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An Assessment of the Walkability of Square Corridors in Developing Countries: a Case Study of Saadatabad, Tehran, Iran

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An Assessment of the Walkability of Square Corridors in Developing Countries: a Case Study of Saadatabad, Tehran, Iran

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Abstract

Walkability is an interdisciplinary concept that is increasingly attracting researchers worldwide. With the advances in transportation technology and the resultant development of automobile-oriented cities, many urban areas have degraded significantly. In many developing countries like Iran, pedestrians often fail to meet international standards in terms of the level of service and spatial attributes. Tehran, the capital of Iran, is among the most polluted cities in the world, primarily because of its heavy vehicular traffic. Nonetheless, limited measures were taken to enhance the quality of pedestrian areas that would stimulate individuals to walk, that is, a green mode of transport. This novel approach is significant for increasing public awareness of the concept of walkability and addressing some issues to the city officials. This study assesses the quality of corridors of two squares in the Saadatabad district. The research methodology involves the combination of an agency policy survey, field observations using the objective method, and subjective analysis, including the direct interviews and the questionnaires filled in the sites. Data is collected using the Global Walkability Index (GWI), which provides a step-by-step guideline for data collection. The walkability score resulting from the objective analysis turned out to be 54, indicating a moderate walkability level, which was consistent with the convenience level, 2 out of 5, derived from the pilot study. Ultimately, the article offers some solutions regarding the identified shortcomings of the selected sites, which also apply to other areas.

Keywords: global walkability index, Iran, pedestrian environments, urban planning, walkability.

Introduction

Walking and walkability are increasingly-appealing topics for researchers majoring in various fields of study, such as public health, architecture, and urban planning (Rafiemanzelat et al., 2017). Likewise, travel behavior, transportation, and walking are worth analyzing through the lens of landscape. Landscape is a dynamic and interdisciplinary concept that considers not only the physical attributes, fabric, and structure of the space but also seeks to grasp the totality and spatial character of the environment, which have shaped several interacting historical, social, identity, activity, and structural factors (Mahan et al., 2022). Walking is attributed to travel by foot for exercise, pleasure, or to reach a destination (Wigan, 1995). Active transportation, as opposed to a sedentary lifestyle, decreases the risk of depression and obesity, which are prevalent in elderlies (Lee & Dean, 2018). In the urban context, walking definition is a short-distance movement between two points (Rafiemanzelat et al., 2017). City, one of the most important manifestations of civilization, has some primary elements, including the street. One's understanding of cities should not be

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limited to the physical body and urban fabric. But should consider human presence, his exchange with and perception of the environment (Negarestan et al., 2010). In general, a walkable or walking-friendly city is one in which people prefer walking for travel, among other options for health and leisure, and has a high degree of walkability (Seles & Afacan, 2019). According to the Mayor of London (2004), in the research 'making London a walkable city, the walking plan for London', the term 'walkability', in turn, is the extent to which an environment is walking-friendly. Mayor of London (2004) further defines walkable cities as connected, convivial, conspicuous, comfortable, and convenient places for the citizens. Forsyth and Southworth (2008) attribute four major features: closeness, barrier-freeness, safety, provision of pedestrian infrastructure and destinations, and being upscale or cosmopolitan to the walkable environments. Southworth (2005), however, believes that urbanization has changed in favor of automobiles mostly because of the advances in transportation technology. Therefore, pedestrian environments have degraded significantly and been overlooked for a long time. As a result, many scientific papers have been published that have analyzed different pedestrian areas and considered the walkability of urban areas using different methods (Rafiemanzelat et al., 2017). In addition, Speck (2012) explored the concept more extensively. In his book "walkable city", rooted in his "general theory of walkability", he criticized the common city governance that ignores convincing people to walk. Speck (2014) furthermore, in "Downtown walkability analysis", attempts to demonstrate the considerable impacts of the seemingly-small interventions on the livability of downtown Boise. Ewing and Handy (2009) explore five urban design perceptual qualities of imageability, human scale, transparency, complexity, and enclosure. In the study adopted by the World Bank, Krambeck (2006) generated the Global Walkability Index (GWI), which provides a guideline for researchers worldwide. GWI originally indicated 14 factors for walkability, five of which were eliminated in the modified version of GWI proposed by The Clean Air Initiative for Asian Cities (CAI-Asia). It was because of the easier application of the nine parameters in big Asian cities with a comparatively high pedestrian volume (Mulyadi et al., 2022). The Asian Development Bank (ADB) similarly applied and assessed the GWI method in the context of Asian cities, with some modifications on the guidelines calculating but not considering the two factors of length of the target walking paths and pedestrian count (Leather et al., 2011). "walkscore.com" is a popular website that measures the walkability of an area based on ease of access from the resident's houses to the nearby amenities. Many Asian cities were graded high scores although they are not easy to walk in, so the scoring system has been criticized since they don't consider the qualitative analysis of pedestrian facilities (Gota et al., 2010). As a result, it qualifies the GWI's variables by eliminating two factors of pedestrian counts and surveyed road length in calculating walk score. Tariq et al. (2019) similarly uses the GWI and Asian index in two housing societies; as a result, he acknowledges ten steps to promoting walkability. In continuation of prior research, another relative article uses the walkability compass, which is a well-developed method that relies on nine stages involving space syntax, geographic information systems (GIS), and statistical methods to identify pedestrian-friendly development and transformation scenarios in cities (Zaleckis et al., 2022).

