TeMA

Journal of
Land Use, Mobility and Environment

The characteristics of urban travel behaviors and the attitudes of passengers in the Middle East and North Africa (MENA) is less-studied. There is a considerable knowledge gap about the circumstances of how people think and decide about their short-term, medium-term, and long-term mobility for commute and non-commute travels.

TeMA Journal of Land Use, Mobility and Environment offers papers with a unified approach to planning and mobility. TeMA has also received the Sparc Europe Seal of Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ).

Special Issue 1.2018

URBAN TRAVEL BEHAVIOR IN THE MIDDLE EAST AND NORTH AFRICA

ISSN 1970-9889
University of Naples Federico II

TeMA

Journal of
Land Use, Mobility and Environment

Special Issue 1.2018

URBAN TRAVEL BEHAVIOR IN THE MIDDLE EAST AND NORTH AFRICA

Published by
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

TeMA is realized by CAB - Center for Libraries at “Federico II” University of Naples using Open Journal System

Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | on line ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

Editorial correspondence
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"
Piazzale Tecchio, 80
80125 Naples
web: www.tema.unina.it
e-mail: redazione.tema@unina.it

Cover Image by Houshmand E. Masoumi of landscape in Teheran

TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.

The Italian *National Agency for the Evaluation of Universities and Research Institutes* (ANVUR) classified TeMA as scientific journal in the Area 08. TeMA has also received the *Sparc Europe Seal* for Open Access Journals released by *Scholarly Publishing and Academic Resources Coalition* (SPARC Europe) and the *Directory of Open Access Journals* (DOAJ). TeMA is published under a Creative Commons Attribution 3.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

TeMA Journal of
Land Use, Mobility and Environment

Special Issue 1.2018

URBAN TRAVEL BEHAVIOR IN THE MIDDLE EAST AND NORTH AFRICA

Contents

TeMA

Journal of
Land Use, Mobility and Environment

TeMA Urban Travel Behavior in the Middle East and North Africa
SPECIAL ISSUE 1.2018 | 95-108
print ISSN 1970-9889, e- ISSN 1970-9870

doi:http://dx.doi.org/10.6092/1970-9870/5468

review paper received 09 February 2018, accepted 22 May 2018

Soltani, A., Hosseinpour, M., Sholeh, M. & Zare, P. (2018). The Development of a Walkability Audit. Based on Iranian Cities Pedestrian Environment.*Tema Journal of Land Use, Mobility and Environment*, 95-108. doi: http://dx.doi.org/10.6092/1970-9870/5468

THE DEVELOPMENT OF A WALKABILITY AUDIT

BASED ON IRANIAN CITIES PEDESTRIAN ENVIRONMENT

ALI SOLTANI [a], MOHAMMAD HOSSEINPOUR[b] , MAHSA SHOLEH [c]
PARISA ZARE [d]

[a] Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN
e-mail: soltani@shirazu.ac.ir
[b] Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN
e-mail: m_hosseinpour@shirazu.ac.ir
[c] Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN
e-mail: msholeh@shirazu.ac.ir
[d] Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN
e-mail: parisa.zare.16@gmail.com

ABSTRACT

Given its influence on public health and the vehicle usage, along with its negative consequences, walkability has attracted much attention in recent decades. Meanwhile, the development of a method to measure walkability of urban areas for the purpose of improving this feature is of utmost importance. Hence, after a comprehensive investigation of environmental measures which are related to the users' walking behavior, the researchers attempted to develop an efficient and reliable environmental audit tool based on these measures. Following the development of a protocol for utilization and management of the tool, we designed two different tests to validate it. The participants were taught how to use the tool, then, it was tested in the Eram neighborhood of Shiraz (Fars province, Iran). The statistical analysis of the obtained data showed that 13 of the environmental measures were not reliable to be used in various environments. However, given the remaining 50 items, the tool is valid for being applied to other urban areas.

KEYWORDS:

Walkability; Audit Tools; Design Quality

1 INTRODUCTION

Physical activity is an important requirement for a healthy lifestyle. Walking is the most common type of physical activity (Saelens et al., 2003a). Due to the relation exsiting between the form of the built environment, physical activity, and public health, much research has been encouraged to investigate public health, urban economics, transportation, urban planning and design, etc. (Durand et al., 2011; Ewing & Handy, 2009; Forsyth & Southworth, 2008; Glazier et al., 2014; Handy et al., 2002; Lee & Buchner, 2008; Lee & Moudon, 2006; Litman, 2003; Saelens et al., 2003b). In such studies, the characteristics of the environment in which physical activities are encouraged, including land use, public transportation, street patterns, population density, residential density, urban form, accessibility, and safety are identified and evaluated (Brownson, et al., 2009; Clifton et al., Durand et al., 2011; 2007; Ewing & Cervero, 2010; Frank, 2005; King & Clarke, 2015; Shbeeb & Awad, 2013; Witten et al., 2012). Moreover, studies were carried out on different ethnic and social-economical groups who might have different interactactions with the built environment (Carlson et al., 2012; Jones et al., 2011; Leyden, 2003; Sallis et al., 2009; Panter et al., 2014). However, the way outdoor activities are affected by the qualities of the outdoor space needs to be noted (Gehl, 2011). Moreover, reliable methods for measurement of physical measures of the environment are needed to understand better the influence of the built environment on physical activities. It is due to the fact that a wide range of objective and subjective environmental measures can bring about an active lifestyle (Day et al., 2006a).

