Assessment of uninterrupted pedestrian facility, case study of Al-Mutanabbi Street

Farah Ahmed Subhi[1], and *Abeer* Khudhur Jameel[2,*]

[1]Civil Engineering Department, Al-Shaab University, Baghdad, Iraq
[2]Highway and Transportation Department, College of Engineering, Mustansiriyah University, Baghdad, Iraq

Abstract. Walking is a sustainable transportation mode as it is the most affordable way to reduce the environmental and social effects of the transportation system. Walking can be used for transportation and recreational purposes. To encourage walking, it is necessary to improve walkability and walking behavior. The main aim of this paper is to assess the walkability of Al-Mutanabbi Street in Baghdad City, which is located in a cultural and historical area. The measure of effectiveness is the pedestrian level of service PLOS. In this paper, new indicators reflecting the perception of pedestrians have been included in the assessment method to overcome the limitation of the traditional method of PLOS determination. A questionnaire form was used to collect the data. The questions related to walkability are 21 questions grouped into seven groups. The responses of pedestrians were converted to scores to find the overall PLOS, which was C. However, the scores of some variables were low, reflecting the weakness in walking performance, such as the small spaces, low speed, and frequent conflicts with other pedestrians. The safety and security in the study area have the highest scores because no vehicles are allowed to pass the street. This PLOS method is more comprehensive than the traditional methods because it accounts for variables that other methodologies neglect.

1 Introduction

Walking is the most affordable way to reduce the negative consequences of using motorized vehicles, such as air pollution, traffic congestion, and health issues. It is a sustainable transportation mode with many individual and social benefit. While walking is a kind of human transportation, walkability measures how pedestrian-friendly a location is. Urban designers and planners are using this concept to create a sustainable pedestrian-based environment for communication, recreation, and shopping. Walkability is the foundation of sustainable cities. It is a "green" mode of transportation that reduces crowding, conserves energy, and eliminates air and noise pollution [1, 2]. In addition, it promotes equity by using renewable resources and noise and balancing regional growth by safely and healthily addressing society's access and development needs. These have been recognized by the WHO and UN, which promote sustainable transportation, liveable cities, and physical activity. The

* Corresponding author: abeer_khudhur@uomustansiriyah.edu.iq

Sustainable Development Goals (SDG) of Goal 3 “Ensuring healthy lives and promoting well-being for all at all ages”, Goal 9 “Building resilient infrastructure”, and Goal 11 “Making cities and human settlements inclusive, safe, resilient and sustainable” require walking promotion. Therefore, attention has been paid to walking, especially after transit-oriented development (TOD) was introduced [2-4].

The pedestrian facilities are the space for walking in the form of a sidewalk, a raised space on the side of the road to provide optimal service to pedestrians [4] or a walkway, an off-street separated exclusively pedestrian facility [6,7]. However, pedestrian interactions are challenging to understand because they are highly related to human behavior and the surrounding environment [7,8]. Researchers and planners consider two primary purposes for walking: utilitarian and recreational. Utilitarian walking trips have specific destinations, such as work or school. Recreational and personal trips do not have particular destinations, including walking for leisure and cultural and social activities [4]. Providing pedestrian-oriented infrastructures and facilities is considered a contributing factor because it reflects the quality of the walking path. It includes sidewalk length, pedestrian fencing, walkway width, paving condition, landscaping, signing, and lighting. Route aesthetics and cultural and commercial buildings increase pedestrian satisfaction, especially for recreational purposes. Safety and weather conditions also increase the recreational walking frequency [4, 9-11].