Tehran, an automobile-oriented city with environmental problems

Iran is a developing country in the middle east. One of the main characteristics of developing countries is that they provide poor living standards, and in the case of urbanization, poor infrastructure is obvious through obstructions, narrow streets, comparatively aggressive driving against pedestrians, and lack of shaded corridors or attractive elements (Shaaban, 2019). In this regard, Southworth (2005) implies that with the advances in transportation technology and the resultant development of automobile-oriented cities, many urban areas have degraded in terms of walkability.

In historical context, Tehran was built in 4000BC and became the capital of Iran in the Qajar dynasty in 1786. This city evolved from a small city into a metropolis (Madanipour, 2021). The primary form of the city underwent three large-scale town planning exercises. The reasons behind the radical changes were the advent of motorcycles, the extreme population growth, the regime's inclination to modernize infrastructure, and its intention to control the population (Madanipour, 2006). Streets played a conceptual role in the urban formation of traditional cities in Iran. Soon later, did they fade out of the semantic scale and downgraded to only the form (Atashinbar & Motedayen, 2018). The changes of urbanization in favour of modernism resulted in the dominance of vehicles over pedestrians.

As brought in the 'Air Pollution in Tehran: Health Costs, Sources, and Policies', Tehran has many severe environmental problems, which account for a number of respiratory and cardiovascular diseases in its inhabitants. In fact, 'Tehran is one of the most air polluted cities in the world' (Heger & Sarraf, 2018). The reason behind the recurring problem of heavy pollution in Tehran includes vehicular traffic alongside the industries of oil refineries, power plants, and factories, in which low-quality fuel oil is burnt (Anadolu Agency (AA), 2021). As the transport sector is the main cause of Tehran's air pollution, Heger and Sarraf (2018) suggest how to reduce the adverse effects of low air quality by building bicycle and pedestrian paths. Many measures were implemented to reduce traffic congestion's detrimental effects due to the intense environmental problems.

In continuation of prior research, this study aims to address the issues concerned with the quality of built environments to the city officials and increase public awareness of the importance of the concept of walkability. Ultimately, it will assist city planners in obtaining necessary information on the shortcomings of the pedestrian areas. In the end, the flaws of the sites being pointed out will provide some potential solutions to the identified problems.

Various factors contribute to walkability; subsequently, the examination of walkability requires subjective and objective analysis. GWI attributes various factors to walkability. The indicators include spatial attributes of the spaces, including dimensions and facilities. Other indicators that are less tangible at first sight are pedestrians' and motorists' behaviours and level of safety and security. On top of that, the laws and regulations and the degree they are implemented by agencies also contribute to the analysis of pedestrians.

Site selection

The study examines the walkability of sidewalks around city squares. 'Shahid Tehrani Moghaddam' (STM) and 'Farhang' are two squares with serious walkability issues that have remained unresolved for years. The STM square, formerly known as Kaj, is located in district 2 of the capital of Iran. People often attend the square mostly for its commercial function. In addition, there are a mosque, clinics and Pharmaceutics, a variety of lavish cafés and restaurants, banks, shopping malls, a grocery store, and several private and public institutes and schools located around the square, stimulating both diurnal and nocturnal activities. The sidewalks have distinct spatial features; as a result, four stretches on different sides of the roundabout were selected for detailed analysis, as shown in (**Fig. 1**).

The Farhang square, however, is also located in Saadat Abad, which is similar in function and scale to STM. Both of these squares are good representatives of Saadat Abad's urbanization. The squares share some qualities; however, they have significant differences. STM has many activities; therefore, it's more crowded, but that doesn't necessarily mean it has better walking paths if one takes walkability into account. The functions of the surrounding places in Farhang square are an international school, a bakery, several hospitals, clinics, and pharmacies, some renowned corporations and commercial buildings, and a bank. Three road stretches in the quarter were chosen for data collection, as shown in (**Fig. 2**).

Fig. 1

Coding of the road stretches of STM square for further analysis (source: lines are drawn by authors, and texts are included based on Google Earth)