Many audit tools related to walkability and bike-ability have been developed to evaluate physical-activity-related environment measures (Brownson et al., 2004; Day et al., 2006b; Moudon & Lee, 2003). Nevertheless, the physical features of a place do not provide much information about its qualities, especially the perception of its patrons, despite the fact that such perception is in close relation to physical features. Many qualities which affect the walking environment are addressed in the urban design literature (Ewing & Handy, 2009). Considering the previous studies, five main urban design qualities that influence walkability were evaluated and tested. However, walkability audit tools always address broad measures such as density, education level, etc. or the physical details of the environment such as the physical conditions of the sidewalks. It means that walkability audit tools are not taking into account urban design qualities. Therefore, considering such qualities in the walkability audit is crucial in urban design and transportation. That said, solutions can be presented to enhance qualities related to walkability when designing urban streets based on their evaluation. Considering that the aim of the current study was to develop a comprehensive walkability audit tool which took both environmental qualities and quantities into account. It was the first attempt to develop the tool based on the studies conducted on urban context (environmental qualities which can affect the quality of users' experiences in an urban space include enclosure or transparency in a space; and environmental quantities such as traffic condition or land-use which can be measured quantitatively). Accordingly, the main question of this study was how we can develop a walkability audit tool that can measure built environment qualitatively and quantitatively. Following a review of the literature and similar tools in various urban contexts, we identified and categorized the measures required for the development of the tool.

The next step was to create the tool and determine how to use and manage the data it provided. The next aim of this study was to utilize the tool in a real urban environment to validate it. To this end, the tool was used to examine the walkability of 21 street segments in Shiraz. Furthermore, two different statistical methods were employed to test the reliability of the tool. In the Conclusion section, the modified tool was examined after presenting the results; ending with a conclusion on the preference of using this tool in urban planning and comparing it to the similar cases.

2 LITERATURE REVIEW

Different definitions have provided for walkability in transportation planning and urbanism literature. It shows that there is an ever-expanding meaning regarding the definition for them (Brown et al., 2007; Clifton et al., 2007; Talen & Koschinsky, 2013). Southworth (2005) seems to have provided a comprehensive definition for walkability based on which walkability is the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network (Southworth, 2005). Different walkability audit measures have been incorporated in the literature. These measures evaluate the built environment by considering different scales and different aspects of the subject. Some studies have used large-scale measures such as population, density, unemployment rate, land use, street network connectivity, and etc. which were extracted from various sources including consensus data. At the end, in order to evaluate the data, tools such as Geographic Information Systems were used (Adams et al., 2014; Brown et al., 2009; Blečić et al., 2014; Cerin et al., 2007; 2014; Giles-Corti et al., 2011; Hajna et al., 2013; Leslie et al., 2007; Soltani & Allan, 2006). On the one hand, this group of the studies did not consider the walking environment and the real conditions that the pedestrians went through. On the other hand, another group of studies addressed the walking environment and its quality. These studies addressed the micro-scale measures such as the sidewalk width, the street width, the quality of the sidewalk material, and urban furniture. In such studies, walkability measurement tools were applied to street segments to evaluate these measures (Brownson et al., 2004; Clifton et al., 2007; Day et al., 2006b; Emery et al., 2003; Millington et al., 2009). Moudon and Lee (2003) defined the walkability audit tools as "a tool used to inventory and assess physical environmental conditions associated with walking and bicycling" (Moudon & Lee, 2003). The walkability audit tool is, in fact, a method for evaluating streets based on measures of walkable environments. Moreover, micro-scale measures such as land use, road infrastructure conditions, security issues, lighting, beauty, and public transportation facilities are employed under categories such as street characteristics, street functionality, and aesthetics to create survey forms that can be rated by a few pedestrians. Ultimately, the sum of these scores shows the walkability of the street. It can also be used to give suggestions about the street and the quality of walking. Table 1 overviews the characteristics of the tools that are presented for urban design, transportation planning, and public health.

Audit tool	Presented by	Characteristics
WSAF: Walking Suitability Assessment Form	University of North Carolina, Chapel Hill	This tool focuses on the safety of the pedestrians. To this end, measures such as route characteristics, traffic control devices, and pedestrian facilities are considered. This tool does not take into account measures such as land use, aesthetics, etc. and ranks the street segments by the safety of the pedestrian.
WPS: Walkable Places Survey	Baltimore Metropolitan Council	This method was developed for encouraging neighborhood unit planning. No attempts were made in this method to define specific measures and employ them in ranking. This tool consists of 30 visual street features that are rated based on the Likert scale. Measurement characteristics were categorized based on parking space, buildings, intersections, facilities, and perception.
SLU: Analytic Audit Tool	Saint Louis University	This tool incorporates 150 measures such as land use, distance from destination, etc.
SPACES: Systematic Pedestrian and Cycling Environmental Scan	The University of Western Australia	The tool includes a subjective evaluation of attractiveness and hardness of physical activity in the walking environment.
I-M Inventory: Irvine-Minnesota Inventory	University of California Irvine and University of Minnesota	More than 200 measures are incorporated in this method for evaluation. Similar to the SLU, this tool incorporates many questions about details of the land use and such. However, there are no measures in this tool to evaluate sidewalk quality.