1.1 Walkability and pedestrian level of service

To measure the extent to which the quality of road infrastructures is perceived for walking, pedestrian level of service (PLOS) has been used as the most common measure of effectiveness in assessing the quality of pedestrian facilities' operations [5]. It is highly used to support better decision-making and to highlight limitations and motivators to walking. PLOS is more specific measure than walkability. The variables considered in PLOS considered by Turoń et al. as a main scale of walkability and could be say it is more specific than walkability. Scholars considered the PLOS is an interpreting of the quality of the pedestrian environment while Meeder defined the PLOS as a link between walkability which is a scale of social-economic, land use and accessibility characteristics to pedestrian-friendly places. Guzman et al. expressed the relation between the walkability and built environment characteristics as complex to interpretation. The PLOS might be the best interpretation of the effect of the geometric design characteristics and pedestrians flow characteristics on the walkability. Dovey and Pafka supported the definition of Henson who showed that the PLOS concept prioritized the metrics of individual pedestrian space and safety at pedestrian facilities such as sidewalks, walkways and pedestrians, crossing; while walkability encompasses the concepts of pedestrian access, street interconnectivity, and the density and diversity of land use which is broader than PLOS concept. Urban planners focus more on the walkability studies while transportation engineers pay attention to PLOS.

Among the developed methodologies to measure the PLOS for walkway, the Highway Capacity Manual (HCM) methodology is the oldest and most valid one . The HCM methodology is based on the quantitative measures of the effectiveness of MOEs, which are different according to the type of pedestrian facility. However, the limitations of this methodology have been highlighted in the studies that involved factors that HCM is not considered, such as land use, accessibility, quality of pedestrian facilities, comfort, and safety [1]. In addition, walking is highly linked to people's cultural context and behavioral intention. The influence of perceptions of walking facilities and other measures related to walkability, such as safety, security, and attractiveness, have been taken into account recently by researchers and decision-makers. Questionnaires were designed to collect data from pedestrians. Specific methodologies have been adopted to analyze these data and measure perceptions. The findings of most of these studies demonstrated that both the physical and

perceptual attributes must be considered and employed by transport planners and decision-makers.

Talavera-Garcia and Soria-Lara proposed the "Quality of Pedestrian Level of Service," which aimed to integrate a broader range of factors than the traditional methods. These factors were grouped into accessibility, safety, comfort needs, and attractiveness. This study concluded that this method has been more effective in comprehending most of the factors that transport planners in Granada (Spain) considered in transportation and walking promotion strategies. Zannat et al. developed a wide-ranging framework to measure pedestrian facilities' qualitative and quantitative impact in the Chittagong Metropolitan Area in Bangladesh on perceived PLOS. The principal factors investigated were accessibility, safety, comfort, and attractiveness. It was found that accessibility and attractiveness significantly affect the footpath, carriageway, and transit, whereas safety has an insignificant effect on the footpath. Ujjwal and Bandyopadhyaya developed satisfaction rating models for walkability conditions using an ordered probit model. Data were collected through a survey of 550 pedestrians in two cities in India. The most significant factors were safety, pedestrian infrastructure, convenience, security, encroachment, and walking comfort. Asadi-Shekari et al. investigated a group of pedestrian indicators derived from the various walking guidelines, specifically for campus areas in the Universiti Teknologi Malaysia (UTM). The investigated factors were related to the available infrastructures, such as lane width, presence of barriers, crossing area, landscapes, supporting service, furniture, surface conditions, and marking. The results were different from one location to another. However, it produced a valuable model to identify current service issues and propose improvements for a higher level of pedestrian service.