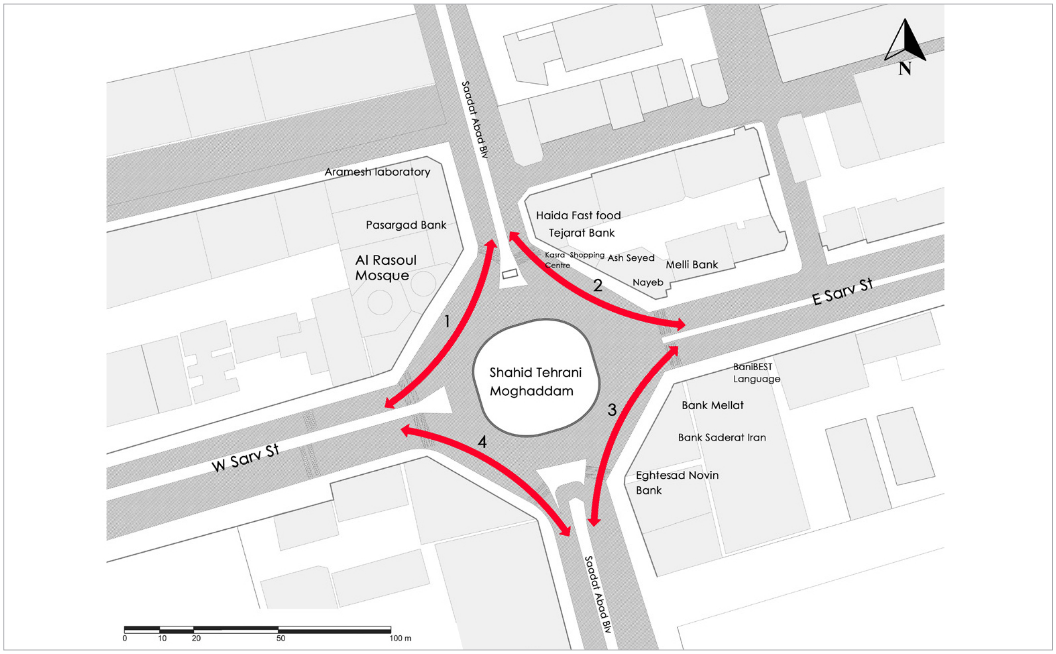
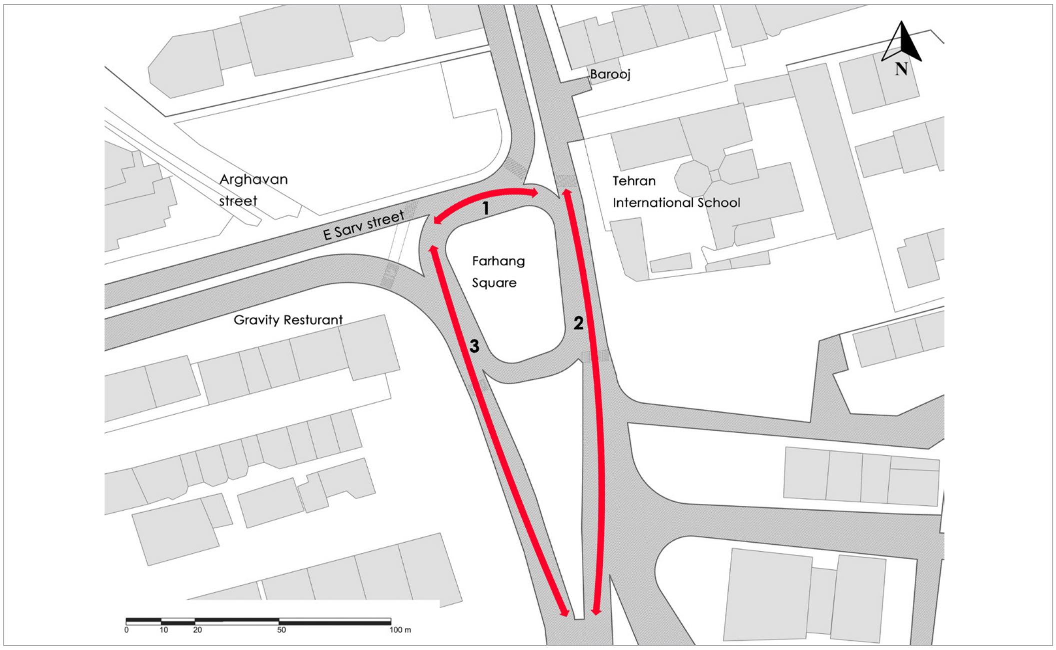


Fig. 2

Coding of the road stretches of Farhang square for further analysis (source: lines are drawn by authors, and texts are included based on Google Earth)



Methods

In the study adopted by the World Bank, Krambeck (2006) generated the GWI, which provides a guideline for researchers worldwide. The GWI analyzes walkability through qualitative, quantitative, subjective, and objective approaches, which require a multifaceted way of thinking. Similarly, the study includes a combination of a public agency survey, field observations, and a field survey. The method developed by the World Bank is an authentic resource for researchers interested in measuring walkability. This study took this aforementioned resource to examine walkability and followed the step-by-step guideline provided in GWI. The components of GWI are as follows:

- Safety and security: the degree to which pedestrians feel safe and secure along the walking paths.

- Convenience and attractiveness: the pedestrian's accessibility with adequate crossing paths, coverage from weather elements along walking paths, and absence of temporary and permanent obstructions on the way.
- Policy support: the third component reflects on municipal governance and support of improvements in pedestrian infrastructure and related services. It also depends on the budget allocated for pedestrian planning and the inclusion of pedestrian zones in the city master plan.

The aforementioned components are defined with respective variables explored through data collection. The following sections indicate the data of each step coupled with the related results in detail.

Results

The first stage was the policy support survey, which was needed to reach out to the authentic information of agencies of city planning, traffic safety, law enforcement, and transportation planning. The Pedestrian-related laws and regulations survey results are brought to the (Table 1).

Table 1

The agency policy survey

Agency Survey	
Question	**Answers**
1. Please rate the degree of municipal funding and resources devoted to pedestrian planning.	Enough to sustain a high-quality program in long-term. Sufficient for short term, but not the long term. Neutral. ✓ Insufficient to achieve meaningful goals. Non-existent.
2. Please check the pedestrian-related urban design guidelines that are already well-established. Feel free to add any relevant guidelines that are not included in the list.	✓ Sidewalk pavement type. ✓ Placement of benches and similar amenities on walk paths. ✓ Sidewalk widths. ✓ Design for disabled persons.
3. Attach available data on pedestrian fatalities and Injuries to survey materials. Enter estimated proportion of traffic fatalities involving pedestrians in 2004.	38%[2]
4. Have there been public outreach efforts (by this or other agency) to educate pedestrians or drivers on road and pedestrian safety?	✓ Yes No
5. Is there a law or regulation for any of the following Items? If so, is the law or regulation enforced? Feel free to add any relevant laws or regulations that are not included in this list. Is there a law or regulation for .... enforced?	✓ Jaywalking (rarely)[3]. ✓ Vendors on sidewalks (sometimes). ✓ Parking on sidewalks (usually). ✓ Driving/ riding on sidewalks (usually). ✓ Drunk driving (usually). ✓ Littering (rarely). ✓ Other- Trumpet horns (usually).