PBIC Checklist: Partnership for a Walkable America	-	This tool collects environmental information to be employed for evaluating the satisfaction of the residents by the walking environment and gathers details from every place but measures such as land use are not evaluated by this tool.
PEAT: Path Environment Audit Tool	Robert Wood Johnson Foundation	The PEAT is a computer-based tool that is used to evaluate the physical characteristics of paths and sidewalks by trained observers. Design, facilities, aesthetics, and maintenance are the evaluation measures assumed in this tool.
WABSA: Walking and Bicycling Suitability Assessment	University of North Carolina at Chapel Hill	WABSA is an evaluation tool for walkability and bike-ability in urban streets. The streets can have sidewalks or not. This tool is suitable for evaluation of green and pedestrian paths. In fact, less than 12 measures are examined in this checklist at the scale of a street segment.
SWAT: Scottish Walkability Assessment Tool	Scottish Physical Activity Research Collaboration (SPARColl)	The SWAT is used to evaluate the features of a physical environment in connection with walkability in Scotland. Features evaluated by this tool can be categorized into four general groups: functionality, safety, aesthetics, and destination.
Portland- PPI: Pedestrian Potential Index	Portland Office of Transportation	This tool evaluates the strength of the environmental factors associated with walking. This tool was developed for the city of Portland and is designed to audit road segments. Characteristics that are evaluated by this tool are categorized into three groups: political, proximity and the use.
AAT: Analytic t Audit Tool	-	The AAT is used to comprehend the relation between the built environment at the street-scale and physical activity. This tool, consisting of 24 questions, gathers information in five general categories: land use, transportation, aesthetics, and social environment.
Active Neighborhood Checklist:	Washington University	The Active Neighborhood Checklist tool is an observational tool that is designed to evaluate the characteristics of a neighborhood unit environment that are associated with physical activities at the street-scale. The tool consists of five parts: Land use, public transit stops, street characteristics, quality of the walking environment, and walking and bicycling places.
MAPS: Micro scale Audit of Pedestrian Streetscapes	University California San Diego	The MAPS is created based on previous tools. This tool consists of four general sections: The overall route, street segments (the area between two crossings), intersections, and cul-de-sacs.
PEDS: Pedestrian Environment Data Scan	University of Maryland, College Park	The environmental characteristics of a segment, such as information about the sidewalk quality, are gathered simultaneously with the large-scale characteristics such as the land use.
MIUDQ :Maryland Inventory of Urban Design Qualities	University of Maryland	According to the MIUDQ protocol, walkability can be measured reliably using 5 urban design perceptual qualities, namely imageability, enclosure, human scale, transparency and complexity/
Walk Score	-	This tool is available at www.walkscore.com. After specifying a location, this tool measures the distance between that location and facilities such as schools, shops, parks, etc. and rates it on a scale of 0-100 showing the walkability of a place.
POLS	Highway Capacity Manual (HCM)	This tool uses three measures for walkability evaluation on urban street facilities; including average pedestrian space, average pedestrian speed, and pedestrian LOS score which is based on the typical pedestrian's perception of the travel experience. There are two common approaches for evaluating the last measure of PLOS: The first can be defined as a capacity-based model, and the second is a roadway characteristic-based model. The HCM designates six level of service from A to F.

Tab.1: A summary of walkability audit tools

In addition to what is available in the literature on this subject, various environmental measures are investigated and categorized in the aforementioned tools. Therefore, considering the studied urban context, three categories of measures can be incorporated in this study. These categories are functionality, safety, and aesthetics. Each of these categories has sub-measures which can be used in order to audit walkability.