Wibowo and Nurhalima examined the applicability of four methods of PLOS assessment on the sidewalks and walkways in the Bandung Institute of Technology campus: HCM, Trip Quality, Gainesville, and Australian PLOS. The HCM methodology considers only the capacity of pedestrian facilities. At the same time, the Trip Quality method focused on the qualitative PLOS measures such as pleasures, safety, comfort, the complexity of network and space, shade trees, transparency, and physical characteristics. Ratings of 1 to 5 are applied, reflecting poor to excellent condition. The total rating scores are averaged for PLOS grades from A to F. The third method, Gainesville PLOS, was explicitly developed for Gainesville (Florida). This method grouped indicators into six categories: facility type, vehicle-pedestrian conflict, supporting facilities, vehicular level of service (VLOS), maintenance, and multimodal transport. The total scores ranged between 1 to 21 and were divided into six levels, A to F. The fourth method is the Australian PLOS method, which considers three factors: physical characteristics, location factors, and user factors. By comparing the four methods, Wibowo and Nurhalima found that the four methods did not consider user characteristics such as age, gender, income, and perception. In addition, the four methods considered the infrastructure characteristics, but the HCM lacks the inclusion of land use, safety, and comfort indicators. They concluded that no single method could produce a comprehensive assessment. Abdulhussein and Jameel investigated the impact of the role of infrastructure as a Latent Variable (LV) in the transport mode choice. They found that the provision of cycling fences and pedestrian bridges are the most significant variables. Consequently, it is recommended that these results be considered in the provision and improvement of cycling and walking infrastructures to promote active transportation.

1.2 Walkability assessment

Walkability was measured in previous research objectively, subjectively, or both. Subjective measurements employ interviews and surveys to assess user impression, while objective

measurements use physical attributes. This classification has been utilized in several studies. The most accurate walkability measures are NEWS and GWI.

Saelens et al. designed the NEWS Worldwide, which is the most extensively used subjective walkability neighborhood environment measure. A special inventory form containing 83 questions has been designed for NEWS survey; they cover residential density, land use mix–diversity, retail and leisure access and closure, street connectivity, pedestrian infrastructure (sidewalks and walkways), aesthetics, traffic safety, and criminal safety. Further research adopted NEWS with modifications to meet the objectives of their studies; such as the Australian NEWS survey, Ghent NEWS and the abbreviated (NESW-A) which excluded some groups of questions that are not required in their studies.

The World Bank interns created the Global Walkability Index (GWI) to assess international walkability. Key indicators include 14 parameters reduced to nine parameters in three groups: safety and security, convenience and attractiveness, and policy support. The safety and security indicator measures the number of pedestrian fatalities from traffic accidents and crimes. Maintenance, cleanliness, facilities, amenities, walking path difficulties, and crossings rated convenience and attractiveness.

1.3 The research question and aim

The research question is: How can the perception of using walking be incorporated into the methodology of PLOS determination to extend its concept to the walkability concept? And what indicators can be used to reflect the perception of walkers for recreational walking trips? This research aims to qualify road users' perception of walking in a selected area in Baghdad City, Iraq, in terms of Pedestrian Level of Service (PLOS) to assess the walkability and identify issues from a pedestrian point of view.

This paper's novelty is that it includes indicators that reflect the perception of pedestrians in the methodology of PLOS determination. This is essential in studying and promoting walking for recreation in areas with unique characteristics. The outcome of the research will establish methods and metrics to study the relationship between walking behavior, physical environment, and city sustainability to improve urban design and "walkability" knowledge and practice.

2 Materials and methods

The main steps followed to achieve the study's aim started with selecting the study area and then defining the general situation through monitoring and observation. After that, data were collected through a designed questionnaire form and field observation. The details of the assessment stages are shown in the subsequent subsections. Figure 1 shows the methodology flowchart.

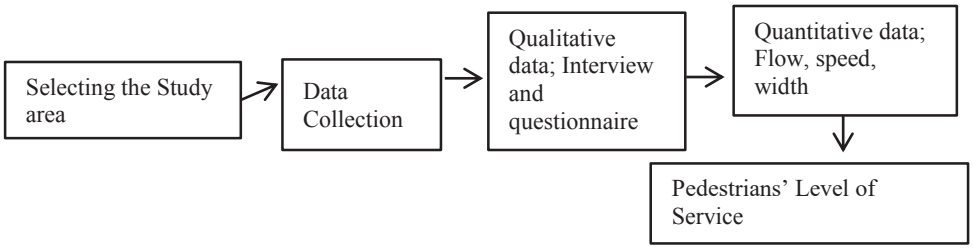

Fig. 1. The Methodology of the research.