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[1] Deputy of transportation. (2020). بخش ۱۰: مسیرهای پیاده و آیین نامه طراحی معابر شهری [urban Highways and Streets Design Guide Section 10: Pedestrian Ways] (Vol. 10). ministry of road & urban development, Islamic Republic of Iran.

[2] IRNA. (2019, 05/24/2022). افزایش دو درصدی فوت عابران پیاده در سال جاری؛ با مثلث کاهش تلفات آشنا شوید. IRNA https://plus.irna.ir/news/83593581/.

[3] The options that indicated the seriousness of implementation of laws and regulations for question were scaled based on 'rarely', 'sometimes', and 'often'.

According to this survey, the funding allocated to the walkable areas is inadequate to achieve meaningful goals. Notably, there are laws and regulations regarding pedestrian urban design for all the items mentioned in the urbanization (Deputy of transportation, 2020) however, in practice, they are poorly implemented or overlooked. The answer to the third question, the data on pedestrian Fatalities of traffic accidents in the year 2019, according to a report of the Islamic Republic News Agency IRNA (2019), is 38%. In July 2022, a direct conversation with Niru-ye entezami-ye jomhuri-ye eslami-ye Iran, or NAJA, yielded the following valuable information. The answer to the question of whether have been efforts to increase the awareness of individuals about traffic rules is true since these instructions are given to students in schools. In addition, some relative courses will be incorporated into the universities' curricula. All items mentioned in the last question are included in the law. To be more specific, there are some laws regarding jaywalking, but they are rarely enforced. On the other hand, the vendors' activities are associated with the law enforcement police, and the laws are sometimes enforced. Both parking and driving on sidewalks are prohibited, and police usually issue a heavy fine or tow the cars to a parking lot. Dropping litter is penalized when captured by the police camera; however, Littering is rarely penalized inside the city. Another law regarding pedestrian and motorist behaviour prohibits drivers from sounding air horns since they produce harsh sounds, causing harm to others' ears.

The latter stage was the field observations, in which the sites had to be analyzed objectively, and some features of the stretches had to be recorded on site. Multiple trips to the sites during peak hours were made to collect the required data. The data collection on site was based on ten components, including walking path modal conflict, security from crime, crossing safety, motorist behavior, amenities, disability infrastructure, sidewalk width, maintenance and cleanliness, obstructions, availability of crossings, pedestrian count, and length of the surveyed area. The data was achieved through multiple trips to the sites during peak hours. (Table 2) illustrates the parameters of the physical infrastructure survey, which were, in turn, scored with the meticulous guidelines of the GWI.

Table 2

Definitions of the parameters of the survey on physical infrastructure

Explanations of the physical infrastructure's parameters	
Walking path modal conflict	The conflict between pedestrians and other modes such as bicycles' motorcycles, and cars.
Security from crime	Indicated the degree to which the pedestrians feel susceptible to crime like robbery, mugging, and unprovoked attack, particularly at night.
Crossing safety	It refers to the factors of the exposure to the other modes, for instance, the exposure time spent by pedestrians (including elderly and people with children) waiting and crossing the street.
Motorist behavior	It is assigned to the extent to which motorists' behavior toward pedestrians.
Amenities	The amenities such as benches, trees cultivated along the walking paths, street lights, pedestrian signage, and public toilets have a significant role in the convenience and attractiveness of the pedestrian environment.
Disability infrastructure and sidewalk width	Provision of effective walking paths and accessible roots for all pedestrians, including physically disabled people, the elderly, and people with small children.
Maintenance and cleanliness	Provision of smooth and clean walking surfaces devoid of holes, cracks, and irregularities for a more pleasant and convenient environment.
Obstruction	Includes the presence of temporary or permanent obstacles on the walkways that restrain pedestrians' movements and decrease the effective width of the pathways, which results in inconvenience to pedestrians.
Availability of crossings	Availability of sufficient walking paths in reasonable distances stimulating pedestrians to walk over the zebra crossings rather than jaywalk.

(**Table 3**) shows the given scores for each indicator regarding walkability. Data collection was adopted from GWI. Data assigned to each variable ranged from 1 to 5 to, which indicated the worst to the best based on the semantic scale method. The table also includes other data that are influential in quantifying the degree of walkability. Thus, the following items were recorded on-site:

- pedestrian count: the number of people passing a particular place in 5 minutes.
- The street lighting: the number of street lights divided by the length of the selected road stretches per kilometer.
- The trees count: the number of trees alongside the pathways divided by the length of the road stretches.

