

The Impact of Accessibility on Walkability to Enhance Social Interaction in Mixed-Use Streets

Musaab Sami Al-Obeidy*

musaab.sami.y@uomosul.edu.iq

Nor Zalina Harun***

nzalina@ukm.edu.my

Nor Haslina Ja`afar**

mell_ina@ukm.edu.my

Mohd Iskandar Abd Malek**

iskandarmalek@ukm.edu.my

*Architecture and Built Environment Department, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Selangor, Malaysia.

**Department of Architectural Engineering, College of Engineering, University of Mosul, Mosul, Iraq.

** Architecture and Built Environment Department, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Selangor, Malaysia.

*** Institute of the Malay World and Civilization (ATMA), Universiti Kebangsaan Malaysia, Selangor, Malaysia.

Received: June 17th 2025 Received in revised form: August 24th 2025 Accepted: October 4th 2025

ABSTRACT

The design and quality of urban streets significantly influence accessibility, determining how easily pedestrians—particularly those with mobility challenges—can reach essential services, amenities, and social opportunities. While prior studies have established accessibility as a key factor in promoting walking, the relative importance of specific accessibility indicators remains unclear. There is also uncertainty about how much each of these factors actually influences people's decisions to walk. Improving these accessibility factors not only makes walking easier but also enhances social interactions, as walkable streets encourage people to meet, engage, and spend time in public spaces. This study addresses the question: What are the most important accessibility indicators of walkability that influence social interaction in mixed-use streets? Identifying the main accessibility factors of walkability that affect social interaction in mixed-use streets is the objective of this paper. The aim of the study is to design a walkability model that explains how accessibility influences social interactions in mixed-use streets. The study distributed 400 Likert-scale questionnaires (1=strongly disagree to 5=strongly agree). It used SPSS (for statistical analysis) and Smart PLS (for structural equation modeling) to process and design the model. The analysis revealed strong model fit (GoF=0.69), emphasizing that perceived accessibility of walkability plays a crucial role in shaping social interaction. The study concluded that the indicators contributing to ease of walking such as street configuration, obstruction-free, sidewalk levels and condition, curb ramps, crosswalks, signage at night were among the most influential in making the street environment more encouraging for pedestrians.

Keywords:

Accessibility; Walkability; Mixed-use Street; Social interaction.

This is an open access article under the CC BY 4.0 license (<http://creativecommons.org/licenses/by/4.0/>).

<https://rengj.uomosul.edu.iq>

Email: alrafidain_engjournal3@uomosul.edu.iq

1. INTRODUCTION

Walking is the primary and simplest transportation for people moving in space [1-6]. The term “Walkability” derives from combining “walking” and “ability,” referring to the capacity of individuals to move on foot. Recently, walkability has emerged as a rapidly expanding and much-discussed topic within the fields of urban design and city planning. Recently, walkability has emerged as a rapidly expanding and much-discussed topic within the fields of urban design and city planning [1]. However, some researchers contend that a major deterrent of

walking is the lack of access within the built environment which frequently characterizes many cities [7].

In addition, walkability, considered a particular form of accessibility, describes how easily individuals can move around an area on foot and reach desired destinations [8], [9]. Globally, perceived walkability, i.e. how easy people find it to walk (in an area or to destinations), has only received limited attention [9]. Moreover, There has been limited exploration of the link between activity participation and social exclusion through perceived accessibility [10]. While globally many

researches like [11-13] explore how the accessibility and design of public places impact social interaction, user experience and community perception, there have not been any research studies in Iraq that have developed or specifically examined a model explaining how walkability affects social interaction in mixed-use streets. Furthermore, even internationally, most walkability models have only considered a small selection of factors related to accessibility, rather than including a comprehensive set of indicators. Few studies have designed broader or more detailed models that fully explore how accessible urban environments support or limit social interaction, especially in the context of mixed-use streets. Hence, this research attempts to address existing shortcomings and construct a thorough model. This model aims to incorporate a broader spectrum of accessibility indicators to clarify social interaction dynamics within mixed-use streets, specifically within the environment of Iraq.

Social interactions can be enhanced by walkable areas [14]. All individuals gain advantages from walking [15]. Promoting walking as a sustainable form of transport brings a wide array of environmental, social, and economic advantages. Numerous studies have asserted on the positive outcomes associated with walkability and pedestrian-friendly cities. Notably, walking fosters personal well-being, encourages healthy habits, strengthens social ties and community belonging, enhances fitness, promotes inclusivity, and contributes to both quality of life and urban livability.

The scope of the study is limited to examining indicators related to perceived accessibility in mixed-use streets. It focuses on micro scale level of street that shape how people access the street and how they move from one place to another along it, and identifies the elements, facilities, and services that make the street more accessible and help strengthen social interaction. It does not include information acquired by specific tools or extensive data sources; rather, it depends entirely on a questionnaire survey provided to street users.

Hence, the aim of the study is to design a model that demonstrates how accessible walking influences how people interact with one another on mixed-use streets. The study aims to investigate whether different indicators of accessibility (26 items) are related to social interaction (23 items), and users' overall perception (4 items) on Al-Masaref Street in Mosul City, Iraq. By analyzing these relationships, the research examines the impact of accessibility in shaping social interaction and perception on mixed-use streets.

2. ACCESSIBILITY DEFINITIONS

Accessibility in urban environments is a multifaceted concept that varies across different contexts and studies like [16-33]. Each study provides a unique perspective on accessibility, reflecting the diverse ways it can be defined and measured.

Accessibility (or just Access) refers to the ability to reach desired goods, services and activities [16], [17], [32]. It is a crucial component that contributes to a walkable environment [18]. It refers to streets that allow the users to access, enter, use and walk to wherever they wish to go; streets that can be easily accessed offer local services and amenities, are conveniently interconnected to each other (persons, services, resources, activities, location indicators and directories), have broad, flat pathways and safe ground level pedestrian crossings with adequate signal controls [30], [34], [35]. Accessibility is a fundamental aspect of the street and an essential performance element of urban space and the people that use it [19], [20], [23], [34], [36]. [37]in page 302 defines 'accessibility' as a matter of public access to places along the street by intersecting or crossing streets or public ways. Pedestrian accessibility also refers to the ability of pedestrians to reach destinations or opportunities, with respect to a time or distance cost [38], [39].

3. ACCESSIBILITY IN RALATIONSHIP WITH WALKABILY

Walking is essential for basic mobility, particularly for transportation-disadvantaged groups such as the elderly, disabled, children, and low-income individuals. Poor pedestrian infrastructure exacerbates social exclusion by isolating these vulnerable populations economically, physically, and socially. Hence, pedestrian access to public transport significantly enhances overall accessibility [16].

Wang in (2020) [40] identifies six key dimensions of inclusive street design, each with specific subcategories. Accessibility is one of them. It ensures that streets and transit nodes are accessible to all users, including those with physical disabilities, covering aspects such as roads, transit nodes, car parking provision, walking paths, cycling paths, bicycle parking provision, and universal design [40].

In the work of [21], accessibility was the third important walkability factor after comfort and safety respectively. They indicate that accessibility is determined by three primary factors: permeability or directness, ease of movement, and facility access [21]. Planting strategies—such as the spatial organization, species selection, and placement of trees—can help improve how directly pedestrians can navigate streets. Trees, when

positioned thoughtfully, can form canopies and trunks that define street edges and overhead cover, shaping the walking environment. Such spatial definition not only enhances accessibility but also guides pedestrian sightlines and facilitates movement and activity. Moreover, clear signage and well-connected sidewalks to major campus facilities contribute significantly to overall accessibility. It is crucial that important campus destinations—such as dormitories, academic buildings, and transit stops—are well-connected and conveniently accessible to pedestrians in order to maximize street accessibility.

The principles of accessibility to create more walkable environments include locating parking areas close to public spaces [41], providing drop-off zones near building entrances, ensuring well-defined site entrances, readable signage, accessible public facilities, overhead shelters, adequate seating and lighting, and continuous accessible walkways. Transit stops should be in visible and convenient areas to support pedestrian movement [18].

Loo in (2021) [42] emphasizes the importance of convenience in terms of mobility and accessibility, distinguishing mobility as the overall ability to move freely and efficiently, while accessibility is more specific, focusing on reaching particular destinations and engaging in relevant activities. Universal access is crucial for providing accessibility to all pedestrians, including those with special needs, ensuring their active participation in society. The study highlights that pedestrians have diverse abilities, needs, and preferences, and should not be viewed as a homogeneous group. Several key variables are used to assess walkability: clear directional signs, continuity and obstructions, traffic cycle time, vehicular road width, directness and connectivity, and distance between major attractions. These variables are rated based on specific criteria, such as the quality of directional signs, the presence of pavement obstructions, the pedestrian-friendliness of road-crossing facilities, the number of traffic lanes, the directness of road design, and the compactness of a neighborhood. This framework is used to evaluate walkability in Hong Kong, with cases approved for building footbridges. Future adjustments to the framework may be made based on local citizens' preferences and strategic walking policy directions [42].

According to [26], the walkability of any street is significantly enhanced when it features safe, comfortable, and accessible infrastructure for pedestrians. Accessibility encompasses several factors: the ease of reaching a destination, the distance to that destination, physical and perceived barriers to walking, and the connectivity between

land uses. These factors are measured using indicators such as walkway width, broken paving surfaces, obstacles like utility poles, uneven level changes, and feeder roads.

Accessibility, crucial for pedestrian comfort and route selection, benefits from connected street networks and adequate pavements linking various destinations, public spaces, and transportation systems [22], [39], [43] classify pedestrian accessibility into four categories: functional walking, access sub-mode, recreational walking, and circulation exchange mode. [20], [23] identify accessibility components as physical, visual, and symbolic, highlighting the importance of barrier-free integration with sidewalks for physical accessibility.