2.1 Study area

The study area is Al-Mutanabbi Street, a 300 m street and one of the most ancient streets in Baghdad City, Rusafa Side. It was built and established during the Abbasi Era to be a meeting place for poets and writers, and then it was expanded to be a center of bikeshares. It is now considered a center of recreational, cultural, and historical activities. Visitors come to this street to buy books and visit the folklore restaurants, cafes, historical places, and the Tigris River bank, which is located at the end of this street. Al-Mutanabbi Street is exclusive for walking; no vehicles are moving on it. It is usually crowded with pedestrians during the day and evening, especially on Thursday, Friday, and Saturday. The sidewalks on both sides of the road are only adequate during the day, but in the evening, they are closed by shopkeepers. Figure 2 shows a plan view of the study area.

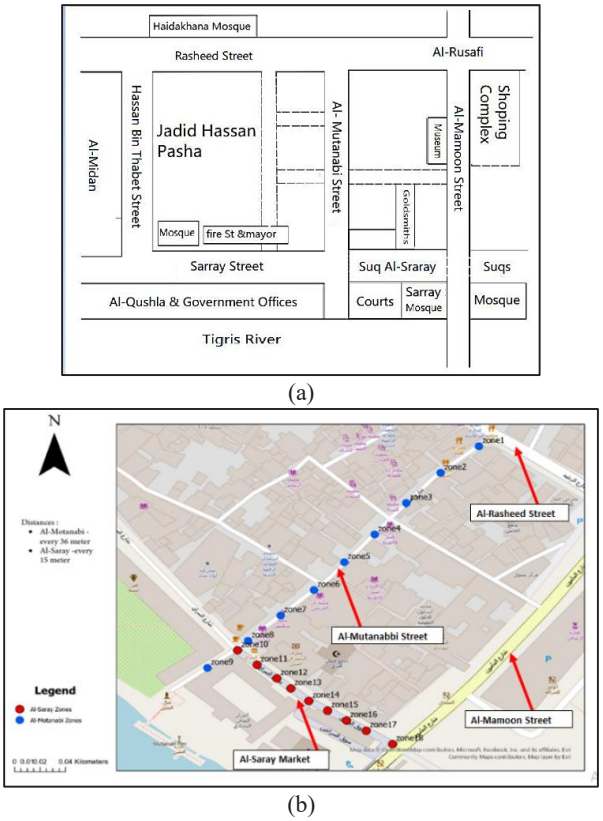

Fig. 2. The study area, Al-Mutanabbi Street (created by the author).

2.2 Data collection

Roadside interviews with pedestrians visiting the streets were carried out to ask them about the general situation of Al-Mutanabbi Street, the main factors motivating them to walk on the street, the drawbacks, and their recommendations to improve the walkability of the street.

A roadside questionnaire was designed to consist of two parts. The first part contains the respondents' demographics, including age, sex, income, occupation, and whether the respondents own a car. The second part includes psychological factors and awareness of physical factors (Factors affecting people who choose to walk in the city center. The

questions of the questionnaire were selected based on previously designed survey forms such as The Neighborhood Environment Walkability Scale (NEWS) and the Global Walkability Index (GWI). The selection of questions is based meeting the aim of this research which focuses on cultural and historical areas and encompasses the metrics of PLOS and walkability concepts. The selected questions were 21 questions grouped into seven groups, shown in Table 1. The answers are designed on a six-Likert scale, from 1 representing "Excellent" to 6 representing "very bad".

The preliminary form of the questionnaire was subjected to a pilot test by being distributed to experts in transportation and urban planning. It was also distributed to about 30 visitors to give feedback and identify unintelligible, repeated, non-understandable and out of scope questions. Based on the feedback and comments of the experts, the questions have been modified to the final forms.