Table 3

The survey results on physical infrastructure[4]

Physical infrastructure Survey									
	STM Square					Farhang Square			
The codes of Road Stretches[5] / Physical Factors	#1	#2	#3	#4	Unweighted average	#1	#2	#3	Unweighted average
1. Walking path modal conflict	3	3	3	1	46.1	3	3	3	53.7
2. Security from crime	3	3	3	2	48	3	2	2	38.1
3. Crossing safety	2.3	2.7	2.3	2	39.1	3	3	2	47.3
4. Motorist behavior	4	4	4	4	66.6	4	4	4	72
5. Amenities	4	3	4	1	56.5	5	4	3	67.5
6. Disability infrastructure and side walk width	1	1	1	1	16.7	5	1	1	27.2
7. Maintenance and cleanliness	3	4	3.5	2.5	54.3	5	4	4	73.9
8. Obstruction	4	5	4	1	65.2	4	3	3	56
9. Availability of crossings	4	4	4	4	66.6	4	4	4	71.6
10. Pedestrian count[6]	42	25	15	32		10	12	9	
11. Length of the surveyed stretch(km)	0.08	0.07	0.06	0.07		0.07	0.23	0.21	
Average number of trees per kilometer[7]	62	257	133	14		200	204	198	
Average number of street lights per kilometer[8]	50	43	50	28		28	30	33	
(∑(x*length*10*pedestrian count))/#)/10[9]	51.1					56.3			
Walkability index	53.7								

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[4] It took from 26th May to 11th June for the data collection for the physical infrastructure survey to be complete.

[5] Based on the codes assigned to the road stretches in (**Fig. 1**) and (**Fig. 2**).

[6] Indicates the number of pedestrians that pass a particular place in duration of 5 minutes.

[7] Indicates the number of trees in each stretch divided by the length of each stretch per kilometer.

[8] Indicates the number of light poles in each stretch divided by the length of each stretch per kilometer.

[9] The formula used for the normalization of data based on the pedestrian count and the length of each route, which is then divided by the number of road stretches.

(Eq. 1) represents the formula to obtain the walkability score. That is, for the calculation of the collective score in each Area, the values assigned to the indicators are normalized based on the road stretches and pedestrian counts. For normalization, the value of each indicator must be multiplied by the pedestrian counts, that is, the number of pedestrians who pass a specific place in each stretch in 5 minutes and the road stretches' length. Each value is then multiplied by ten for simplicity. Finally, the resultant values are summed up and divided by the number of roads stretches to achieve the mean in each row (= unweighted average).

Eq. 1. The formula for the evaluation of walk score:

$$Walkability\ index = \frac{\sum_i (n_i * length_i * 10 * ped.\ count_i\ )}{k * 10}\ , i = 1, 2 \ldots k$$

With i = the ordered number of the surveyed road stretches; n_i = the score assigned to each variable; $length_i$ = the length of each road stretch per kilometer; $ped.\ count$ = number of pedestrians per segment; k = the number of road stretches.

The unweighted score in each row was derived from the collective score in the nine rows. Then, the scores were summed up and divided by the number of rows (=9) to achieve the walk score in each zone. Walk score is a number between 1 to 100 that reflects the walking ease to the nearby amenities. The walk score grading system rates the walkability of a given address on five levels. The range (90-100) is attributed to the walkers' paradise (daily errands that don't require a car), (70-89) is very walkable (most errands can be accomplished on foot), (50-59) is somewhat walkable (some errands can be accomplished on foot), and (20-49) is attributed to care-dependent zones, in which most errands require a car. Finally, (0-24) is an automobile-oriented area with the lowest degree of walkability, in which almost all errands require a car.

As is brought in (Table 3), the number derived from the calculations for the walk score is 53.7. This number is in the range of (50-69), which means the selected sites are moderately walkable, and most errands can be accomplished on foot.

In order to get an in-depth understanding of each quality in the selected zones, one can compare the quantitative data in each row. The unweighted average of each indicator is comparable, so the sites almost have the same degree of walkability in many aspects, except for a couple of variables. For instance, the squares have significant differences in terms of security. The difference is probably because, in the STM square, police officers patrol the area, which inhibits offenses and crimes. However, the presence of outnumbered beggars, the homeless, and vendors on the sidewalks is one of the worrying concerns of pedestrians, making the quarter's walking experience uncomfortable. Less conflict between motorists and pedestrians is perceivable in Farhang. For instance, the stretch (#4) of STM, as shown in Fig 3. a, is located near a construction site and has a narrow sidewalk blocked with multiple obstructions, which compels pedestrians to intrude the motorist zone. Subsequently, crossing safety is higher in Farhang, as well. The average time spent on waiting was about 20 to 30 seconds, while the total time given to cross the given streets would not exceed one minute and would take about 40 to 60 seconds; as a result, the allotted time for crossing the street was sufficient for a healthy adult, but it would pose a degree of danger to the elderly, the disabled and small children. The crossing opportunities are higher in Farhang because of the presence of pedestrian signals in the intersections, as depicted in Fig 3.b, allowing pedestrians to cross the street more comfortably. Furthermore, the green space inside the roundabout is more accessible through zebra crossings; thus, it decreases the inclination of pedestrians to jaywalks. Motorists' behaviour is almost the same. In fact, in both sites, motorists often slow down for pedestrians. Regarding amenities, the Farhang road stretches have fewer bins and are poorly sheltered. Both sites didn't have considerable coverage apart from trees' canopies and nearby bus stations, and neither did they have benches in the corridors, so the pedestrians would have to sit down on the threshold of the buildings' entrances to rest.