Design elements that facilitate accessibility include even surfaces, tactile guidelines, adequately sized disabled parking, gentle slopes, and ramps. [29], [30] advocate footways at least two meters wide to accommodate diverse pedestrians safely, while minimizing changes in level is crucial for wheelchair users and elderly pedestrians.

Zakaria and Ujang (2015) [24] assert accessibility ensures equal opportunities for all pedestrians. Poorly designed parking can hinder pedestrian access; thus, parking areas must be close, safe, and minimize vehicle-pedestrian conflicts [37], [44], [45]. Clear orientation through landmarks and signage enhances spatial understanding and navigation [38], while unobstructed pedestrian corridors with adequate width support barrier-free walking.

Pratiwi with others in (2015) [27] highlight amenities, safety, and mobility as essential for pedestrian accessibility during events, emphasizing comfort facilities, greenery, architecture, crime prevention, and pathway capacity [27]. Moreover, [31] identifies physical street attributes enhancing walkability, such as connectivity, well-designed junctions, and accessible pathways. These features foster urban vibrancy through safe, visually appealing, and socially engaging environments.

According to [46], accessibility encompasses subjective and objective dimensions. Subjective accessibility involves pedestrian experiences, feelings of safety, and facility conditions, while objective accessibility considers built environment attributes like mixed land use, proximity to essential services, and proper green spaces implementation. Furthermore, [47] emphasizes accessible community spaces, such as plazas and community centers, as critical for fostering social interactions and enhancing neighborhood connectivity and livability. [48] adds the importance of navigable shared streets for

all users, particularly those with disabilities, through features like tactile walking indicators, clear pedestrian zones, and defined crossings.

Finally, linkage, as discussed by Da Silva (2008) [49], underscores the importance of physical and visual connectivity between urban elements to unify and simplify pedestrian access. Features like tree lines, crossings, and consistent sightlines enhance visual continuity and facilitate seamless pedestrian movement, thus strengthening urban coherence [49].

The study builds on insights gained from previous research to identify 26 specific indicators

related to accessibility (Table 1). These indicators were selected because they are believed to potentially influence both social interaction and user perception of public spaces, as detailed in Table 1. To investigate this relationship, the study will incorporate these 26 indicators into a questionnaire survey, forming the foundation of the proposed accessibility model. The goal is to collect data that will help measure how accessible features of the built environment impact how people interact with each other and how they perceive the quality and usability of the space.

Table 1: The indicators of accessibility in relating to social interaction and user perception, Source: by the authors.

Main Variable	Sub-Variables	Indicators	[18]	[21]	[22]	[24]	[26]	[27]	[29]	[30]	[40]	[42]	[46]	[47]	[48]	[49]	[50]	
Accessibility	Access to facilities	Inclusive social spaces																
		Public transportation																
		Playground facilities																
		Parking and drop-off																
		Accessibility options																
		Accessible destinations																
	Ease of movement (For abled people)	Street configuration																
		Obstruction-free																
		Sidewalk Levels																
		Sidewalk condition																
		Curb ramps																
		Crosswalks																
		Signage at night																
		Signage																
	Ease of movement (For physical, visual, auditory, and cognitive impairments)	Signage																
		Tactile																
		Signals																
		Curb ramps																
		Visual clutter or obstructions																
	Directness	Wayfinding																
Trees																		

4. THE ROLE OF ACCESSIBLE WALKABILITY IN ENHANCING SOCIAL ACTIVITY, USER EXPERIENCE, AND USER PERCEPTION

In contemporary urban design, accessible walkability is increasingly recognized as a fundamental driver for enriching social activity, improving user experience, and shaping positive user perception of public spaces. Accessibility—referring to the ease of reaching, entering, and moving through an area—intertwines with walkability, which emphasizes pedestrian comfort, safety, and connectivity. Numerous studies have highlighted how walkable, accessible streets and public spaces create environments conducive to social engagement, enjoyable experiences, and favorable

perceptions among users [13], [51], [52] and [53]. The design of our surroundings significantly shapes how we interact, and in this sense, the ease with which people can access public areas is vital for encouraging social interaction and cohesion [54].

According to [55], walkable urban areas play a crucial role in fostering social interaction and strengthening community ties. Walking is considered the most sociable mode of transportation, as it naturally encourages encounters and communication among people. By promoting opportunities for face-to-face interaction, walkability enhances social cohesion while also providing environmental and economic benefits to the community [55]. The study revealed that neighborhoods with easily reachable shops experience higher rates of walking among residents as they seek to meet

every day needs. Their study also demonstrates that the accessibility of daily services, particularly shops within walkable distances (200–500 meters), significantly encourages people to walk rather than use private vehicles.

Accessible walkable environments foster a variety of social activities by enabling easy movement, encouraging lingering, and providing opportunities for interaction. If a public space is made more easily accessible to those who visit, it tends to boost the social atmosphere. This, in turn, can foster more activity and richer interactions amongst people [56]. According to [13], increased walkability correlates directly with higher rates of social activity, such as casual conversations, group gatherings, and shared events. The types of activities supported by accessible streets include window shopping, visiting street markets, engaging in exercise or fitness, attending local events, and socializing in cafes or outdoor seating areas. These activities are only possible when pedestrians feel comfortable and unrestricted [23]. Based on [35], social activity can be understood as conduct that commonly occurs within collective or festive environments. According to [57], it also involves contextual elements including the involved individuals, time, photos, comments, and the associated social network. Within the scope of this study, social activity is conceptualized as a discretionary engagement that brings individuals together in public or semi-public spaces to share meals, experience music, and take part in events of cultural or religious importance.

Empirical studies confirm that streets with high accessibility promote more frequent and diverse social interactions [58], and [59]. For example, [51] found that in well-designed, accessible urban squares, users reported increased social contacts, such as meeting friends, talking to acquaintances, and participating in public events. The design attributes—wide sidewalks, absence of physical barriers, clear signage, and comfortable amenities—directly influence the volume and quality of social activity [19], [53].

User experience in urban spaces encompasses a range of cognitive, emotional, and sensory responses, including interest, enjoyment, discovery, practicality, aesthetics, belonging, and sensory satisfaction. Walkable environments with high accessibility enable users to engage with the physical (architecture, landscaping), social (activities, culture), and natural (trees, fountains) attributes of the street, making their visits more stimulating and enjoyable [51].

Carmona et al. (2010) note that practical elements—such as navigable sidewalks, effective crossings, and traffic signals—are essential for positive user experience [53]. Meanwhile,

aesthetic and sensory dimensions, including landscaping, public art, and ambient sounds or scents, further enhance user satisfaction [13]. Accessible walkability also facilitates a sense of discovery by encouraging users to explore new areas and experiences within the urban landscape. Spatial experience of the users can be significantly influenced by interventional elements in the spaces as mentioned by [60]. These elements might include things like seating arrangements, lighting, landscaping, signage, public art, or even architectural structures.

Inclusivity is another crucial aspect: environments that are accessible for people with disabilities, children, and the elderly support a greater sense of belonging and equity, reinforcing the positive user experience [19], [61]. Empirical research demonstrates that people rate their experience more favorably when they feel comfortable, safe, and able to discover new things while walking [62], [63]. According to [63], user experience is the use of the product and use of the public, and urban space should be interesting, enjoyable and pleasant. It suggests that effective design goes further than addressing just the form and function of a product or space; it also involves creating experiences that inspire and satisfy users by considering emotional factors like feeling, enjoyment, comfort, and clarity. The goal is to craft urban spaces and products that not only serve practical needs but also offer engaging, memorable experiences that establish a clear identity and a lasting sense of place. These qualities are crucial for fostering a meaningful connection between the user and the environment, making spaces both inviting and distinctive.

User perception reflects how individuals evaluate and feel about a street or public space—whether they find it attractive, safe, and worth returning to, or whether they recommend it to others. Perceptions are shaped by a combination of physical, functional, and social qualities [36], [53]. High accessibility and walkability enhance perceptions of attractiveness and attachment. Users report greater attraction to, attachment with, and willingness to revisit streets that are easy to walk, aesthetically pleasing, and vibrant with activity [51]. Social perception is further strengthened when users regularly interact with others, share experiences, and feel part of a community in accessible environments [13], [58]. [59] found that accessible parks and streets in Malaysia were positively associated with user perceptions of safety, social connection, and place attachment. Similarly, [19] demonstrated that in Middle Eastern cities, enhanced pedestrian accessibility correlated strongly with favorable perceptions of urban streets.

5. CONCEPTUAL FRAMEWORK

Building on the walkability literature, this research proposes that accessibility, viewed as a multi-faceted factor, precedes both social interaction and how users perceive mixed-use streets (visualized in Figure 1). Building on earlier findings, we define accessibility through three interconnected groups tied directly to walkability, as outlined in Table 1: (i) access to facilities (e.g., inclusive social spaces, public transportation, playground facilities, commercial facilities); (ii) the ease of getting around (e.g., street configuration, obstruction-free, sidewalk levels, sidewalk condition); and (iii) inclusive provisions for people with disabilities (e.g., clarity of signage, tactile, audible signals). Our theory, therefore, is that enhancements within these areas of accessibility stimulate social interaction – which we see as a higher-level concept comprised of social activity (e.g., repeat visitation, friends on the street) and social contact (e.g., window shopping, engagement with vendors and cafés, casual conversations, fitness, everyday trips). In turn, increased social interaction is theorized to positively shape user perception (for instance, the street's attractiveness, the frequency of visits with friends, regular engagement, and sharing of knowledge). Aligning with existing proof demonstrating how walkable, mixed-use areas encourage frequent encounters, robust social connections, and positive evaluations of urban settings, the proposed framework highlights direct positive impacts stemming from each accessibility group on both social interaction and user perception, along with an indirect (mediated) path demonstrating accessibility's effect on user perception through social interaction, as shown in the conceptual model.