The questionnaire was designed in electronic form using KOBO software, which is used to create questionnaires and collect online and offline responses in the field using Mobile phones. The authors asked randomly selected visitors about the questionnaire questions and entered their responses through KOBO software. The respondents were first asked if they agreed to conduct the survey and to record their reactions for academic research purposes. They were also free to answer the questions about their income and educational level as they were optional. They also asked if they had any limitations regarding responding to the survey before recording their answers.

The size of the respondents was 322 people; it is checked according to Equation (1) to meet the sample size with a confidence interval = 1.96

$$N_{min} = (SK/E)^2 \quad (1)$$

The results were analyzed using the IBM SPSS Microsoft program.

Where: N_{min}=Sample size, S=Standard deviation =10, K=Confidence interval=1.96, E=Coefficient = 2.

The responses were then subjected to a Reliability test to measure the stability and consistency of the answers. This was done using Cronbach's Alpha via the SPSS IBM Statics 25 program; the stability coefficient should be close to one. The validity test was also measured by multiplying the reliability coefficient by itself. The result of this test showed that Cronbach's Alpha was 0.809, reflecting the significant internal consistency between the questions.

2.3 Analysis of the data

The responses obtained from the previous step were analyzed; The participants demographics were analyzed firstly to identify the limitations of the results that will be obtained in the analyzing of the second part of the questionnaire.

2.3.1 Analsys of the respondents' demographics

In this section, the results of the respondents' demographics; including age, gender, income, academic level, and having own car will be presented.

According to the age of the participants, the highest participation was from people with age of 20 to 45 years which their percentage was about 79%. This has been expected because older people may could not use walking for not providing elderly facilities in the area. Younger people were expected to be more, probably the attention to visit cultural areas and the parents' restrictions for young people are reasons for low percentages of young people visiting Al-Mutanabbi Street.

Regarding the gender of walkers, the percentage of female was about 54%, which is slightly greater than the percentage of. This means the gender restrictions was not a main issue in walking at the study area.

The monthly income range of about 57% of respondents was 500,000 to 1,000,000 Iraqi dinars; which is higher than the average monthly income in Iraq. This reflects the positive attitude of people with this range of monthly income to walk. On the other hand, people with monthly income less than the average were only 19% of the visitors. This may reflect the attitude pf people within this range of monthly income to make recreational trips.

According to the participants' academic profession levels, it has been reported that about 70% of the walkers had bachelor's degrees. This is expected because the nature of the case study area is more attractive for people who have high profession levels.

About 59% of participants has no private cars while car-owners were about 41%. The latter percentage is optimistic as it reflects the positive perception of people to walk even when thy have a car.

2.3.2 Analsys of the walakbility indices

To analyze the second part of the questionnaire responses, a score ranging from 0 to 5 has been allocated to each answer based on a method developed by Gallin (2001); 0 is allocated for the worst scale, while six is allocated for the best scale. Table 1 shows the six-scale of each question adopted from Gallin.

This method requires determining each question's weight (W), reflecting to what extent each variable affects the assessment results. The expert's opinions were used to identify the weights. Another questionnaire was designed to ask 22 experts about the subjective weights out of 5 of the 21 variables in the first questionnaire, subjectively based on their experience in urban transportation planning.

3 Results

The experts' answers for each question were averaged, and the results are shown in Table 1.

To determine the overall level of service, PLOS bands have been determined by assuming the worst condition has a zero score for all elements, and the best condition has a full score of 5 for all elements with a total of 350.5 points. The total score is the maximum score, and it is divided by six to find the interval length. The determined interval length is 58, and the PLOS bands are shown in Table (2). The sum of the multiplication of the weight of each variable by its score was divided by six and entered into Table 2 to determine the PLOS, which is C, as shown in Table (3) and Figure 3.

Table 1 The categories and variables of walkability with their scores and weights.