Conclusively, both sites lacked the amenities of shelters, benches, drinking water, and toilets, which indicates the flaws in the level of service in the areas. Even though most of the walking areas of Saadat Abad have standard pavements suited to disabled people, the sidewalks of the selected corridors don't provide a comfortable path for people with disabilities. The pavements are uneven and difficult to walk on. The pavements of STM are smoother, but they are somehow slippery and dangerous for pedestrians, as illustrated in **(Fig 3. c)**.

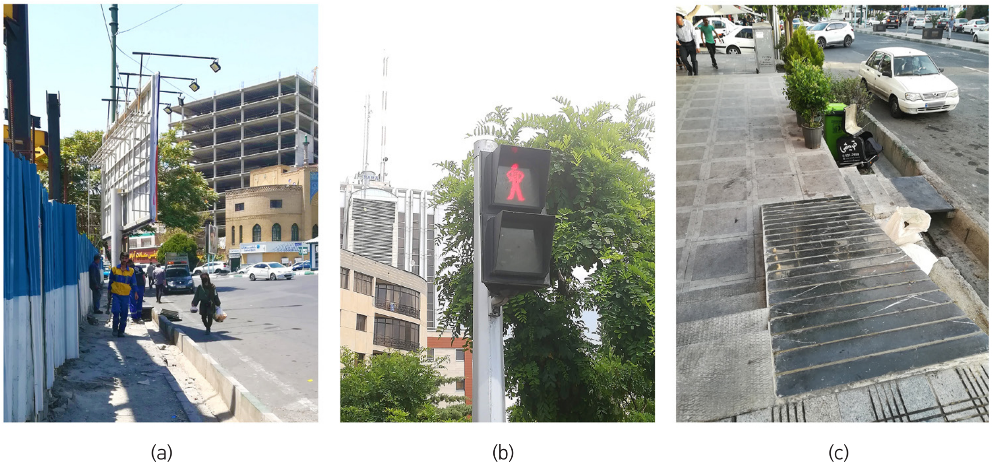
(a) (b) (c)

Fig. 3

(a) walking path modal conflict, pedestrians walking in the motorist zone because of obstructions.
(b) Crossing safety, pretimed signaling in Farhang.
(c) Disability infrastructure and sidewalk width, the slippery paving of the STM ramps unsuited to the disabled
(Photo archives of the authors, 2022)

The low friction in pavements is more severe in times of precipitation than on ordinary days. The sidewalks of Farhang, on the other hand, are paved with asphalt and not well-maintained, which is perceivable from **(Fig 4. a)**. In both quarters, the pedestrian path fails to create interconnected walking paths. Because the routes assigned to pedestrians are fragmented or blocked by obstructions, the trails are not in favour of the disabled.


(a) (b) (c)

Fig. 4

(a) Disability infrastructure and maintenance, the uneven surfaces paved with asphalt that are poorly maintained
(b), (c). Obstructions, temporary and permanent obstacles in the sidewalks
(Photo archives of the authors, 2022)

For instance, the pavements attributed to the disabled are discontinued in the middle of the routes. Moreover, the sidewalks are higher than the streets, with no curb ramps connecting the two zones. Subsequently, people with mobility impairments can't have to access the zebra crossings independently. Regarding cleanliness, Farhang is very clean and almost devoid of litter. In the STM, on the other hand, rubbish degrades the quality of the environment but is not an obstacle to walking. However, the open sewers in STM emit a foul smell, which is quite unpleasant for walking experience individuals. The corridors of both squares had major obstructions, which were more intense in the STM. That being said, the sidewalks of STM are wider but are often congested with people and, proportionately, have more temporary and permanent obstructions, as is evident from (Fig 4. b) and (Fig 4. c).

However, the areas needed to be assessed subjectively for the intensive research. The third stage was the pilot survey; the information was derived from direct interviews and the questionnaires distributed among randomly-selected pedestrians in parks and walking paths as well as the salespeople and the employees of the nearby institutions. The emphasis was to gather responses from at least 100 people at each site. To be more specific, in total, about 275 individuals answered the questionnaires, 266 of which were helpful. In both locations, a high proportion of the questionnaires were filled in place, reinforcing the data's accuracy. The target population was the local people or ones who had the experience of walking in the square corridors to eliminate the potential errors. (Table 4) demonstrates the descriptions of the respondents in each location.

Table 4

The respondents' description

Respondents' Description					
Variables	Description	Responds	STM(%)	Farhang(%)	Total(%)
Number of respondents in each site	Proportion of the respondents		56	44	50
Gender:	Gender of respondents	female	56	46	51
		male	44	54	49
Disabled:	Physical condition	healthy	100	99	100
		disabled	0	1	0
Have small children (living with you at present):	Parental status	yes	31	20	26
		no	69	80	74
Age:	Age of respondents	10 - 19	5	3	4
		20 - 39	58	65	62
		40 - 59	27	30	28
		60+	10	2	6
Income Level (do you earn significantly less or more than local median?):	Income classes	low	20	19	19
		medium	74	74	74
		high	6	7	7
Do you own (in this city):	Motorized or non-motorized vehicle ownership	bicycle	12	7	9
		motor two-wheeler	7	9	8
		car	62	68	65
		none	26	21	24
How much time do you spend per day walking (minutes)?	Average time spent on walking per day		16-30	16-30	16-30

The questionnaires were filled in different places and distances from the target sites to decrease the potential errors of receiving biased answers. One of the challenges of the pilot survey was that several questions had to be read and answered orally. It was necessary to elaborate on the questions and interpret the answers since several respondents were unfamiliar with academic surveys or were reluctant to read the questions, even though the questions were simplified and were modified in format after the pilot survey. Therefore, the survey process turned out to be unexpectedly demanding and time-consuming. It is inferred from the (Table 4) that the survey excluded none of the social classes, age groups, no users of various modes of transport from the target society. There is a perfect balance of males and females. There was a limited approach to people with disabilities on the sites. Almost one-fifth of respondents (26%) were parents of small children. Most respondents' age was (20-60), which is consistent with the Population Pyramids of Iran in 2011 (Noroozian, 2012). The answer to the level of income was not obligatory since many respondents felt defensive about giving their personal information. The usage frequency of the pedestrians was 16 to 30 minutes on average, among the options of (0-15), (16-30), (31-60), and (+60) per minute. The field studies' duration was from the 10th to the 28th of June 2022.