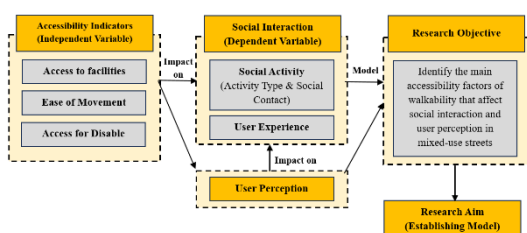


Fig. 1 Conceptual Framework of the Study

6. RESEARCH HYPOTHESIS

Promoting walking as a means of local travel can enhance opportunities for informal social interactions and foster vibrant community connections [64]. Hence, this paper suggests two hypotheses presented below are grounded in extensive literature that explores the relationship between accessibility and its impact on social interaction and user perception.

H1: There is a positive relationship between accessibility and social interaction (social activity and user experience) in mixed-use streets.

H2: There is a positive relationship between accessibility and perception of users in mixed-use streets.

H3: there is positive relationship between social interaction and perception of users in mixed-use streets.

Hence, the theoretical framework that addresses the concepts that lead to the development of dependent and independent variables to achieve the study objectives can be shaped. As a result, all environmental attributes, activity values, and investigation outcomes influence overall social interaction (user experience and social activity) and user perceptions in urban places. Accessibility (independent variable) can influence social activity, user experience, and perception (dependent variable) of the user to investigate the level of association between the main variables.

7. CASE STUDY

Al-Masaref Street, located in the city of Mosul, Iraq, was selected as the case study site for this research (Fig. 2). The street extends for approximately one kilometer and was chosen due to several distinctive characteristics. Notably, it features wide sidewalks on both sides, enhancing pedestrian accessibility. Moreover, Al-Masaref Street is a mixed-use street, hosting a high concentration of specialized medical clinics, laboratories, and pharmacies. These facilities attract a diverse population, including patients, individuals with disabilities, and elderly people. As a result, the study is not limited to a specific user group but rather assesses the effectiveness of accessibility for all types of users, ensuring that the findings are representative and not biased toward any particular demographic.

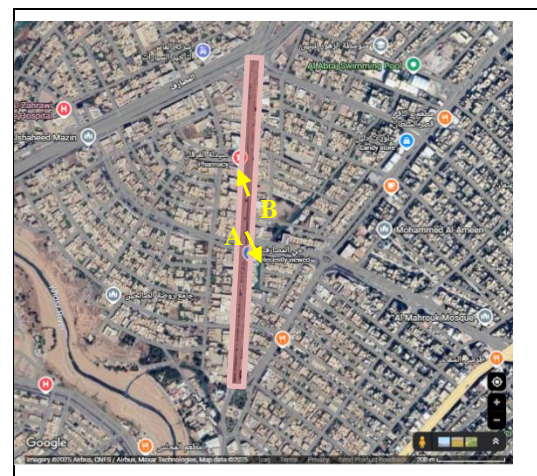




Fig. 2 Al-Masaref Street as the Case Study, Google Maps: <https://maps.app.goo.gl/UfeKQbJMLRM-pibCQ8>, and photos by the corresponding author.

8. ADOPTED METHODOLOGY

This study is to design a walkability model that explains how accessibility influences social interactions in mixed-use streets (See Fig. 3). This can be done by examining the relationship between accessibility aspects, social interaction (social activity and the user experience) and user perception of social environment on mixed-use street.

The study utilizes quantitative method which involves the use of structured questionnaires to gather numerical data from participants. These questionnaires were designed based on a Likert scale, allowing respondents to express their opinions or experiences on a scale ranging from 1 (strongly disagree) to 5 (strongly agree). The research gathered questionnaire surveys information from every street user—static and mobile as stated in many references such as [65], [66], [67].

Moreover, this research was conducted using a cohort of 400 participants. The selection of this size was guided by a 95% confidence level, and a 5% margin of error, following established recommendations [68]. Furthermore, the research considered the advice provided in [69], which proposes a sample of 384 individuals as sufficient for populations exceeding 100,000 people, to guarantee both precision and dependability of the outcomes.

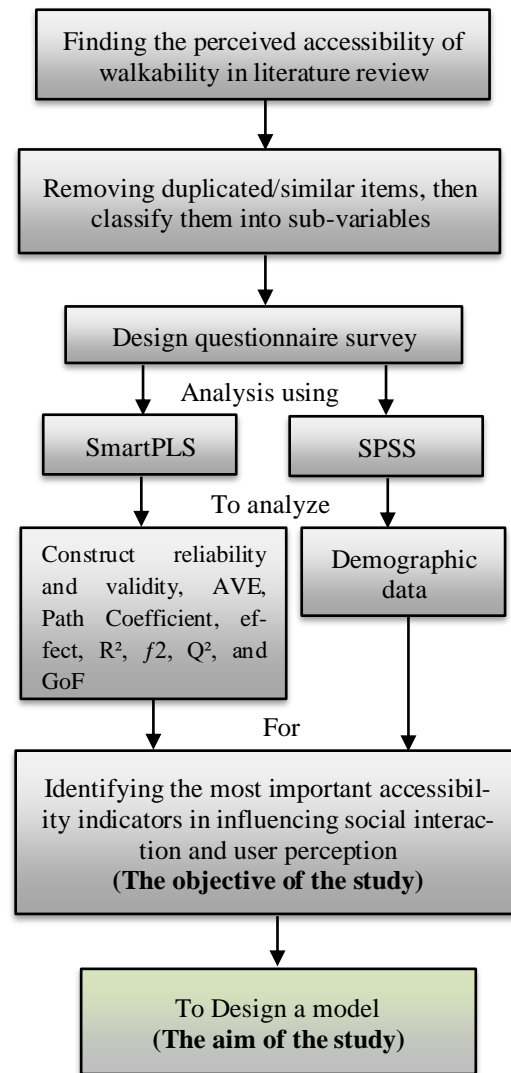


Fig. 3 The Design of the Study.

Considering the projected population of Mosul in 2025 is around 1,904,140, these two recommendations both applied to the project. The choice to use the larger sample size was a deliberate decision to enhance the study's representational nature and enhance the accuracy of the measurements [70]. To accomplish these objectives, this study adhered to De Vaus' recommendations. A slightly bigger sample offers improved statistical reliability, leading to more substantial and comprehensive research findings.

To analyze the collected questionnaire data, the study employed SmartPLS, a software tool commonly used for Partial Least Squares Structural Equation Modeling (PLS-SEM) [35], [71]. This software facilitated the creation of a theoretical model representing the relationships between variables related to accessibility (IV) and social interaction (DV). PLS-SEM allows researchers to estimate complex cause-effect relationship

models with many constructs, indicators, and paths. It is well-suited for predictive modeling and theory development. Its practical orientation provides results that are useful for policy-making, managerial decisions, and design interventions [72], [73].

The research applied several rigorous statistical measures to evaluate the model and its relationships:

- **R-squared (R^2):** Measures the strength of the predictive power of independent variables on dependent variables.
- **rho-c and rho-a:** Reliability measures assessing the internal consistency of the constructs in the model.
- **Average Variance Extracted (AVE):** Determines how much variance is captured by a construct in relation to the variance due to measurement error.
- **Outer Loadings:** Indicate the relationship strength between observed indicators (questions/items) and their respective constructs.
- **Path Coefficients:** Evaluate the strength and direction (positive or negative) of relationships between different variables in the model.
- **F-squared (f^2):** Measures the effect size, indicating the practical significance of relationships between variables.
- **Q-squared (Q^2):** Assesses predictive relevance, determining how well observed values are reconstructed by the model.
- **P-values and t-values:** Statistical significance tests, confirming whether observed relationships between variables are statistically meaningful.
- **Standard deviation:** Quantifies the variability or dispersion within the data set.

Utilizing the various statistical approaches mentioned above, this paper analyzes the Goodness of Fit (GoF) to evaluate the overall adequacy of both the measurement and structural components, determining how accurately the proposed model aligns with the collected data. As explained by [74], GoF as the geometric mean of two

principal elements: Average Variance Extracted (AVE), and the mean R-squared (R^2) values for the endogenous variables, representing both communality and explanatory power. GoF results are typically classified as small (0.10), medium (0.25), or large (0.36 or above). A GoF score approaching 1 suggests that the model accurately represents the dataset and demonstrates strong capacity to explain the observed relationships and provides strong explanatory power.

9. RESULTS AND DISCUSSION

The analysis of the 400 respondents' socio-demographic data shows a sample skewed toward males (72.3% men, 27.8% women) (Table 2). Due to prevailing religious considerations and local social-cultural norms, most women declined to respond to the survey on Al-Masaref Street. Consequently, the male-to-female ratio in the sample does not reflect the true distribution of street users. A significant majority of the sample fell within younger age ranges (18-39 years old, 71%), which implies a strong presence of young adults on the street. Concerning their health, the great majority of individuals reported no health issues (83%). However, a noticeable segment of the participants disclosed difficulties with hearing (16%) and mobility (5%), which underscores the need for designs catering to everyone's needs. The foremost motives for traversing this street were practical rather than recreational. This is evident through the prominence of doctor and pharmacy visits (62%), journeys to work (38%), and shopping expeditions (36%). Thus, the location functions as a center for everyday needs and services. Activities associated with leisure were less prevalent. These included meeting friends (20%), exercise (11%), and recreation (11%), but remained noteworthy, particularly amongst women. These results indicate the street is primarily geared toward essential and practical transportation, whilst offering spaces for social interaction and optional endeavors. Therefore, accessibility enhancements prove relevant, promoting both ease of movement for daily tasks and enabling greater opportunities for social participation.

Table 2: Socio-demographic Indicator Dimension, the field of questionnaire surveys.