Categories	Variables	W	Scores					
			0	**1**	**2**	**3**	**4**	**5**
Physical Characteristics	Width (at day)	3.9	No path	0–<1 m	1.0–<1.5 m	1.5–<2.0 m	2.0-<3.5 m	≥ 3.5
	Width (at night)	3.5	No path	0–<1 m	1.0–<1.5 m	1.5–<2.0 m	2.0-<3.5 m	≥ 3.5
	Quality of surface	3.1	Extremely poor	Poor	Moderate	acceptable	Good	Excellent
	Obstacles per km	3.8	>10	8-10	5-8	2-5	<2	0

Continuation of Table 1.

Categories	Variables	W	Scores					
			0	1	2	3	4	5
Safety and Security	Pedestrians crossing	3.4	Not provided	Few / poorly located	Some / reasonably well located	Adequate /reasonably well-located	Supplied at an adequate frequency	Extremely adequate
	Pedestrian' crashes	3.8	Very High	High	Moderate	Few	Very few	No
	Crossing control system	3.6	No	Poor	Ineffective signals	effective at some crossing	Effective at all	Extremely Effective
	Feeling of secure	3.4	Insecure	Poor security	Reasonable	Natural	Good	Very good
	Visibility	3.6	No lighting	Poor	Moderate	Good	Very good	Excellent
Elderly and Disabilities	Facilities for Elderly and Disabilities	2.7	Very poor	Poor	Moderate	Acceptable	Adequate	Extremely Adequate
Pedestrians' movement	Speed of walking	2.4	Very slow	Slow	Moderate	Reasonable	High	Very high
	Number of pedestrians	3.4	> 350	226 -350	151-225	100-150	50-99	<50
	Pedestrians' conflicts	3.1	Very high	High	Moderate	Few	Very few	No
	Space between pedestrian	3.2	Very poor	Poor	Moderate	Acceptable	Adequate	Extremely Adequate
	Delay	3.4	Very high	High	Moderate	Limited	Very short	No
Presence of Supporting facilities and amenities	Recreational activities	3.2	Very poor	Poor	Moderate	Acceptable	Adequate	Extremely Adequate
	Historical and cultural activities	3.6	Very poor	Poor	Moderate	Acceptable	Adequate	Extremely Adequate
	Walking furniture	2.9	Very poor	Poor	Moderate	Acceptable	Adequate	Extremely Adequate
	Supported facilities	2.9	Very poor	Poor	Moderate	Acceptable	Adequate	Extremely Adequate
Weather condition	Protecting from bad weather	3.8	Very poor	Poor	Moderate	Acceptable	Adequate	Extremely Adequate
Accessibility	Accessible to the assessed area	3.4	Very poor	Poor	Moderate	Acceptable	Adequate	Extremely Adequate

Table 2. The PLOS bands.

PLOS	Total Scores
A	≥290
B	232 - <290
C	174 - <232
D	116 - <174
E	58 - <116
F	0 - <58

Table 3 The results of the data analysis, the score of indicators, and the overall PLOS.

Factor	Weight	Score	Scores×weight
Width (at day)	3.9	3	11.7
Width (at night)	3.5	5	17.5
Quality of surface	3.1	4	12.4
Presence of Obstacles	3.8	0	0
The presence of pedestrians crossing	3.4	5	17
Pedestrian' crashes	3.8	5	19
Crossing control system	3.6	5	18
Feeling of secure	3.4	4	13.6
Visibility	3.6	4	14.4
Facilities for Elderly and Disabilities	2.7	3	8.1
Speed of walking	2.4	2	4.8
Number of pedestrians	3.4	0	0
Pedestrians' conflicts	3.1	2	6.2
Space between pedestrian	3.2	2	6.4
Delay	3.4	3	10.2
Presence of Recreational activities	3.2	4	12.8
Historical and cultural activities	3.6	3	10.8
Walking furniture	2.9	3	8.7
Supported facilities	2.9	3	8.7
Protecting from bad weather	3.8	3	11.4
Accessible to the assessed area	3.4	3	10.2
Total			221.9
PLOS			C