Street functionality can be investigated in three sections including, in order, land use, traffic, and permeability. These measures have to be evaluated on a larger scale compared to what considered by the current study; however, their importance at street-scale cannot be ignored. Although these items can be measured directly by other methods rather than in field evaluation, the rater perception of these measure plays an important role in this kind of estimations. Moreover, since the main objective of this research was to assess walkability in street scale and because in this scale none of the computer software could do such assessing in a proper manner due to their lack of considering real condition of pedestrian in environment, rater perception would find a higher importance. Land use refers to the distribution of activities, thus, it affects the traveling behavior by shortening destinations or decreasing the cost of reaching the destination (Handy et al., 2002). In this case, land-uses (residential, commercial, recreational and etc.), their distributions (accumulated in one point, accumulated in two points, accumulated in some points or distributed evenly) and combination of land-uses in each building (number of mixed use buildings) should be recorded by a rater for each segment. Traffic characteristics are the specifications of the street which include: Path specifications, the type and width of the street, traffic volume and speed, and the directness of the path in order to reach destinations (Pikora et al., 2003). Moreover, accessibility was evaluated based on street network connectivity and the manner of reaching destinations (block length, number of intersections, number of alternative routes to reach a destination, public transportation) (Schlossberg et al., 2006; Chin et al., 2008; Grasser et al., 2013). The safety of the pedestrian was always being one of the most important measures in the study of walkability. The safety is addressed both in the forms of personal safety against crimes and safety regarding traffic. Hence, in the current study, the researchers evaluated safety in both terms. According to the literature, the environmental variables which create crime-ridden areas can limit the social ties. Furthermore, the environmental variables can hinder the presence of people in the urban space include: demographic-gender variables, the social-economical state of the region, the lighting of the environment at night, the condition of the building parts, and their maintenance (Austin et al., 2002; Doyle et al., 2006; Foster & Giles-Corti, 2008a). At the street-scale, design characteristics that provide safety against traffic include the manner pedestrians travel along with the streets and intersections, the design of refuge islands, buffer space between pedestrians and vehicles, appropriate crosswalk width etc. (Clifton et al., 2007; Foster & Giles-Corti, 2008b). The aesthetics aspect is defined based on urban design qualities in connection with walkability. The quality of the public sphere is the most crucial measure to be considered when evaluating cities and urban areas. It is an inevitable fact that people judge their surroundings by what they see and experience (Tibbalds, 2003). The quality of a place specifies this experience. When a space has high quality, users have better understanding of that space and the surrounding spaces. The criteria which specify the quality of these spaces have been shifting during different times, including the last century. The qualities used in the current study were selected based on the book "Measuring Urban Design" authored by Ewing and Clemente (2013). The book identifies key perceptual qualities of the urban environment based on the classic urban design literature. Ewing and Clemente listed 51 perceptual qualities of the urban environment. Eight of the 51 qualities were selected for further study based on the importance they have been expressed in the literature, namely: Imageability, enclosure, human scale, transparency, complexity, coherence, legibility, and linkage. The first five qualities were measured and passed validity and reliability tests (Ewing & Clemente, 2013). In this study, it was attempted to evaluate the qualities in the urban environment of Iran considering the urban context. When considering the set of environmental characteristics associated with the walkable environment, and the information provided in Table 1, one can understand that none of the tools audit the built environment in detail. Each of the tools considers only a specific set of aspects in the environment.

Function	Land Use Mix	Land Use Diversity
		Land Use Distribution
		Combination of Land Use in Building Scale
	Traffic Role	Characteristics of Riding Path
		Volume, Speed & Type of Traffic
		Characteristics of Pedestrian Path
	Accessibility	Urban Blocks Design
		Streets Connectivity
		Accessibility of Destination
Safety	Safety from Crime	CPTED
		Social Characteristics
	Safety from Traffic	Intersection Characteristics
		Pedestrian Crossings along Streets
		Separation of Pedestrian from Traffic
Aesthetic	Imagability	Path Layout
		Characteristics of Street Walls
		Nodes Design
		Land Marks Quality in Paths
	Enclosure	Height-to-Width Ratios in Streets
		Specification of the Beginning and the End of Streets
		Attributes of Street Walls
	Human Scale	Building Heights in Street Walls
		Human Scale Moderator Elements
	Transparency	Predictability of Space
		Portions of Windows at Street Level
		Amount of Activity overflows into Street
	Complexity	Special Characteristics of Streets Design
		Amount of Activity in Street
		Combination of Land Use in Environment

Tab. 2 Components and indicators of walkable environment

Some emphasize on pedestrian safety, while others address, for example, the characteristics of the pedestrian network. Furthermore, the studies that addressed the validity of these environmental measures reported ambiguous results (Clifton et al., 2007). The subjective and objective characteristics in walkability audit are also problematic issues regarding these measures. Some researchers have attempted to investigate the perception of the pedestrian from the environment, thus incorporating subjective methods in their studies (Ariffin & Zahari, 2013; Park et al., 2014). Nevertheless, others incorporated objective and measurement methods in their study of the walking environment (Day et al., 2006b; Clifton et al., 2007). Given the categorization for environmental factors affecting walkability, all tools which were discussed in this regard are not without deficiencies. Tools such as I-M or SLU redundantly evaluate the environmental characteristics; moreover, they are associated with inefficient management. The PBIC checklist collects environmental information by evaluating the satisfaction of the residents from the walking environment to be incorporated in behavior models. This tool is not designed for collecting details about environmental characteristics. The WSAF only focuses on the pedestrian facilities such as road markings for the pedestrian, or path characteristics, not evaluating various measures nor providing a rating system for quick evaluation of pedestrian safety. It is worth mentioning that the PEDS has the following advantages compared to other tools: Efficient management, time efficiency, more efficient and brief sizes, economic approach, and robust training protocol. PEDS is defined based on measures that assume purely physical aspects and they do not consider the quality of the pedestrian paths. However, Ewing and Handy (2009) attempted to evaluate the walking environment based on urban design qualities. The tool they presented was very capable in the qualitative audit of the built environment in terms of the attractiveness of walking. However, it did not consider the safety and functional aspects of walkability; moreover, it was developed based on the American urban context. That all said, the aim of this study was to present a walkability audit tool which took both quantitative (path width, number of lanes, traffic speed and volume) and qualitative aspects (quality of walking in a space) of walkability into account. Considering what has been said about audit tools, none of them incorporate three general sections, which are functionality, beauty, and safety, (except for the SWAT which is developed based on European environment) or the number of the sub-measures they incorporate decreases their efficiency. This study emphasized on walkability; furthermore, it considered other aspects of the subject matter. To this end, two tools (PEDS and MIUDQ) were selected as the development basis for the tool. The walkability audit tool in this study was developed based on what was said about the audit tools. This tool incorporates three main components (namely functionality, safety, and aesthetics), and ten measures (land use, traffic role, permeability, personal safety, environmental safety, imageability, enclosure, human scale, transparency, and complexity). The items in this tool were created considering the introduced measures and the two mentioned tools. Finally, every measures had been contextualized based on Shiraz urban context as each city is unique in its own and for using this audit in other cities it should be revised. For measuring weight of each measures, 100 questioners were filled by urban science experts. the analysis of the responded questionnaires was done through using Structural equation modeling (SEM). The result of this study are presented in a research by Soltani et al. (2018).