		Male		Female	
	Category	number	Male %	number	Female %
Gender	Total	289	72.25%	111	27.75%
Age	18-29	117	29.25%	57	14.25%
	30-39	83	20.75%	26	6.50%
	40-49	49	12.25%	13	3.25%
	50-59	27	6.75%	6	1.50%
	60 and above	13	3.25%	9	2.25%
Health	No health problem	240	60.00%	92	23.00%
problem	Has health problem	49	12.25%	19	4.75%
	Mobility impairment	11	2.75%	8	2.00%

Purpose of visiting the Street	Visual impairment	4	1.00%	0	0.00%
	Hearing impairment	46	11.50%	19	4.75%
	Shopping	103	25.75%	42	10.50%
	Visiting doctor/pharmacy	178	44.50%	71	17.75%
	Leisure time	33	8.25%	11	2.75%
	Going to work	114	28.50%	36	9.00%
	Going to mosque	19	4.75%	3	0.75%
	Meeting friends	66	16.50%	14	3.50%
	Walking to a bus / Taxi stop	9	2.25%	3	0.75%
	Walking to exercise	26	6.50%	17	4.25%
	Walking to deliver someone	21	5.25%	7	1.75%
	Walk for other purposes	2	0.50%	2	0.50%

The examination of summary statistics of 53 items assessing accessibility, social interaction, and user perception provided meaningful understanding of Al-Masaref Street as perceived by respondents. As shown in Table 3, the mean values and standard deviations for each indicator. The

results indicate a generally positive perception of physical accessibility attributes, with several items scoring above 4.00 on a 5-point Likert scale, indicating widespread approval of their existence or effectiveness.

Table 3: Mean and Standard Deviation of the Accessibility, Social Interaction, and User Perception Indicators, source: by the authors.

Question no.	Code	Questions	Mean	Standard deviation
1	AC1	Inclusive social spaces	2.808	0.816
2	AC2	Public transportation	2.04	0.555
3	AC3	Playground facilities	2.027	0.54
4	AC4	Commercial facilities	3.058	0.533
5	AC5	Parking and drop-off	3.067	0.518
6	AC6	Accessibility options	4.03	0.542
7	AC7	Number of destinations	4.05	0.563
8	AC8	Variety of destinations	3.058	0.552
9	AC9	Street configuration	4.043	0.535
10	AC10	Obstruction-free	3.01	0.538
11	AC11	Sidewalk Levels	4.058	0.524
12	AC12	Sidewalk condition	3.035	0.514
13	AC13	Curb ramps	2.02	0.533
14	AC14	Crosswalks	2.027	0.512
15	AC15	Signage at night	4.053	0.557
16	AC16	Signage at daytime	3.027	0.531
17	AC17	Sign and direction	3.035	0.528
18	AC18	Street intersection	4.037	0.525
19	AC19	Trees	4.03	0.547
20	AC20	Clarity of Signage	3.067	0.564
21	AC21	Tactile	4.058	0.547
22	AC22	Audible Signals	4.045	0.527
23	AC23	Visual clutter or obstructions	3.06	0.535
24	AC24	Wayfinding	3.083	0.53
25	AC25	Accessible pedestrian signals at signalized crossings	4.067	0.559
26	AC26	Crosswalk mark	4.072	0.559
27	UP1	Overall, I am attracted to this street	4.067	0.527
28	UP2	I visit this street with most of my friends	3.062	0.533
29	UP3	I regularly come here and talk with people	3.1	0.561
30	UP4	I share my knowledge and experience with other people in this street	3.05	0.532
31	AcT1	I visited the street more than three times.	3.042	0.53
32	AcT2	I have many friends in the street.	2.038	0.58
33	SC1	Window Shopping	4.04	0.528
34	SC2	Street Markets and Vendors	4.03	0.499

35	SC3	Exercise and Fitness for health	2.795	0.89
36	SC4	Casual Conversations	3.053	0.538
37	SC5	Local Events	2.752	0.903
38	SC6	Cafes and Outdoor Seating	3.06	0.516
39	SC7	Residential Interaction	3.792	0.839
40	SC8	Waiting to socialize	4.095	0.525
41	SC9	Entertainment	2.783	0.908
42	SC10	Company	3.075	0.524
43	SC11	Transportation	4.06	0.562
44	SC12	Going to work or school/university	4.075	0.533
45	UE1	The architecture and buildings in this street capture my interest.	4.037	0.525
46	UE2	The natural attributes (tress, fountains) and others in this street capture my interest.	4.01	0.529
47	UE3	The social attributes (activities, culture) in this street capture my interest.	3.78	0.776
48	UE4	Enjoyment	4.037	0.53
49	UE5	Discovery	3	0.566
50	UE6	Practicality	4.03	0.556
51	UE7	Aesthetics	3.987	0.55
52	UE8	Belonging	4.008	0.536
53	UE9	Sensory Experience	3.01	0.897

Regarding the top-rated items, waiting to socialize (SC8) achieved the peak average rating of 4.095, followed closely by going to work or school/university (SC12) at 4.075, and crosswalk mark (AC26) at 4.072. In addition, indicators such as accessible pedestrian signals (AC25), street transportation (SC11), and general street attraction (UP1) also reflected strong ratings exceeding 4.06, highlighting the perceived functional and experiential quality of the street in supporting daily travel and casual interaction.

On the other hand, the lowest rated indicators point to possible shortcomings in both universal design and opportunities for social engagement. Notably, Playground facilities (AC3) along with Crosswalks (AC14) were given an average rating of just 2.027, while Curb ramps (AC13), Public transportation (AC2), and Having friends on the street (AcT2) also recorded mean values close to 2.0. Such scores imply that these features are either lacking or fail to meet user expectations, particularly those related to social infrastructure and inclusive pedestrian amenities.

The following sections show a detailed presentation and interpretation of the results

derived from the SmartPLS analysis. These results pertain specifically to the accessibility model and its relationship with both social interaction and user perception.

9.1. Construct reliability and validity

Analysis of construct reliability and validity provides evidence the accessibility measurement model achieves strong robustness, with composite reliability (rho-c and rho-a) values for all constructs surpassing the suggested minimum of 0.70 (see Table 4; [72]). This supports the notion that the measurement items are internally consistent and suggest that the associated items reliably capture the core aspects of accessibility. Additionally, the obtained Average Variance Extracted (AVE) scores of 0.658, 0.716, and 0.763, all above the 0.50 benchmark, confirms sufficient convergent validity by illustrating that each construct successfully explains a significant share of variance from its measurement items [75].

Table 4: The Model Assessment for All Study Aspect. Checking the Factor Loading and Construct Reliability and Validity (Before Deleting), source: by the authors.

in Construct	Main Variables	Sub-Variables	The main indicators items	Outer loadings	(rho_a)	rho_c	(AVE)
Walkability	Access		AC1 <- Access to facilities (AccA)	0.611	0.929	0.939	0.658
			AC2 <- Access to facilities (AccA)	0.824			
			AC3 <- Access to facilities (AccA)	0.838			

		Access to facilities (AccA)	AC4 <- Access to facilities (AccA)	0.842	0.96	0.965	0.716				
			AC5 <- Access to facilities (AccA)	0.837							
			AC6 <- Access to facilities (AccA)	0.85							
			AC7 <- Access to facilities (AccA)	0.84							
			AC8 <- Access to facilities (AccA)	0.822							
		Ease of movement (AccB)	AC9 <- Ease of movement (AccB)	0.858							
			AC10 <- Ease of movement (AccB)	0.832							
			AC11 <- Ease of movement (AccB)	0.863							
			AC12 <- Ease of movement (AccB)	0.859							
			AC13 <- Ease of movement (AccB)	0.856							
			AC14 <- Ease of movement (AccB)	0.835							
			AC15 <- Ease of movement (AccB)	0.831							
			AC16 <- Ease of movement (AccB)	0.834							
			AC17 <- Ease of movement (AccB)	0.854							
		Importance of Unavailable elements (AccM)	AC18 <- Ease of movement (AccB)	0.848							
			AC19 <- Ease of movement (AccB)	0.837							
			AC20 <- Importance of Unavailable elements (AccM)	0.885							
			AC21 <- Importance of Unavailable elements (AccM)	0.867							
			AC22 <- Importance of Unavailable elements (AccM)	0.854							
			AC23 <- Importance of Unavailable elements (AccM)	0.863							
			AC24 <- Importance of Unavailable elements (AccM)	0.866							
		AC25 <- Importance of Unavailable elements (AccM)	0.89								
		AC26 <- Importance of Unavailable elements (AccM)	0.889								
		User Perception	Social Environment	UP1 <- User Perception				0.798	0.818	0.88	0.646
				UP2 <- User Perception				0.773			
				UP3 <- User Perception				0.832			
UP4 <- User Perception	0.811										
Social Interaction	Social Activity	Activity Type	AcT1 <- Activity Type	0.922	0.597	0.769	0.632				
		AcT2 <- Activity Type	0.643								
		Social Contact	SC1 <- Social Contact	0.85	0.922	0.92	0.502				
			SC2 <- Social Contact	0.747							
			SC3 <- Social Contact	0.457							
			SC4 <- Social Contact	0.814							
			SC5 <- Social Contact	0.531							
			SC6 <- Social Contact	0.792							
			SC7 <- Social Contact	0.49							
			SC8 <- Social Contact	0.799							
			SC9 <- Social Contact	0.46							
			SC10 <- Social Contact	0.779							
	SC11 <- Social Contact	0.807									
	SC12 <- Social Contact	0.783									
	User Experience	UE1 <- User Experience	0.838	0.916	0.928	0.62					
		UE2 <- User Experience	0.764								
		UE3 <- User Experience	0.62								
		UE4 <- User Experience	0.794								
		UE5 <- User Experience	0.828								
		UE6 <- User Experience	0.785								
UE7 <- User Experience		0.807									
UE8 <- User Experience		0.82									
UE9 <- User Experience	0.477										