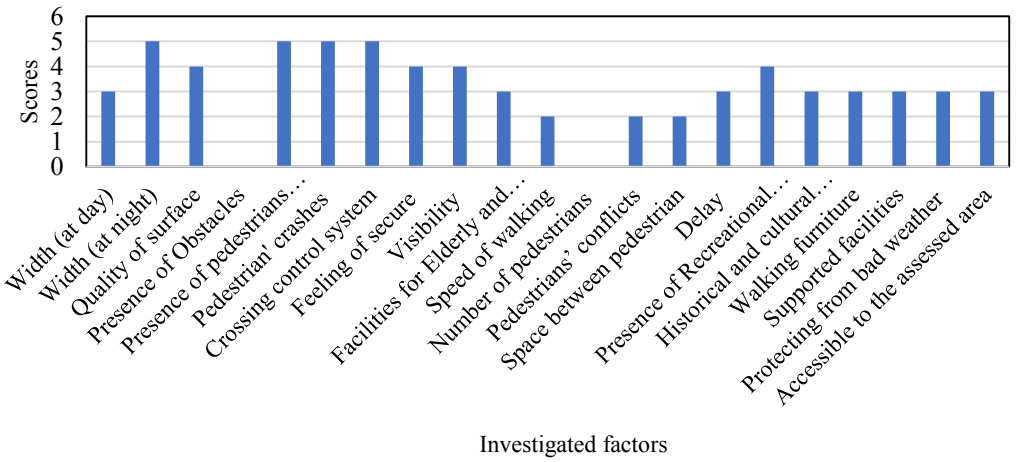

Fig. 3. The score of indicators.

It can be observed that the highest scores were allocated to the perception of the width of the street in the evening because the space of the main walkway is allocated for pedestrians only, while in the day, the bookseller's occupied spaces for their packages; therefore, the scores are less. Safety and security variables also have the highest score because the street is exclusively for walking, and there are no cars crossing the street; therefore, the feeling that pedestrians are absolutely safe from motorized vehicles. The second highest score, 4, is allocated to variables of the quality of the surface. The questionnaire was distributed in 2023 when the street was rehabilitated, and the surface quality was adequate without observed failing. The folklore visibility of the street and the presence of recreational activities also score four, reflecting the attractiveness of the walkers to this street for these reasons. The lowest scores, 2, were allocated to the speed of pedestrians, the space per pedestrian, and the conflict between pedestrians. This may result from the high walker volume in the study area, resulting in lower speed and small space for each pedestrian. A slower walking speed for recreational is more acceptable than a slow speed for transportation. Therefore, the visitors were not rated with 0 or 1. It can be seen that a score of 3 has been allocated to the supportive facilities such as seats and weather-protective shells. Another issue is highlighted, which is the accessibility to the study area. It has been observed that the streets approaching Al-Mutanabbi Street have issues of traffic congestion and unsuitability for walking. In addition, the nearest public transportation stop is far away. According to these results, improvements should be proposed to increase the PLOS and the scores for the highlighted issues. Regarding the width of the walking street, it is suggested that the booksellers have space for their packages in the surrounding areas to make the spaces available for walking only. It is also suggested that seats and other supported facilities be provided. It is also recommended to improve the PLOS in Al-Rasheed Street, Al-Midan Street, and Al-Mamoon Street to improve the accessibility to the study area.

4 Conclusion

The perception of walking is a significant variable that should be considered when assessing pedestrian safety. The designed questionnaire includes the most relevant questions used in the previously designed questionnaire to the characteristics of the study area. The results of the respondent's analysis highlight the strengths that attract pedestrians to walk in the street, such as safety, amenities, and recreational activities. The study area is more attractive in the evening because there is more available space for pedestrians than on days. It also highlights the drawbacks that need improvements, such as space and the supplied facilities. The surface quality is also reported as a drawback, so rehabilitation is required. The weather is recorded as an issue at a lower rate, and the walkers suggested providing shelters to protect them from hot and sunny weather in summer and rainy weather in winter. The analysis results could be presented to planners and decision-makers so that they can take them into account in further programs and strategies for walkability improvements on this street and other street.