Results of this study showed that safety feature had the highest impact in walkability of streets. The weights of each measures in that study have been used in calculating total walkability of segments for developing this audit tool.

3 THE CASE STUDY

For the purpose of doing this study, Eram neighborhood which is located in District 1 of Shiraz, Iran was selected to be studied. The region is 181 hectares and consists of 11 streets and 2101 building segments. According to the comprehensive urban plan of Shiraz (2016), Eram neighborhood houses a population of 14766. This region plays an important role in the traffic of the city. Two of the boulevards, called Jomhuri, and Daneshju, are recognized as the main arteries of the city. Given the fact that in the current study we considered only streets or what had a street-like nature, the main and side alleys were omitted from the walkability audi.

3.1 DATA COLLECTION AND ANALYSIS

Eleven streets exist in this region selected for the purpose of doing this study. Based on their characteristics, predominantly with respect to intersections, streets were divided into definite segments, resulting in 21 segments in total. Therefore, the data collection was carried out considering the aforementioned measures. The data collection included an evaluation form or the walkability audit tool which consisted of 63 items derived from 10 measures. The items of the questionnaire were either multiple choice or fill-in-the-blank questions for writing the number of elements or other information.

Most of the items were dedicated to the traffic characteristics of the street since the environmental items in connection with this section included details of the environmental measures. In order to guarantee the suitability of the items, four auditors from different fields of study were asked to fill the forms for the corresponding segments. Before performing the audit, the participants were trained about the concepts used in the evaluation form and how to answer its items. In this session, every section was explained in detail. Then after, a practice session was conducted to make sure the participants' answers are eligible. During this session, a few items were found not be useful since they seemed to ask for answers that are too much affected by the personal view of the participant. Hence, seven items were omitted from the audit after further examining the environmental characteristics and consulting urbanism experts. Ultimately, the audit was performed incorporating 56 items which were derived from the 10 main measures. To study the data collected by the auditors, all of the results from the four participants were analyzed using SPSS. Cronbach's alpha was found to be above 0.7 for all four auditors, suggesting the reliability of the collected data for further investigation.

	I-M	PBIC	WSAF	SLU	WPS	LOS	PPI	SWAT	PERS	SPACES	PEDS	PEAT	WABSA	AAT	MAPS	ANC	MIUDQ
Charactristics																	
Field Protocol	✓	×	✓	✓	×	✓	×	✓	×	✓	✓	✓	✓	×	✓	✓	✓
Be Tested	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Context oriented	✓	×	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	×	×	×	×	✓
Time Required per Seg	20	5-10	30	10	-	-	-	30	-	-	3-5	-	15	-	30	5-10	20
Measuring Aspect	1-2	1-2	1	1-2	1-2	1-2	1	1-2	1-2	1-2	1-2	1	1	1	1-2	1-2	2
Item Measured																	
Function																	
Land Use	✓	×	×	✓	×	×	✓	✓	×	✓	✓	×	×	✓	✓	✓	×
Traffic	✓	B	✓	B	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	×
Accessibility	✓	×	×	×	×	✓	✓	✓	✓	✓	✓	×	×	✓	×	×	×
Safety																	
From Crime	✓	✓	×	✓	×	✓	×	✓	✓	✓	×	×	×	✓	×	×	×
From Traffic	✓	✓	✓	✓	×	✓	×	✓	✓	✓	✓	✓	B	✓	✓	✓	×
Aestetic																	
Public art	✓	×	×	×	✓	✓	×	✓	×	×	×	B	×	×	✓	✓	✓
Building architecture	✓	×	×	×	×	×	×	✓	×	×	B	×	×	×	✓	×	✓
Street design	×	×	×	×	×	✓	×	✓	✓	✓	×	×	×	×	✓	×	✓
Landscape	✓		×	✓	✓	✓	×	✓	✓	✓	B	B	×	B	✓	✓	✓
Perceptual perception																	
Attractivity	×	×	×	×	✓	✓	×	×	×	×	×	×	×	B	×	×	×
Pleasurability	×	✓	×	×	✓	×	×	×	×	×	×	×	×	×	×	×	×
Comfort	×	×	×	×	×	×	×	×	×	×	×	×	×	B	×	×	×

Tab. 3 Audit comparisons (source: authors)

✓ :Consisting feature ،× :Do not consisting feature ،B: Considering some aspects of feature
1: Quantity aspects 2: Quality aspec

Auditor	Cronbach's alpha	Number of items	Number of segments
A	0.874	56	21
B	0.870	56	21
C	0.860	56	21
D	0.853	56	21