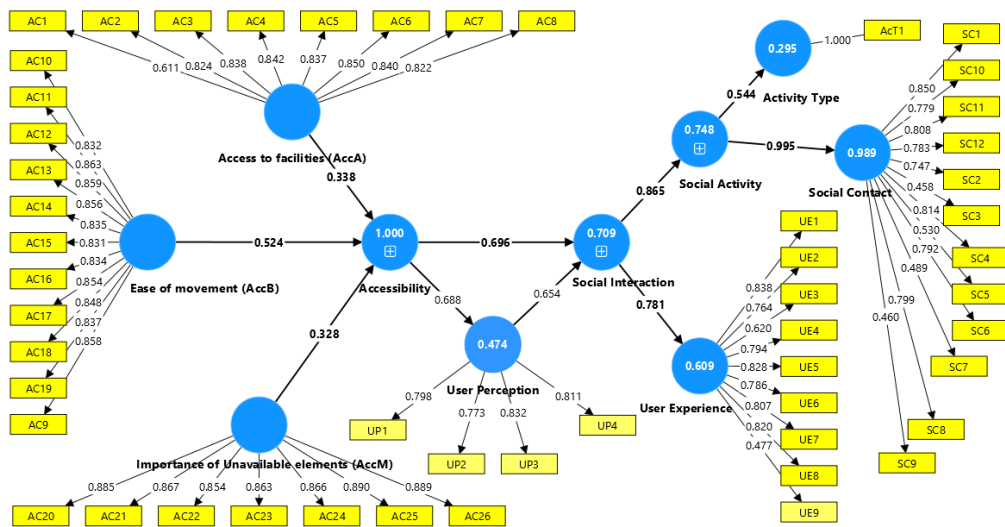


Fig. 4 The proposed model and the outer loading for the accessibility aspects items after removing items below the threshold using Smart PLS 4.1.1.2 software, source: by the authors

Retention of items with outer loadings between 0.4 and 0.7 is acceptable when their exclusion does not result in a substantial enhancement of composite reliability or AVE, as outlined by [76]. Building on this, [72] also emphasize in their revised edition that measurement items exhibiting loadings as low as 0.4 may remain in the model as long as the associated construct demonstrates acceptable reliability and validity levels. [77] emphasizes that removing items should be based not just on loading thresholds but on whether construct-level reliability improves.

Wong (2013) provides guidelines that indicators below 0.7 can be kept if composite reliability and AVE are acceptable [78]. Hence, the decision to retain or remove depends on the balance between individual item performance and overall construct integrity. Indicators barely below 0.7 (e.g., ~0.6–0.69) are often kept if construct metrics are within the threshold. Based on the model assessments and required thresholds, the AcT2 item will be removed because its loading is significantly low and negatively affects composite reliability, particularly rho_A, which measures the internal consistency reliability of the construct (Fig. 4). Retaining this item would weaken the overall reliability of the construct, making its removal necessary to improve the quality of the measurement model. However, other items with factor loadings below 0.70 like AC1, SC3, SC5, SC7, SC9, UE3, and UE9 are retained because they do not have a substantial negative impact on composite reliability (rho_A or CR) or the Average Variance Extracted (AVE), and their inclusion helps preserve the content validity of the construct.

The construct reliability and validity analysis demonstrate that the measurement model for the accessibility aspects is both robust and reliable (Table 3.0). The composite reliability values, measured through rho-c and rho-a, exceed the recommended threshold of 0.70 for all three constructs. These results confirm the internal consistency and reliability of the constructs, indicating that the items consistently measure the underlying dimensions of accessibility. Furthermore, the Average Variance Extracted (AVE) values—0.658, 0.716, and 0.763 respectively—surpass the minimum threshold of 0.50, confirming adequate convergent validity and showing that each construct captures a substantial proportion of variance from its indicators. Collectively, these findings provide strong empirical support for the measurement model, ensuring that the constructs are both statistically sound and theoretically meaningful for subsequent structural analysis.

9.2. Discriminant Validity

As shown in Table 5, application of the Fornell-Larcker approach to discriminant validity confirms that all constructs in the model are distinct and empirically separable. The square roots of the Average Variance Extracted (AVE) for all constructs—Accessibility (0.709), Social Activity (0.693), User Experience (0.757), and User Perception (0.804), respectively—exceed the corresponding inter-construct correlation coefficients. This outcome fulfills the established benchmark for discriminant validity as outlined by [75]. This indicates that each construct captures unique variance, reducing the risk of multicollinearity and ensuring that the latent variables are conceptually and statistically independent. These findings strengthen the

integrity of the measurement model and provide a solid foundation for the subsequent structural analyses, enhancing the overall validity and credibility of the research outcomes.

Table 5: Discriminant validity for the accessibility and social interaction constructs by the Fornell-Larcker Criterion, source: by the authors.

	Accessi- bility	Social Activity	User Experience	User Perception
Accessibility	0.709			
Social Activity	0.578	0.693		
User Experience	0.572	0.362	0.757	
User Perception	0.688	0.675	0.688	0.804

9.3. Path coefficient of the structural model

The structural model analysis reveals that all hypothesized relationships are statistically significant and supported at the $p < 0.01$ level, underscoring the strength and reliability of the proposed framework. Accessibility exerts a moderate but significant direct effect on social interaction ($\beta = 0.246, t = 6.566, p < 0.001$), highlighting its role in shaping the social dynamics within urban environments (Table 6). More notably, accessibility strongly influences user perception ($\beta = 0.688, t = 24.313, p < 0.001$), indicating that improvements in accessibility greatly enhance how individuals perceive and experience their surroundings. In turn, user perception significantly predicts social interaction ($\beta = 0.654, t = 18.193, p < 0.001$), suggesting that positive perceptions foster increased social engagement.

Table 6: Path Coefficient of the Research Study for The Structural Model, source: by the authors.

	Path Co- efficients	Standard deviation (STDEV)	T statis- tics (O/ST DEV)	P val- ues	Decision
Accessi- bility -> Social In- teraction	0.246	0.037	6.566	0	Sup- ported**
Accessi- bility -> User Per- ception	0.688	0.028	24.313	0	Sup- ported**
User Per- ception - > Social Interac- tion	0.654	0.036	18.193	0	Sup- ported**

Significant at $p^{**} = < 0.01, p^* < 0.05$

These findings emphasize the central role of user perception as a mediating factor between accessibility and social interaction, offering important insights for urban planners and policymakers aiming to create inclusive and socially vibrant public spaces. Collectively, the results provide strong empirical support for the structural model, enhancing

the overall validity of the research and informing future urban design interventions.

Based on Table 7, the mediation analysis provides compelling evidence that user perception serves as a significant intermediary between accessibility and social interaction. The indirect effect of 0.45 ($t = 14.561$) is statistically significant, with a 97.5% confidence interval ranging from 0.390 to 0.510, which excludes zero, confirming the robustness of the mediation pathway. These results indicate that accessibility not only directly influences social interaction but also indirectly enhances it by shaping users' perceptions of their environment. Specifically, when accessibility improves, it positively alters how users perceive urban spaces, which in turn fosters greater social engagement.

Table 7: There is an effect between the accessibility and social interaction through the user perception, source: by the authors.

	Path a	Path b	Indi- rect effect	T- value	2.5% CI	97.5 % CI	Deci- sion
H	0.688	0.654	0.45	14.561	0.390	0.510	medi- ation

This finding highlights the crucial role of perceptual factors in translating physical design elements into social outcomes, emphasizing the need for urban planning and design strategies that prioritize both infrastructural quality and user experience to cultivate vibrant, socially connected communities.

9.4. R-square of dependent variables

R squared (R^2) is a statistical value of how near the data be to the fitted regression line. The definition of R-squared is the percentage of the response variable variation that a linear model explains. R^2 additionally recognised as the coefficient of determination, or the coefficient of multiple determination for multiple regression [72]. The study used this measurement to indicate the total impact of the aspect that contained multiple variables.

According to [79] from literature, R-squared values below 0.10 are unacceptable unless the model is improved. Values from 0.10 to 0.50 are acceptable if key variables are significant, while values from 0.51 to 0.99 are acceptable if significant variables dominate and no major issues like multicollinearity arise. R-squared values exceeding 0.67 are regarded as high, values ranging from 0.33 to 0.67 are considered moderate, and values between 0.19 and 0.33 are classified as weak [71]

Based on the results shown in the Table 8, social activity ($R^2 = 0.748$) has the highest explained variance, indicating that the independent variables account for ~74.8% of its variability, a strong predictive outcome. Social interaction ($R^2 = 0.709$) also shows high predictive accuracy. User

experience ($R^2 = 0.609$) and user perception ($R^2 = 0.474$) are in the moderate range, meaning the model explains a moderate proportion of variance for these constructs.

Table 8: R-square proportion of variation in the dependent variables, source: by the authors.

	R-square	Result
Social Activity	0.748	High
Social Interaction	0.709	High
User Experience	0.609	Moderate
User Perception	0.474	Moderate

Overall, the structural model demonstrates solid explanatory power, especially for the key social outcomes.

9.5. f^2 and the Stone-Geisser's Q^2

Table 9 presents the effect size (f^2) values between the main constructs, revealing varying degrees of influence among the variables [73]. The path from Accessibility to Social Interaction shows a small effect size ($f^2 = 0.11$), indicating that while Accessibility contributes to Social Interaction, its influence is modest. In contrast, Accessibility demonstrates a large effect on User Perception ($f^2 = 0.90$), underscoring its critical role in shaping how users perceive the environment. Similarly, User Perception exerts a large effect on Social Interaction ($f^2 = 0.774$), highlighting the strong mediating role perception plays in fostering social exchanges. These results suggest that while physical accessibility alone may not robustly drive social interaction, its impact is substantially amplified when mediated through user perceptions, aligning with the structural pathways proposed in the model.

