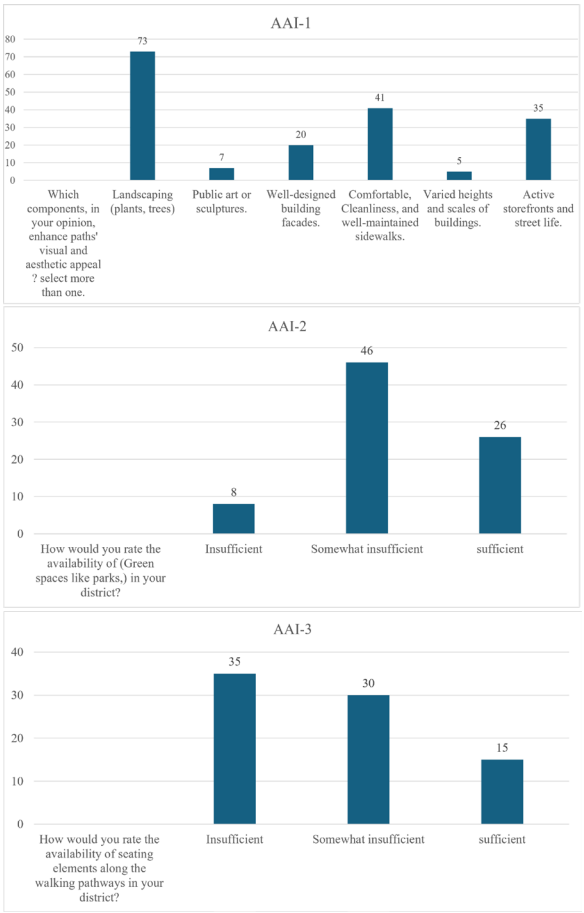

Figure (15). shows the results of the Attractiveness and aesthetic indicators analysis conducted during the interviews in the Al-Falah neighborhood [Author].

Through these interviews, the researcher was able to systematically assess the walkability indicators, which supported, in some instances, the author's field observations.

9. Discussion of the results.

The research endeavored to enhance the discourse surrounding the impact of urban humanization initiatives on the built environment's qualities and walkability within residential regions of Riyadh. It discovered that the change in the environment developed by Riyadh's City Humanization Initiative has significantly motivated walkability.

Field observations in the selected neighborhoods and the collected residents' viewpoints through semi-structured interviews were integral to the study. By employing a thorough methodology and framework, the study unveiled the intricate relationship between built environment qualities and their significant contribution to improving residents' quality of life. Notably, sprawling horizontal expansion played a key role in fragmenting the city into disjointed neighborhoods characterized by elongated building blocks that restricted the ability to walk. A pilot studyA pilot study analyzed walkability conditions in the residential neighborhoods in Riyadh city analyzed Walkability conditions in Riyadh city's residential neighborhoods. They revealed many facts related to a street layout that prioritize street layout that is prioritize prioritizing vehicular traffic over pedestrian movement, whose infrastructure

was very weakly paved. In addition to the absence of adequate public transportation facilities and the network network coverage of bus network coverage, approximately 98% of Riyadh's population relies on automobiles for transportation.

Despite these challenges, the city's Humanization Initiative has led to notable enhancements in the built environment's qualities, particularly in public spaces, fostering greater community engagement in walkability. The research underscores that various factors, such as physical attributes, security, and street connectivity, significantly influence walkability. At the same time, demographic variables like age and education also shape pedestrian patterns in residential settings, in addition to the effect of local customs and social traditions, which also influence transportation behavior, especially in a city such as Riyadh, which has a very hot climate and where habitual car use has been difficult to change due to ingrained preferences for convenience and comfort.

10. Recommendations

Regarding the macroscale indicators, planning form, and Built Environment Quality Indicators:

Many recommendations can be madeto enhance and develop the urban form of the residential neighborhoods in Riyadh, which can increase the walkability there. Those recommendations can be as follows:

- Integrating street networks, connecting dead-end streets with the nearest streets, restricting car movements to dead-end streets with the nearest streets, and restricting car movements to pedestrian and cycling movements.
- Diverse movement modes and cycling infrastructures are also important, as is improving the pedestrian network and access to public transport nodes.
- Creating more connected sidewalk layouts to provide residents with direct access to essential services such as supermarkets, parks, mosques, schools, and commercial establishments, thereby increasing walkability and non-motorized activities.
- Improving accessibility; reconsidering access for people with special needs.
- Redefining the land-use plan of the new residential neighborhood and providing suitable locational distribution of a mixture of needed local services and amenities, with the importance of improving the quality of services.
- Future developments and land-use patterns for residential neighborhoods in Riyadh should investigate the distance and impacts of various facilities on residents' walking behavior and explore the distribution pattern and accessibility to facilities, residents' physical conditions and willingness to walk, and the conditions of the street.
- It is crucial to develop and utilize the large undeveloped tracts within the residential neighborhoods in many areas of Riyadh City to introduce mixed-use functions that benefit residents and promote walkability. Applying the infill strategy and taking advantage of vacant plots can be helpful here.
- Decentralizing services and diversifying services.
- Moreover, the research underscores the importance of studying the width of the sidewalk while considering the actual needed number of parking lots and completing the cycling lanes as part of the Humanization of Cities initiative.
- Increasing the number of public transportation stations in residential areas will further enhance walkability; this significantly enhances the accessibility of of houses to the public transport nodes (bus stops) in the neighborhood. Providing more bus routes and stops throughout the day would also be economical.

Regarding the microscale indicators:

Many recommendations can be suggestedto enhance and develop the safety and attractiveness of the residential neighborhood in Riyadh.

- Adapting urban landscapes to mitigate the effect of outdoor temperature (through various shading strategies)
- Improving pedestrian walkway design
- Improving street furniture (settings, benches, etc.) along the sidewalks.
- Developing a network of green corridors and walkways that connect open spaces within neighborhoods will create ecological balance and reduce pollution.

- Designing an attractive neighborhood environment with diverse housing styles, well-maintained sidewalks and landscapes, trees, green elements, and adequate street lighting will enhance the walking and social environment.
- Extending the "Humanization of Cities Initiative" to other districts, with the importance of promoting public awareness campaigns, should promote walking by highlighting its health benefits and encouraging the culture and habit of walking among all demographics.

11. Further research

Since walkability is a highly contextual topic, studying the factors that influence neighborhood residents' satisfaction with the built environment in a specific geographical and cultural context will aid in the development of walkability macroscale indicators in Riyadh and help the research find a wider range of opportunities and solutions for enhancing walkability aspects of the current urban form. These indicators should be customized for local communities. They should be reviewed regularly and regularly to ensure their continued suitability because the quantity and types of amenities offered locally and the accepted catchment distances to them may vary over time. Additionally, a larger number of neighborhoods studied would provide better generalizability to the research outcome.

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إطلاق العنان لإمكانية المشي في المدن ذات التنمية الموجهة للسيارات: تقييم البيئة المبنية وتأثيرها على المشي في الأحياء السكنية بالرياض

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ملخص البحث. إن تعزيز إمكانية المشي في المناطق الحضرية، وبخاصة في المناطق التي تتميز بالمناخ الحار والجاف وأنماط التنمية الموجهة نحو السيارات، أمر يتم التأكيد عليه بشكل متزايد بوصفه عاملاً محورياً لدوره في رفع جودة البيئات الحضرية. وقد حظي موضوع توفير مساحات صديقة للمشاة باهتمام متزايد بسبب ارتباطه الجوهري بالاستدامة الحضرية. يسعى هذا البحث إلى تجميع الأدبيات حول موضوع إمكانية المشي ضمن السياقات الحضرية، مع التركيز بخاصة على استقراء هذه الأفكار ضمن السياق الحضري للأحياء السكنية في الرياض، بالمملكة العربية السعودية، وهو المجال الذي أبرزت فيه الدراسات السابقة أوجه القصور في البنية التحتية للمشاة والاعتماد السائد على السيارات للتنقل اليومي. تهدف هذه الدراسة إلى تسليط الضوء على فعالية مبادرة أنسنة المدن، وهو توجيه استراتيجي تم تحديده في إطار رؤية السعودية ٢٠٣٠، ومن خلال تحديد العناصر الحضرية التي تزيد قابلية المشي وتحديد سلوكيات المشاة في الأحياء السكنية. تسلط الدراسة الضوء على التحسينات التي تم إدخالها من قبل مبادرة أنسنة المدن ومدى تأثيرها على زيادة إمكانية المشي داخل منطقة الفلاح السكنية، والتي تم اختيارها لتكون الحالة التطبيقية لأهداف هذه المبادرة. ومن خلال تحليل شامل، بما في ذلك نتائج مبادرة أنسنة المدن والرؤى المستمدة من الدراسات السابقة، يسعى هذا البحث إلى تطوير نموذج مفاهيمي قوي لتعزيز معايير إمكانية المشي واقتراح توصيات لتحسينها داخل السياق الحضري للرياض.

الكلمات المفتاحية: المدن الموجهة نحو السيارات، ميزات البيئة المبنية، إمكانية المشي، العوامل، مبادرة أنسنة المدن.