Tab. 4 Reliability of the collected data

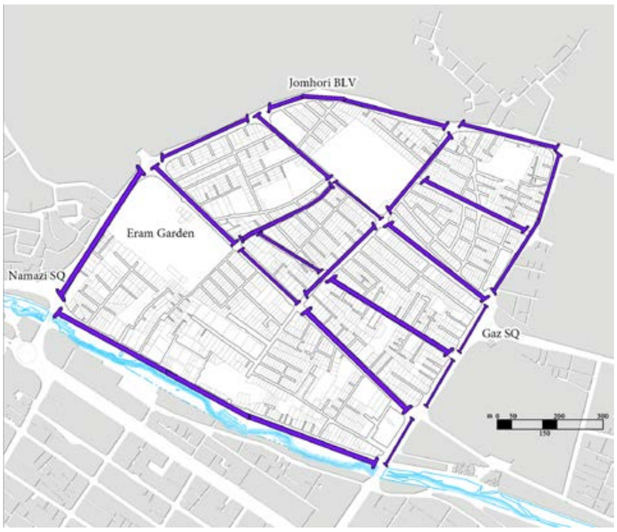

Fig. 1 Segments defined by the walkability audit tool

Feature	Indicator	Kappa Score	Percent of Agreement
Land Use Mix	Land Use Type	0.942	95.2
	Land Use Distribution	0.447	61.9
	Combination of Land Use in Building Scale	0.682	76.2
Traffic Role	Number of Travel Lane	1	100
	Traffic Direction	1	100
	Condition of Road	0.781	90.5
	Riding Speed	0.616	81
	Traffic Volume	0.798	90.5
	Parking Amenities	0.893	95.2
	Walkway type	1	100
	Pedestrian Path Width	0.696	85.7
	Pedestrian Path Condition	1	100
	Pedestrian Path Obstructions	0.741	81
	Maximum Path Slope	0.740	81
	Pedestrian Facility	0.834	90.5
	Climate Comfort of Path	0.840	90.5
Accessibility	Block Length	0.864	90.5
	Viewable Start and End node	0.445	71.4
	Number of Alternative routs	0.782	85.7
	Public Transport Condition	0.876	90.5
Safety from Crime	Presence of Different Social Classes in Space	0.794	85.7
	Presence of the Elderly and the Children	0.683	81
	Variety of activities	0.430	66.7
	Sense of Security	0.774	85.7
	Maintenance of Buildings	0.702	90.5
	Lighting	1	100
	Blind Spots	0.620	76.2
	Street Surveillance	0.398	61.9
Safety from Traffic	Safety of Intersections	0.847	90.5
	Pedestrian Crossings along Street	0.913	95.2
	Separation of Pedestrian from Traffic	0.775	90.5
Imageability	Historical buildings	1	95.2
	Building with Identifier	0.939	95.2
	Landmarks	0.920	95.2
	Public Open spaces	0.873	90.5
Enclosure	Height-to-Width Ratios	0.675	76.2
	Proportion of Sky	0.419	66.7
	Break in street Wall	0.781	85.7
	Non-directional Building	0.910	95.2
	Rows of trees	1	100
	Trees spacing	0.798	90.5
	Break in street wall height	0.603	71.4
Human Scale	Building Height	0.872	90.5
	Recessed buildings	0.806	85.7
	Portions of Windows at Street Level	0.672	76.2
	Street Furniture	0.831	90.5
Transparency	Portions of Windows at Street Level	0.735	81
	Active edge	0.765	81
	Amount of Activity overflows into Street	0.736	81
	Predictability of Space	0.826	90.5
Complexity	Activity types in Streets	0.555	66.7
	Diversity of Facade Materials	0.743	85.7
	Façade Details	0.272	71.4
	Public Art	0.753	90.5
	Number of people	**0.655**	**71.4**

Tab.5 Evaluation of the collected data

Items with K<04 showed little agreement between the data corresponding to them. Data analysis results pertaining to this tool are presented in Table 4. Given the fact that the Kappa statistics is the only suitable estimation for ranking variables, and a few questions, such as the number of lines, crosswalk width, building height, etc. were not of this type, percent agreement was also employed. Percent agreement yielded similar results. In this method of statistical analysis, 100 indicates perfect agreement while 0 indicates full disagreement.

As evident from Table 5, items are associated with a value smaller than 0.4. These cases are related to the distribution of land use, the possibility of seeing the start of the path, varied activities, the possibility for monitoring the street from within the segments, the visible portion of the sky and details of the street walls. Meanwhile, two items are related to the functionality of the street, while two pertain to safety, and two are related to aesthetics. The poor reliability of data collection can be attributed to the relative subjectivity of the answers to the items, and the influence of personal judgment on the answers. Considering this fact, the items are not sufficiently valid to be used in the walkability audit tool. After the required modifications were made to the walkability audit tool considering that it was to be used in the studied region, it consists of 50 questions. Finally, the data can be incorporated in location-based maps to present the audit.