Table 9: The effect size f^2 between the main variables of the study, source: by the authors.

	F-square	Result
Accessibility -> Social Interaction	0.11	small
Accessibility -> User Perception	0.9	Large
User Perception -> Social Interaction	0.774	Large

In Table 10, the Stone-Geisser Q^2 statistics are displayed, serving as indicators for evaluating the predictive validity of the endogenous constructs in the model [80]. According to the results, Social Interaction ($Q^2 = 0.483$) and User Perception ($Q^2 = 0.471$) show the highest predictive relevance, indicating that the model possesses substantial predictive power for these constructs. Social Activity ($Q^2 = 0.332$) and User Experience ($Q^2 = 0.324$) also demonstrate moderate predictive relevance, suggesting that the model can adequately predict these outcomes, albeit to a slightly lesser

extent. As indicated by [72], Q^2 statistics exceeding zero provide evidence of the model's predictive relevance, while scores above 0.35 are interpreted as reflecting strong predictive ability. These findings validate the model's ability to meaningfully predict key aspects of user behavior and interaction within the studied framework.

Table 10: Examine Stone-Geisser's Q^2 value, source: by the authors.

Construct	Q-square
Social Activity	0.332
Social Interaction	0.483
User Experience	0.324
User Perception	0.471

9.6. Goodness of fit (GoF)

The Goodness of Fit (GoF) index is frequently applied in PLS-SEM studies for summarizing model adequacy. Originally proposed by [74], GoF captures both the predictive strength of the model (as expressed by the average R-squared of all principal endogenous variables) and the quality of construct measurement (through AVE, for all constructs with indicators).

While GoF provides a straightforward way to report the holistic quality of PLS-SEM models, current literature [81], [82] urges researchers to complement GoF results with a more nuanced evaluation of measurement validity, reliability, and predictive relevance. Therefore, this study employs GoF as supportive role in reporting model fit.

As outlined by [83], several thresholds were established to interpret the Goodness of Fit (GoF) index in PLS-SEM, enabling researchers to classify models as having poor, small, medium, or substantial fit on a global scale. Researchers suggested that a GoF less than 0.1 represents insufficient model fit, scores between 0.1 and 0.25 are interpreted as low, the range of 0.25 to 0.36 indicates moderate adequacy, and any value above 0.36 is considered high or excellent.

Applying cutoffs mentioned by [74], [83] to the current study, it reveals that the GoF of the study is around 0.69 which clearly places the current model in the "large fit" category, supporting its adequacy and confirming that the global validity of the PLS model is acceptable (Table 11).

Table 11: The Goodness of Fit (GoF) of the study, source: by the authors.

Construct		R ²	AVE
Accessibility	AccA	1	0.658
	AccB		0.716
	AccM		0.763
Social Interaction		0.709	
Social Activity		0.748	0.632
User Experience		0.609	0.62
User Perception		0.474	0.646
Total Average		0.70775	0.6806
GOF			0.694

10. CONCLUSIONS

The objective of this research was to develop and assess an accessibility-based walkability model aimed at exploring the impact of accessibility as a significant factor of walkability on user perception and social interaction in mixed-use urban settings. Supported by comprehensive theoretical foundations and rigorous methodology, the research employed Smart PLS structural equation modeling (PLS-SEM) to evaluate the interplay among 26 indicators of accessibility, 23 dimensions of social interaction, and 4 variables related to user perception.

Regarding survey gathering, the research finds that the gender distribution of participants might not mirror individuals' real presence on the street, since when surveys were given to women, many refused to partake. Various aspects could clarify this. Firstly, the questionnaires were carried out in Mosul, an Arab community shaped by Arab and Islamic customs and traditions that typically deter women from conversing with strangers, especially while in public spaces. Secondly, numerous women go to the street with a companion—frequently a father, brother, son, or another male relative—who tries to answer for her and does not permit direct interaction. The same pertained to patients: it was hard to acquire their opinions because a lot were in critical or fragile health and incapable of answering. Thus, the study deduces that sampling women in Arab and Islamic settings—and sampling patients—may not entirely represent what occurs in public areas, especially streets.

The results clearly confirm that the study successfully achieved its objectives and answered the primary research question: What are the most important accessibility indicators of walkability that influence social interaction in mixed-use streets? Besides, the accessibility influence on both user perception and social interaction was validated, thereby strengthening the conceptual structure of the study.

All hypotheses proposed in the study were empirically supported. H1—stating a positive

link between accessibility and social interaction—was supported by a statistically significant path coefficient ($\beta = 0.246$, $p < 0.001$). Similarly, H2—predicting a meaningful relationship between accessibility and user perception—was affirmed with a higher coefficient ($\beta = 0.688$, $p < 0.001$). Furthermore, H3—user perception itself emerged as a strong predictor of social interaction ($\beta = 0.654$), and mediation analysis revealed that user perception plays a significant intermediary role between accessibility and social interaction (indirect effect = 0.45, $t = 14.561$).

The ease of movement sub-variable (AccB)—which includes street layout, absence of physical barriers, consistent sidewalk elevation, pavement quality, presence of curb ramps, designed pedestrian crossings, visible nighttime and daytime signage, directional guidance, well-designed intersections, and greenery like street trees—represent the most influential set of indicators that define a pedestrian-friendly and inclusive walking environment. AccB played the most important role than access to facilities (AccA) and importance of unavailable elements (AccM). This means that serious efforts should focus on these two aspects to further improve the walkable environment in mixed-use streets.

Our research backs up the conclusions reached by [54], [56]. It supports the idea that the sociability of the public space in generating activities and creating interaction can be strengthened if the public space is more accessible. These findings highlight how crucial it is to implement a full package of accessibility enhancements. This study emphasizes the importance of delivering a comprehensive suite of accessibility provisions including parking and drop-off, commercial facilities, playground facilities, and a sufficient number and diversity of destinations. Such measures should be reinforced with an infrastructure that is fully inclusive and removes obstacles for all, encompassing individuals with disabilities as also confirmed by [48].

The model demonstrated strong explanatory power, with R² values of 0.748 for social activity, 0.709 for social interaction, and moderate values for user perception (0.474) and user experience (0.609). Additionally, a GoF index of 0.694 indicated excellent model fit, further supporting both the theoretical soundness and empirical robustness of the framework.

These results collectively confirm that accessible environments significantly shape how users perceive and interact in mixed-use streets. The findings emphasize the importance of both physical design and perceptual factors in creating socially vibrant and inclusive streets. Therefore, this research enriches the academic literature on urban

walkability while offering applicable strategies for urban planners, architects, and decision-makers committed to promoting social connectedness through design.

11. RECOMMENDATIONS

- a. **Model Enhancements:** This study designs a model of perceived accessibility of walkability and its impact on social interaction.. It suggests developing models that also integrate additional walkability aspects—like connectivity, and safety—and analyzing their impacts on social engagement.
- b. **More Methodological Techniques:** The data collection used in this study was based exclusively on the distribution of a questionnaire. A broader research approach should include methodologies like structured observations and interviews with subject experts. Subsequently, it's suggested that investigators measure differences and find correlations by comparing the outcomes of those varied approaches to those of the original survey. On the other hand, for women in Arab and Islamic contexts (e.g., Iraq), we recommend gender-sensitive fieldwork—employ female enumerators and recruit respondents at educational and service institutions they frequently visit the case study area.
- c. **Applicability to other street types:** The research was conducted on a mixed-use street. Another street typologies like residential and recreational street are recommended to choose for the case study to generate broader findings.
- d. **Geographic Area:** The specific location for the analysis was Al-Masaref Street, located in Mosul. Further research efforts should analyze additional streets throughout Mosul, extending into other areas of Iraq as a whole. Researchers are encouraged to then undertake cross-comparison, using key parameters and factors to find the most influential indicators of accessibility within walkability for enhancing social interaction and user perception.