The (Table 5) indicates the results of the pilot survey. The questions of the pilot study evaluated the level of convenience, safety, and security based on a five-point scale, in which the number 1 meant the worst, whereas 5 meant the best. One must determine the range of each answer to assess the mean of 5-point Likert-scale questions. To do so, one should calculate by subtracting the minimum of the maximum value, so number 1 should be subtracted from 5. Then to calculate the range, the number 4 is divided by 5, which results in the number 0.8. Subsequently, the ranges are (1-1.80), (1.81- 2.60), (2.61-3.40), (3.41- 4.20), and finally (4.21- 5.00).

For the subjective walkability analysis, one needs to study the individuals' perception of the sites' quality. To do so, the respondents answered the questions that pointed out the issues of the sites and indicated their severity based on three options 'Rarely', 'Sometimes', and 'Often'. For simplicity of comparing two sites, the rate of respondents who have chosen the option of 'often' is considered. For instance, 26% have asserted that STM square is often blocked with obstructions, while 30% have claimed the same for the Farhang square; conclusively, this problem is more prevalent in the Farhang square. In the second row, 32 % of respondents stated that the STM square is congested with non-pedestrian traffic; but the fewer percentage of people in Farhang square, comparatively, thought the same. The temporary obstructions in STM were the parked motorcycles on the sidewalks and the cars that blocked the way to the zebra crossings. Another obstacle in the sidewalks was the multiple street vendors whose properties were situated on the sidewalk and occupied much space; however, the effective width in STM is still more than 1 meter. On the other hand, the temporary obstacles in Farhang were less of a problem. According to the third row, more than half of individuals (70%) believed that the sidewalks were not suitable for people with disabilities, which is consistent with the percentage of people who thought that the walk paths were uneven and difficult to walk on. The findings were also consistent with the direct reports of pedestrians since many believed that the sidewalks of the squares had steep slopes that made walking demanding. In the next row, 32% of people felt that the STM square was poorly lit at night, and so did a higher percentage of pedestrians in Farhang square. The lighting poles are only placed in the middle of the road in medians, so the quarter experiences hours of darkness, which lead to the decline of security. Another flaw of Farhang, in terms of security, is the limited activities near the square walk paths. Contrary to STM, the quarter is devoid of small shops and street hawkers in the sidewalks. In the STM square, the lighting of the buildings and advertisement boards are also contributed to the ambient lighting, enhancing the luminance at night. The same amount of people often had problems with littering in both regions, which indicates the degree of cleanliness from the respondents' perspective. More people (43%) were satisfied with the availability of crossings and opportunities to cross the street. The degree of convenience in

Table 5

The pilot survey results

Pilot survey data							
		STM Square			Farhang square		
Walking perceptions from pedestrian survey	Points	%	Mean	Standard deviation	%	Mean	Standard deviation
Blocked with Obstructions	Rarely	28			26		
	Sometimes	46			44		
	Often	**26**			**30**		
Congested with Non-pedestrian Traffic	Rarely	26			35		
	Sometimes	42			51		
	Often	**32**			**14**		
Inadequate for Blind or Disabled People	Rarely	13			11		
	Sometimes	17			17		
	Often	**70**			**71**		
Poorly Lit at Night	Rarely	30			17		
	Sometimes	39			39		
	Often	**32**			**44**		
Covered with Litter	Rarely	48			46		
	Sometimes	30			32		
	Often	**22**			**22**		
Uneven and/or Difficult to Walk On	Rarely	23			18		
	Sometimes	43			33		
	Often	**34**			**49**		
Sufficient Crossing Opportunities	Rarely	15			21		
	Sometimes	42			44		
	Often	**43**			**35**		
Degree of Convenience (1-5)[10]	1	10			17		
	2	23			19		
	3	44	2.9	1.06	38	2.85	1.20
	4	13			15		
	5	9			11		
Degree of Safety (1-5)	1	13			16		
	2	21			28		
	3	39	2.9	1.18	29	2.74	1.18
	4	14			18		
	5	13			9		
Degree of Security (1-5)	1	28			30		
	2	23	2.5	1.27	33	2.22	1.08
	3	28			26		
	4	13			7		
	5	9			4		
Motorists Fail to Yield to Pedestrians	Rarely	34			25		
	Sometimes	36			48		
	Often	**30**			**27**		
Motorists Drive Too Fast	Rarely	24			12		
	Sometimes	40			46		
	Often	**36**			**42**		
Motorists Drive Through Stops	Rarely	56			53		
	Sometimes	29			31		
	Often	**15**			**23**		

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[10] The level of each component based on 1 to 5 Likert scale.