The main limitation of this research is that its scope is limited to a specific study area with historical and cultural characteristics. In addition, the methodology could be applied to walking for recreational purposes only; different factors should be considered for walking for transportation. Furthermore, and according to the results of demographic characteristics of the participant, the results could be limited to people with age 20 to 45 years, having Bachelor degree, with monthly income slightly above the average monthly income in IRAQ (I QD500, 000 to IQD1000,000).

The perception and attitude could be considered in further research to study the behavior of trips with various modes of transportation. In addition, these factors could be incorporated into the mode choice models to get more comprehensive and accurate results. Other methodologies could be used to determine the level of service and compare the results with

the commonly mused methodologies to investigate the most thorough method that produces results that meet the guidelines of various policies.

References

1. R. Rafiemanzelat, M. I. Emadi, A. J. Kamali, "City sustainability: the influence of walkability on built environments," Transportation research procedia **24**, 97-104 (2017)
2. S. Ridha, S. Ginestet, S. Lorente, "Adopting A Sustainable Urban Design to Improve Thermal Comfort in An Arid Climate," Journal of Engineering and Sustainable Development **27(2)**, 171–179 (2023), https://doi.org/10.31272/jeasd.27.2.2
3. W. D. Lee, W. Ectors, T. Bellemans, B. Kochan, D. Janssens, G. Wets, K. Choi, Chang-Hyeon Joh, "Investigating Pedestrian Walkability using a Multitude of Seoul Data Sources," Transportmetrica B-Transport Dynamics **66(1)**, 1-20 (2018)
4. M. Z. Muttaqin, A. Munawar, M. Zudhyirawan, "Assessment of HCM 2010 and HBS 2002 for Pedestrian Lane Quality in Indonesia (Case Study: Sardjito Hospital and Sudirman Office, Yogyakarta)," Turkish Journal of Computer and Mathematics Education **12(14)**, 4646-4652 (2021)
5. A. Banerjee, A. K. Maurya, G. Lämmel, "A Review of Pedestrian Flow Characteristics and Level of Service over Different Pedestrian Facilities," Collective Dynamics **3**, 1–52 (2018), https://doi.org/10.17815/CD.2018.17
6. D. Pemberton, *Are our suburbs walkable for the elderly? Focus on walking for transport* (Master's thesis, Itä-Suomen yliopisto, 2022)
7. Z. Wang, D. Ettema, M. Helbich, "Objective environmental exposures correlate differently with recreational and transportation walking: A cross-sectional national study in the Netherlands," Environmental research **194**, 110591 (2021)
8. A. Colom, S. Mavoa, M. Ruiz, J. Wärnberg, J. Muncunill, J. Konieczna, D. Romaguera, "Neighbourhood walkability and physical activity: moderating role of a physical activity intervention in overweight and obese older adults with metabolic syndrome," Age and ageing **50(3)**, 963-968 (2021)
9. G. Ferrari, A. O. Werneck, D. R. Silva, I. Kovalskys, G. Gómez, A. Rigotti, M. Fisberg, "Perceived urban environment attributes and device-measured physical activity in Latin America: an 8-nation study," American Journal of Preventive Medicine **62(4)**, 635-645 (2022)
10. F. A. Subhi, A. K. Jameel, "Investigating the Key Components of Walking Behaviour in Baghdad City," in IOP conference series. Earth and environmental science **1232(1)**, 012052 (2023), https://doi.org/10.1088/1755-1315/1232/1/012052
11. K. Turoń, P. Czech, M. Juzek, "The concept of a walkable city as an alternative form of urban mobility," in Scientific Journal of Silesian University of Technology. Series Transport **95**, 223-230 (2017), https://doi.org/10.20858/sjsutst.2017.95.20