REFERENCES

- [1] A. H. Sirjani and Á. Szabó, "Perceiving Liveability through the Diverse Aspects of Walkability," *Periodica Polytechnica Architecture*, vol. 52, no. 1, pp. 46–53, May 2021, doi: 10.3311/ppar.16449.
- [2] Y. C. Chiang and H. Y. Lei, "Using expert decision-making to establish indicators of urban friendliness for walking environments: A multidisciplinary assessment," *Int J Health Geogr*, vol. 15, no. 1, Nov. 2016, doi: 10.1186/s12942-016-0071-7.
- [3] R. N. R. Ariffin and R. K. Zahari, "Perceptions of the Urban Walking Environments," *Procedia Soc Behav Sci*, vol. 105, pp. 589–597, Dec. 2013, doi: 10.1016/j.sbspro.2013.11.062.
- [4] O. R. Manifesty, "Towards Walkability: Qualitative Assessment of Pedestrian Environment in Yogyakarta and Singapore," *International Journal of Architecture and Urbanism*, vol. 5, no. 2, pp. 193–209, Aug. 2021, doi: 10.32734/ijau.v5i2.6206.
- [5] M. Jamal, W. Khasraw, S. Khabat, and R. K. Mohammed-Amin, "Investigating and boosting walkability in Sulaimani's mixed-use streets: Jamal Irfan street as a case study," *Kurdistan Journal of Applied Research*, vol. 2, no. 3, pp. 397–409, Aug. 2017, doi: 10.24017/science.2017.3.29.
- [6] S. Abdollahi, "The influence of physical, social and safety aspects on walkability in neighbourhoods of Rotterdam," Master's thesis, Erasmus University Rotterdam, Rotterdam, the Netherlands, 2019.
- [7] D. Barrera-Femández and M. Hernández-Escampa, "Mobility in urban events: walkability and accessibility in the Guelaguetza," *Annals of Leisure Research*, vol. 25, no. 2, pp. 247–272, Mar. 2022, doi: 10.1080/11745398.2020.1800497.
- [8] H. Wang and Y. Yang, "Neighbourhood walkability: A review and bibliometric analysis," *Cities*, vol. 93, pp. 43–61, Oct. 2019, doi: 10.1016/j.cities.2019.04.015.
- [9] J. De Vos, K. Lättman, A.-L. van der Vlugt, J. Welsch, and N. Otsuka, "Determinants and effects of perceived walkability: a literature review, conceptual model and research agenda," *Transp Rev*, vol. 43, no. 2, pp. 303–324, Mar. 2023, doi: 10.1080/01441647.2022.2101072.
- [10] F. J. Pot, E. Heinen, and T. Tillema, "Sufficient access? Activity participation, perceived accessibility and transport-related social exclusion across spatial contexts," *Transportation (Amst)*, vol. 52, no. 4, pp. 1679–1707, Aug. 2025, doi: 10.1007/s11116-024-10470-z.
- [11] J. Jacobs, *The Death and Life of Great American Cities*. New York: Random House, 1961.
- [12] R. Ewing and S. Handy, "Measuring the unmeasurable: Urban design qualities related to walkability," *J Urban Des (Abingdon)*, vol. 14, no. 1, pp. 65–84, 2009, doi: 10.1080/13574800802451155.
- [13] J. Gehl, *Life between Buildings: Using Public Spaces*, 6th Edition. London: Island Press, 2011.
- [14] Economist Intelligence Unit, "A Summary of the Liveability Ranking and Overview," 2011. [Online]. Available: www.eiu.com
- [15] S. F. I. Haji Bilyamin, "Factors Influencing the Walkability Characteristics of Kuala Lumpur City Centre," MSc, Universiti Teknologi Malaysia, 2014. [Online]. Available: <http://go.to/Research>
- [16] T. Litman, "Measuring transportation: Traffic, mobility and accessibility Affordable-

- Accessible Housing in a Dynamic City,” *ITE Journal*, vol. 73, Oct. 2003.
- [17] Oana A. McKinney, “An Investigation of Methodologies for Determining Walkability and its Association with Socio-Demographics: An Application to the Tampa - St. Petersburg Urbanized Area,” MSc, University of South Florida, 2014.
- [18] Z. S. Belge, “Increasing Walkability Capacity of Historic City Centers: The Case of Mersin,” MSc Thesis, Middle East Technical University, 2012.
- [19] K. O. Abdulwahhab and N. H. Ja`afar, “User-friendly Streets for a Walkable, Liveable and Sustainable Environment: A Review,” *Jurnal Kejuruteraan*, vol. 32, no. 2, pp. 215–220, May 2020, doi: [https://doi.org/10.17576/jkukm-2020-32\(2\)-05](https://doi.org/10.17576/jkukm-2020-32(2)-05).
- [20] N. Abdul Rahman, “User-Friendly Street in Malaysia,” PhD thesis, University of Nottingham, 2013.
- [21] N. Z. Harun, A. Nashar, and S. Bachok, “Walkability factors for a campus street,” *Planning Malaysia*, vol. 18, no. 1, pp. 45–55, 2020, doi: [10.21837/pm.v18i1.708](https://doi.org/10.21837/pm.v18i1.708).
- [22] M. A. A. Khairi, “An Assessment Framework for Walkability in Libyan City Centres: Public Spaces in Tripoli,” PhD thesis, Nottingham Trent University, UK, 2019.
- [23] S. Carr, *Public Space*. Cambridge University Press, 1992.
- [24] J. Zakaria and N. Ujang, “Comfort of Walking in the City Center of Kuala Lumpur,” *Procedia Soc Behav Sci*, vol. 170, pp. 642–652, Jan. 2015, doi: [10.1016/j.sbspro.2015.01.066](https://doi.org/10.1016/j.sbspro.2015.01.066).
- [25] J. S. Lee, S. Park, and S. Jung, “Effect of crime prevention through environmental design (CPTED) measures on active living and fear of crime,” *Sustainability (Switzerland)*, vol. 8, no. 9, Aug. 2016, doi: [10.3390/su8090872](https://doi.org/10.3390/su8090872).
- [26] J. Kinyingi, N. Mugwima, and D. Karanja, “Walkable Streets: A Study of Pedestrians’ Perception, and Attitude towards Ngei Street in Machakos Town,” *Current Urban Studies*, vol. 08, no. 03, pp. 381–395, 2020, doi: [10.4236/cus.2020.83021](https://doi.org/10.4236/cus.2020.83021).
- [27] A. R. Pratiwi, S. Zhao, and X. Mi, “Quantifying the relationship between visitor satisfaction and perceived accessibility to pedestrian spaces on festival days,” *Frontiers of Architectural Research*, vol. 4, no. 4, pp. 285–295, Dec. 2015, doi: [10.1016/j.foar.2015.06.004](https://doi.org/10.1016/j.foar.2015.06.004).
- [28] W. H. Whyte, *The Social Life of Small Urban Spaces*. PROJECT FOR PUBLIC SPACES, 1980.
- [29] J. Deichman, “Accessible urban spaces- a challenge for urban designers,” in *Walk21-V cities for People, The Fifth international Conference on Walking in the 21st Century*, Copenhagen, Denmark, Jun. 2004, pp. 1–8. Accessed: Oct. 04, 2025. [Online]. Available: <https://library.walk21.com/conference/185>
- [30] E. Burton and L. Mitchell, *Inclusive Urban Design: Streets For Life*, 1st ed. Routledge, 2006.
- [31] R. Wang *et al.*, “Urban greenery and mental wellbeing in adults: Cross-sectional mediation analyses on multiple pathways across different greenery measures,” *Environ Res*, vol. 176, Sep. 2019, doi: [10.1016/j.envres.2019.108535](https://doi.org/10.1016/j.envres.2019.108535).
- [32] M. Al-Obeidy, R. Dabdoob, and O. Sedeeq, “Examining Principles of Sustainability in Streets of Sulaimani City Center towards Achieving Sustainable Urban City,” *Sulaimani Journal for Engineering Sciences*, vol. 6, no. 3, pp. 38–52, May 2019, doi: [10.17656/sjes.10104](https://doi.org/10.17656/sjes.10104).
- [33] A. A. Hamad and E. H. Ismaeel, “Accessibility and Connectivity for Enhancement the Integrative Conservation of the Historic Urban Fabric of Mosul Old City,” *Diyala Journal of Engineering Sciences*, pp. 68–78, Apr. 2023, doi: [10.24237/djes.2023.16206](https://doi.org/10.24237/djes.2023.16206).
- [34] K. Lynch, *A Theory of Good City Form*. MIT Press, 1984.
- [35] R. S. Hajmirsadeghi, “Design Factors That Influence the Effective Use of Public Square for Social Interaction in Iran,” PhD thesis, Universiti Teknologi Malaysia, Skudai, Malaysia, 2015.
- [36] A. B. Jacobs, *Great Streets*. Cambridge.: Cambridge: MIT Press, 1996.
- [37] A. B. Y. Jacobs, *Another Look at Boulevards. Places, A Forum of Environmental Design*. Macdonald, 1995.
- [38] K. Lynch, *The Image of the City*. Cambridge, MA.: The MIT Press, 1960.
- [39] M. Southworth, “Designing the Walkable City,” *J Urban Plan Dev*, pp. 246–257, Dec. 2005, doi: [https://doi.org/10.1061/\(ASCE\)0733-9488\(2005\)131:4\(246\)](https://doi.org/10.1061/(ASCE)0733-9488(2005)131:4(246)).
- [40] Y. Wang, “Sociospatial reframing of walking through inclusive streets and urban heritage,” Doctoral thesis, Nanyang Technological University, Singapore, 2020. doi: [10.32657/10356/142770](https://doi.org/10.32657/10356/142770).
- [41] A. M. Al-Taei, N. H. Aswad, and N. A. Husien, “Characteristics of Parking Garages within Multi-story Building in Duhok CBD Area,” *Al-Rafidain Engineering Journal*, vol. 20, no. 3, 2011, doi: <https://doi.org/10.33899/rengj.2012.50488>.
- [42] B. P. Y. Loo, “Walking towards a happy city,” *J Transp Geogr*, vol. 93, pp. 1–11, May 2021, doi: <https://doi.org/10.1016/j.jtrangeo.2021.103078>.
- [43] R. Kumar, “Walkability of Neighborhoods: A Critical Analysis of Zoning Codes,” MSc, National Institute of Technology, Tiruchirappalli, India, 2009. Accessed: Oct. 04, 2025. [Online]. Available: http://rave.ohiolink.edu/etdc/view?acc_num=ucin1249491710
- [44] S. Handy, X. Cao, and P. L. Mokhtarian, “Self-selection in the relationship between the built environment and walking: Empirical evidence from Northern California,” *Journal of the American Planning Association*, vol. 72, no. 1,