Fig. 2 Walkability of streets based on the walkability audit tool results

4 DISCUSSION AND CONCLUSION

Due to the fact that a wide range of environmental measures can influence the walkability of the urban environment, it was attempted to work out this measure to be used in the walkability audit tool considering the Iranian urban context and previous studies. In addition to functional and physical measure, qualitative environmental measures are also considered in the presented tool that can comprehensively audit the built environment in terms of walkability by combining the qualitative and quantitative aspects. However, some measures that were mostly subjective were found to be inefficient as the audit tool was tried in an urban environment. Moreover, a few questions were omitted as they were not validated by the Kappa statistic. However, the majority of the questions were valid to be used in various environments. Although this tool consists of fewer questions compared to the tools such as the IMI, it is capable of comprehensive environmental audit in connection with regard to walkability. Tools such as the IMI that incorporate a large number of items might evaluate the environment not as good as they are expected to. Since the many questions can distract the auditor from the main goal by unreasonably engaging their mind. Unlike PEDS, PEAT, or WAPSA that only consider the quantities and the functionality of the environment, this tool also takes into account the qualitative aspects of the environment, measuring the qualities of the urban design. Nevertheless, unlike the MIUDQ that only focuses on the quality of the environment, this tool includes other environmental factors which are effective besides design quality. Furthermore, this tool is superior to similar tools given its great agreement percent in most measures. The aim of the present study was to evaluate the walking environment subjectively, as in other walkability audit tools. However, some questions such as the attractiveness or comfort-ability of the path were presented in the primary version of the audit. However, after initial steps, they were omitted due to the little agreement of the answers among auditors. Some other objective measures such as feeling safe, or the possibility of foreseeing beyond the spatial obstructions, were incorporated in the audit. They were not omitted because of their relative agreement. Overall, 53 questions of this tool are associated with sufficient agreement percent and reliability to be used in other Iranian urban environments. Even though all the mentioned measures influence the walkability of the urban environment, only the questions that have sufficient reliability can be used to audit the land use in such environments. This walkability audit tool can be used to evaluate the walking environment in field. The most important advantage of this method is to evaluate the actual situation of pedestrians in the built environment. Other measurement tools, such as those that measure the connectivity or number of destination with special software like GIS, evaluate the environment in large scale and they have a holistic approach in their assessment. Therefore, it is not possible to judge the degree of the walkability of the environment, properly. Moreover, the audit in this research had a very comprehensive approach as it considered the quality of streets along with other criteria and this made it very reliable in measuring walkability. Another advantage of this type of assessment is its easy and efficient management. In this method, it is easy to examine the walking environment by a rater and categorize the streets in terms of walkability without any complex calculations. The results of these tools can be incorporated in a location-based software such as GIS, by designating a code to each street segment that is combined with the statistical software input data. Finally, the software can rank the segments based on the items, measures, and in general, by walkability. This way, a comprehensive image is obtained from walkability in urban streets that can be presented to urban managers to help them make more efficient decisions about each street segment and contribute to the public health. In order to develop this method, it can be used in a mobile application so that data can be electronically entered and evaluated. Additionally, another part of this study can act as an objective assessment. Objective evaluation is an important part of the walkability and it is very important to consider it alongside subjective and specialized assessments.

REFERENCES

Adams, M. A., Frank, L. D., Schipperijn, J., Smith, G., Chapman, J., Christiansen, L. B., … Sallis, J. F. (2014). International variation in neighborhood walkability, transit, and recreation environments using geographic information systems: the IPEN adult study. International Journal of Health Geographics, 13(1), 43. doi:https://doi.org/10.1186/1476-072X-13-43

Ariffin, R. N. R., & Zahari, R. K. (2013). Perceptions of the Urban Walking Environments. Procedia - *Social and Behavioral Sciences,* 105, 589–597. doi:https://doi.org/10.1016/j.sbspro.2013.11.062

Austin, D. M., Furr, L. A., & Spine, M. (2002). The effects of neighborhood conditions on perceptions of safety. *Journal of Criminal Justice*, 30(5), 417–427. doi:https://doi.org/10.1016/S0047-2352(02)00148-4

Blečić, I., Cecchini, A., Congiu, T., Fancello, G., & Trunfio, G. A. (2014). Walkability Explorer. An Evaluation and Design Support Tool for Walkability. *Tema. Journal of Land Use, Mobility and Environment.* https://doi.org/10.6092/1970-9870/2535

Brown, B. B., Werner, C. M., Amburgey, J. W., & Szalay, C. (2007). Walkable Route Perceptions and Physical Features: Converging Evidence for En Route Walking Experiences. *Environment and Behavior*, 39(1), 34–61. doi:https://doi.org/10.1177/0013916506295569

Brown, B. B., Yamada, I., Smith, K. R., Zick, C. D., Kowaleski-Jones, L., & Fan, J. X. (2009). Mixed land use and walkability: Variations in land use measures and relationships with BMI, overweight, and obesity. *Health & Place*, 15(4), 1130–1141. doi:https://doi.org/10.1016/j.healthplace.2009.06.008

Brownson, R. C., Hoehner, C. M., Brennan, L. K., Cook, R. A., Elliott, M. B., & McMullen, K. M. (2004). Reliability of 2 Instruments for Auditing the Environment for Physical Activity. *Journal of Physical Activity and Health*, 1, 191–208. doi:https://doi.org/10.1123/jpah.1.3.191

Brownson, R. C., Hoehner, C. M., Day, K., Forsyth, A., & Sallis, J. F. (2009). Measuring the Built Environment for Physical Activity. American Journal of Preventive Medicine, 36(4), S99–S123.e12. https://doi.org/10.1016/j.amepre.2009.01.005