both sites goes in the range of (2,61, 3.40). It shows a degree of 3 for comfort, which means that the respondents were moderately satisfied, consistent with the walk score derived from the objective analysis. The degree of safety from unintentional incidents goes in the range of (2.61 and 3.40), suggesting a degree of 3 out of 5. The degree of security goes in the range of (1.81 and 2.60), indicating a degree of 2. As a result, both sites are dangerous and, to some degree, exposed to crime. According to the views, Farhang seems less secure than the STM. In addition, in terms of motorist behaviour, 30% in STM and 27% in Farhang confirmed that motorists often failed to yield to the pedestrian. 36% in the STM and 42% in Farhang expressed that the motorists often drove too fast, which shows the degree of concern regarding potential accidents and the resultant conflicts between pedestrians and motorists. A low percentage of respondents (15% in STM and 23% in Farhang) thought drivers often violated the law and drove through stops. From the respondents' view, STM was better regarding lighting, smooth surfaces, crossing opportunities, and safety and security. On the contrary, the sites had slight differences concerning motorist behaviour, obstructions, suitability for disabled people, littering, and overall convenience. But motorist dominance was less severe in Farhang.

Discussion

The study was developed based on GWI, which provides an explicit guideline for every research stage. The process comprised a public agency survey, field observations, and a pilot study. The research targeted two squares, STM and Farhang, as representatives of Saadatabad district, with some serious issues regarding walkability. According to the policy agency survey, there are relative laws and regulations for urbanization and controlling pedestrian and motorist behaviours. Nonetheless, they are often poorly implemented in practice. For the stage of field observation, multiple trips to the sites were made to analyze the road stretches and collect the required data according to the GWI index. The authentic information from agencies, coupled with the objective and subjective analysis, gave a good insight into the current defects of the sites that are drawbacks to walkability. The variable of disability received the lowest score for infrastructure and sidewalk width. The highest scores, conversely, were given to the motorist behaviour and availability of crossings. The resultant total walkability score was about 54 out of 100, which indicates that the selected areas are moderately walkable. The qualitative study obtained valuable information concerning the pedestrians' insight into the target quarters. The score derived from the convenience level survey was 3 out of 5, which was consistent with the walkability score out of field observations. The scores applied to safety and security components, likewise, turned out to be 2 and 3 out of 5, in order. The results of the subjective analysis coupled with the aforementioned objective method led to the conclusion that the STM and Farhang squares corridors are somewhat walkable. It means the quarters are sufficient for the activities of an average person; nevertheless, they fail to provide a comfortable and safe environment for small children, elderly, and disabled people. Tehran municipality is supposed to decrease the conflict between pedestrians and motorists with phased signaling in the corridors and remove the permanent obstructions that decrease the effective width of the sidewalks, thereby increasing crossing safety. Another alternative is that individuals, motorists, and pedestrians, be educated and receive instructions concerning traffic rules. The security problem was more severe in the Farhang; however, vendors' and beggars' activities in STM in the streets must be inhibited to decrease the crime risks. Also, lighting must be intensified in Farhang because it experiences hours of almost total darkness at night, exposing pedestrians to robberies and street offenses. More security cameras and police control are also necessary for the area. The lack of small shops and hawkers' activities in the surrounding square probably accounts for the reports of street offenses in Farhang square, so some functions should be incorporated. With the addition of the facilities of shelters, benches, drinking water and toilets, extra bins, and light poles to the sites, the level of amenity may improve accordingly. The pavements should be maintained regularly to fix the problems of uneven surfaces and broken tiles to be stable and slip resistant. If the aforementioned practice-based solutions are implemented, they can lead to the highest degree of walkability in Saadat Abad, improving the quality of pedestrian environments. The practices can also be applied to other walking paths in urban spaces in Tehran since they are more or less exposed to the same problems.

Conclusions

In many developing countries, walkability is overlooked in urbanization, and cities don't meet international standards in this regard. As a result, outdoor environments fail to provide a convenient and well-equipped space for pedestrians. There is a correlation between the characteristics of pedestrian environments and walkability, the rate of which can be achieved with various methods. The study was based on the GWI method, which takes quantitative, qualitative, subjective, and objective approaches to evaluate walkability. Taking two case studies in Saadatabad of Tehran, the collective Walk Score on the selected spaces indicated a moderate level of walkability. The sites' major defects posed threats to pedestrians' safety and security and little consideration for people with disabilities. Identification of defects leads to practical solutions that could improve the pedestrian environments' walkability. It is worth mentioning that there is a lot of room for this research method development. GWI provides a good framework to assess the features of the built environments. This method has successfully managed to provide an international metric and framework to measure walkability worldwide since it is easily applicable to ordinary pedestrians in urban areas. However, it is not easily applicable in public outdoor places with specific characteristics, such as pedestrian-oriented squares and plazas, parks, and shared spaces in neighborhoods. It presents a useful framework for the assessment of pedestrians on a large scale. In a focused study of walkability in small-scale areas, the method can be complemented if incorporated with other conceptual and physical factors that are just as important to assess walkability, especially in the context of traditional cities. To exemplify, when assessing typical pedestrians, one can also regard the sense of enclosure, the proportion of active facades of the buildings adjacent to the pedestrians, legibility of the walk paths (like the presence of symbolic elements and signs that enhance place identity and sense of belonging). The aforementioned points should be considered by researchers wanting to do an in-depth evaluation of walkability in cities in Iran or similar characteristic cities in other developing countries.

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