- pp. 55–74, Dec. 2006, doi: 10.1080/01944360608976724.
- [45] N. Crankshaw, *Creating vibrant public spaces: Streetscape design in commercial and historic districts*. Washington: DC: Island Press, 2009.
- [46] Y. Liu, X. Ding, and Y. Ji, “Enhancing Walking Accessibility in Urban Transportation: A Comprehensive Analysis of Influencing Factors and Mechanisms,” *Information (Switzerland)*, vol. 14, no. 11, Nov. 2023, doi: 10.3390/info14110595.
- [47] A. A. Zuniga-Teran *et al.*, “Designing healthy communities: Testing the walkability model,” *Frontiers of Architectural Research*, vol. 6, no. 1, pp. 63–73, Mar. 2017, doi: 10.1016/j.foar.2016.11.005.
- [48] A. Elliott *et al.*, “Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities,” 2017. [Online]. Available: http://www.fhwa.dot.gov/environment/bicycle_pedestrian
- [49] P. A. S. F. Da Silva, “The Importance of Pedestrian Spaces,” 2008. [Online]. Available: <http://www.fe.up.pt>
- [50] D. Appleyard, *Livable Streets*. University of California Press, 1981. doi: <https://doi.org/10.1016/C2016-0-05005-2>.
- [51] V. Mehta, “Evaluating Public Space,” *J Urban Des (Abingdon)*, vol. 19, no. 1, pp. 53–88, Jan. 2014, doi: 10.1080/13574809.2013.854698.
- [52] R. M. Dabdoob, “Is Mosul University Campus Comfortable for Walking?,” *Al-Rafidain Engineering Journal (AREJ)*, vol. 28, no. 1, pp. 74–88, Mar. 2023, doi: 10.33899/rengj.2023.136856.1213.
- [53] M. , Carmona, S. , Tiesdell, T. , Heath, and T. Oc, “The social dimension,” in *Public Places, Urban Spaces: The Dimensions of Urban Design*, 3rd ed., New York: Routledge, 2021, pp. 133–166. doi: <https://doi.org/10.4324/9781315158457>.
- [54] J. Qi, S. Mazumdar, and A. C. Vasconcelos, “Understanding the Relationship between Urban Public Space and Social Cohesion: A Systematic Review,” *International Journal of Community Well-Being*, vol. 7, no. 2, pp. 155–212, Jun. 2024, doi: 10.1007/s42413-024-00204-5.
- [55] F. A. Matloob, K. J. Aldeen Ismail, and A. A. Alfakhry, “What Impacts Walkability in Mosul: The Role of Accessibility at Neighborhood Level,” *International Journal of Sustainable Development and Planning*, vol. 19, no. 7, pp. 2579–2586, Jul. 2024, doi: 10.18280/ijstdp.190714.
- [56] S. Amir, A. Azizan, R. K. Zahari, and M. Z. Asmawi, “Urban Public Space as Social Interaction Space: Case Study in Petaling Street,” *Journal of Tourism, Hospitality and Environment Management*, vol. 5, no. 19, pp. 90–101, Jun. 2020, doi: 10.35631/JTHEM.519007.
- [57] J. Simpson and E. Weiner, Eds., *The Oxford English Dictionary*, 2nd ed. New York: Oxford University Press, 1989.
- [58] N. Z. Harun, K. Zakariya, M. Mansor, and K. Zakaria, “Determining Attributes of Urban Plaza for Social Sustainability,” *Procedia Soc Behav Sci*, vol. 153, pp. 606–615, Oct. 2014, doi: 10.1016/j.sbspro.2014.10.093.
- [59] A. Moulay, N. Ujang, and I. Said, “Legibility of neighborhood parks as a predictor for enhanced social interaction towards social sustainability,” *Cities*, vol. 61, pp. 58–64, Jan. 2017, doi: 10.1016/j.cities.2016.11.007.
- [60] A. M. R. M. Mohamed, S. Samarghandi, H. Samir, and M. F. M. Mohammed, “The role of placemaking approach in revitalising AL-ULA heritage site: Linkage and access as key factors,” *International Journal of Sustainable Development and Planning*, vol. 15, no. 6, pp. 921–926, Sep. 2020, doi: 10.18280/ijstdp.150616.
- [61] T. Litman, “Evaluating Accessibility for Transport Planning Measuring People’s Ability to Reach Desired Services and Activities,” *J Urban Plan Dev*, vol. 131, no. 4, pp. 1–63, Dec. 2005, doi: [https://doi.org/10.1061/\(ASCE\)0733-9488\(2005\)131:4\(246\)](https://doi.org/10.1061/(ASCE)0733-9488(2005)131:4(246)).
- [62] V. Mehta, “Neighbourhood Authenticity and Sense of Place,” in *Planning for Authentic CITIES*, 1st ed., New York: Routledge, 2018, pp. 57–74. doi: <https://doi.org/10.4324/9781351202879>.
- [63] N. K. Mamaghani, A. P. Asadollahi, and S.-R. Mortezaei, “Designing for Improving Social Relationship with Interaction Design Approach,” *Procedia Soc Behav Sci*, vol. 201, pp. 377–385, Aug. 2015, doi: 10.1016/j.sbspro.2015.08.190.
- [64] B. M. Hamdoon and K. G. Ahmed, “Assessing Mobility Measures for Socially Sustainable Waterfront Redevelopment Projects: A Case Study in United Arab Emirates,” *International Journal of Transport Development and Integration*, vol. 7, no. 1, pp. 55–65, Mar. 2023, doi: 10.18280/ijtdi.070107.
- [65] N. H. Ja’afar, A. B. Sulaiman, and S. Shamsuddin, “The Contribution of Landscape Features on Traditional Streets in Malaysia,” *Procedia Soc Behav Sci*, vol. 50, pp. 643–656, 2012, doi: 10.1016/j.sbspro.2012.08.067.
- [66] M. S. Al-Obeidy and S. Shamsuddin, “Evaluating Diversity of Commercial Streets by the Approach of Sense of Place,” *Adv Environ Biol*, vol. 9, no. 4, pp. 193–196, 2015, [Online]. Available: <http://www.aensiweb.com/AEB/>
- [67] B. S. Shamsuddin, “Identity of Place: A Case Study of Kuantan Town Centre, Malaysia,” PhD thesis, University of Nottingham, 1997.
- [68] D. De Vaus, *Surveys In Social Research*, 6th ed. London: Routledge, 2014. doi: <https://doi.org/10.4324/9780203519196>.
- [69] D. A. Payne and McMorris F., Eds., *Educational and Psychological Measurement: Contributions to Theory*, vol. 5, no. 2. New York: Blaisdell Publishing Company, 1967. doi: <https://doi.org/10.1002/1520->

- 6807(196804)5:2<190::AID-PITS2310050224>3.0.CO;2-0.
- [70] World Population Review, "Mosul Population."
- [71] O. H. Ali, "The Efficient Use of Urban Square in Iraqi Cities: The Importance of Environmental Attributes That Influence Social Interaction in Erbil Square," PhD thesis, Universiti Kebangsaan Malaysia, Bangi, Malaysia, 2021.
- [72] J. F. Hair, G. T. M. Hult, C. M. Ringle, and M. Sarstedt, *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 2nd ed. Los Angeles: Sage, Thousand Oaks, CA., 2017. Accessed: Oct. 05, 2025. [Online]. Available: <http://lcn.loc.gov/2016005380>
- [73] J. F. , Hair, M. Sarstedt, C. M. Ringle, and S. P. Gudergan, *Advanced Issues in Partial Least Squares Structural Equation Modeling (PLS-SEM)* , 2nd ed. SAGE Publications, 2023. Accessed: Oct. 05, 2025. [Online]. Available: <https://us.sagepub.com/en-us/nam/advanced-issues-in-partial-least-squares-structural-equation-modeling/book279526#contents>
- [74] M. Tenenhaus, V. E. Vinzi, Y. M. Chatelin, and C. Lauro, "PLS path modeling," *Comput Stat Data Anal*, vol. 48, no. 1, pp. 159–205, Jan. 2005, doi: 10.1016/j.csda.2004.03.005.
- [75] C. Fornell and D. F. Larcker, "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research*, vol. 18, no. 1, pp. 39–50, Feb. 1981, Accessed: Oct. 05, 2025. [Online]. Available: <http://www.jstor.org/stable/3151312> .
- [76] J. Henseler, C. M. Ringle, and R. R. Sinkovics, "The use of partial least squares path modeling in international marketing," *Advances in International Marketing*, vol. 20, pp. 277–319, 2009, doi: 10.1108/S1474-7979(2009)0000020014.
- [77] M. Sarstedt, C. M. Ringle, D. Smith, R. Reams, and J. F. Hair, "Partial least squares structural equation modeling (PLS-SEM): A useful tool for family business researchers," *Journal of Family Business Strategy*, vol. 5, no. 1, pp. 105–115, 2014, doi: 10.1016/j.jfbs.2014.01.002.
- [78] K. Wong, "Partial Least Squares Structural Equation Modeling (PLS-SEM) Techniques Using SmartPLS," 2013. [Online]. Available: <http://marketing-bulletin.massey.ac.nz>
- [79] P. K. Ozili, "The Acceptable R-Square in Empirical Modelling for Social Science Research," in *Social Research Methodology and Publishing Results: A Guide to Non-Native English Speakers*, C. A. Saliya, Ed., Sri Lanka Institute of Information Technology, 2022, ch. 9, pp. 134–143. doi: 10.4018/978-1-6684-6859-3.ch009.
- [80] S. Geisser, "A predictive approach to the random effect model," 1974. [Online]. Available: <http://biomet.oxfordjournals.org/>
- [81] J. F. Hair, G. T. M. Hult, C. M. Ringle, M. Sarstedt, N. P. Danks, and S. Ray, *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R*. Cham, Switzerland: Springer Cham, 2021. doi: <https://doi.org/10.1007/978-3-030-80519-7>.
- [82] J. Henseler, G. Hubona, and P. A. Ray, "Using PLS path modeling in new technology research: Updated guidelines," *Industrial Management and Data Systems*, vol. 116, no. 1, pp. 2–20, Feb. 2016, doi: 10.1108/IMDS-09-2015-0382.
- [83] M. Wetzels, G. Odekerken-Schröder, and C. Van Oppen, "Using PLS path modeling for assessing hierarchical construct models: Guidelines and empirical illustration," *Management Information Systems*, vol. 33, no. 1, pp. 177–196, 2009, doi: 10.2307/20650284.