Carlson, J. A., Sallis, J. F., Conway, T. L., Saelens, B. E., Frank, L. D., Kerr, J., ... King, A. C. (2012). Interactions between psychosocial and built environment factors in explaining older adults' physical activity. *Preventive Medicine*, 54(1), 68–73. doi:https://doi.org/10.1016/j.ypmed.2011.10.004

Cerin, E., Leslie, E., Owen, N., & Bauman, A. (2007). Applying GIS in Physical Activity Research: Community ?Walkability? and Walking Behaviors. In P. C. Lai & A. S. H. Mak (Eds.), GIS for Health and the Environment (pp. 72–89). Berlin, Heidelberg: *Springer Berlin Heidelberg*. doi:https://doi.org/10.1007/978-3-540-71318-0_6

Chin, G. K. W., Van Niel, K. P., Giles-Corti, B., & Knuiman, M. (2008). Accessibility and connectivity in physical activity studies: The impact of missing pedestrian data. *Preventive Medicine*, 46(1), 41–45. doi:https://doi.org/10.1016/j.ypmed.2007.08.004

Clifton, K. J., Livi Smith, A. D., & Rodriguez, D. (2007). The development and testing of an audit for the pedestrian environment. *Landscape and Urban Planning*, 80(1–2), 95–110. doi:https://doi.org/10.1016/j.landurbplan.2006.06.008

Day, K., Boarnet, M., Alfonzo, M., & Forsyth, A. (2006a). The Irvine–Minnesota Inventory to Measure Built Environments. American Journal of Preventive Medicine, 30(2), 144–152. doi:https://doi.org/10.1016/j.amepre.2005.09.017

Day, K., Boarnet, M., Alfonzo, M., & Forsyth, A. (2006b). The Irvine–Minnesota Inventory to Measure Built Environments. *American Journal of Preventive Medicine*, 30(2), 144–152. doi:https://doi.org/10.1016/j.amepre.2005.09.017

Doyle, S., Kelly-Schwartz, A., Schlossberg, M., & Stockard, J. (2006). Active Community Environments and Health: The Relationship of Walkable and Safe Communities to Individual Health. Journal of the American Planning Association, 72(1), 19–31. doi:https://doi.org/10.1080/01944360608976721

Durand, C. P., Andalib, M., Dunton, G. F., Wolch, J., & Pentz, M. A. (2011). A systematic review of built environment factors related to physical activity and obesity risk: implications for smart growth urban planning: Smart growth urban planning and obesity risk. *Obesity Reviews*, 12(5), e173–e182. doi:https://doi.org/10.1111/j.1467-789X.2010.00826.x

Emery, J., Crump, C., & Bors, P. (2003). Reliability and Validity of Two Instruments Designed to Assess the Walking and Bicycling Suitability of Sidewalks and Roads. American Journal of Health Promotion, 18(1), 38–46. doi:https://doi.org/10.4278/0890-1171-18.1.38

Ewing, R., & Cervero, R. (2010). Travel and the Built Environment: A Meta-Analysis. Journal of the American Planning Association, 76(3), 265–294. doi:https://doi.org/10.1080/01944361003766766

Ewing, R. H., & Clemente, O. (2013). Measuring urban design: metrics for livable places. Washington, D.C: Island Press.

Ewing, R., & Handy, S. (2009). Measuring the Unmeasurable: Urban Design Qualities Related to Walkability. Journal of Urban Design, 14(1), 65–84. doi:https://doi.org/10.1080/13574800802451155

Forsyth, A., & Southworth, M. (2008). Cities Afoot—Pedestrians, Walkability and Urban Design. Journal of Urban Design, 13(1), 1–3. doi:https://doi.org/10.1080/13574800701816896

Foster, S., & Giles-Corti, B. (2008a). The built environment, neighborhood crime and constrained physical activity: An exploration of inconsistent findings. Preventive Medicine, 47(3), 241–251. https://doi.org/10.1016/j.ypmed.2008.03.017

Foster, S., & Giles-Corti, B. (2008b). The built environment, neighborhood crime and constrained physical activity: An exploration of inconsistent findings. Preventive Medicine, 47(3), 241–251. https://doi.org/10.1016/j.ypmed.2008.03.017

Frank, L. D. (2005). Multiple Impacts of the Built Environment on Public Health: Walkable Places and the Exposure to Air Pollution. International Regional Science Review, 28(2), 193–216. doi:https://doi.org/10.1177/0160017604273853

Frank, Lawrence D., Sallis, J. F., Conway, T. L., Chapman, J. E., Saelens, B. E., & Bachman, W. (2006). Many Pathways from Land Use to Health: Associations between Neighborhood Walkability and Active Transportation, Body Mass Index, and Air Quality. Journal of the American Planning Association, 72(1), 75–87. doi:https://doi.org/10.1080/01944360608976725

Gehl, J. (2011). Life between buildings: using public space. Washington, DC: Island Press. Available at: http://public.eblib.com/choice/publicfullrecord.aspx?p=3317590

Giles-Corti, B., Wood, G., Pikora, T., Learnihan, V., Bulsara, M., Van Niel, K., ... Villanueva, K. (2011). School site and the potential to walk to school: The impact of street connectivity and traffic exposure in school neighborhoods. Health & Place, 17(2), 545–550. doi:https://doi.org/10.1016/j.healthplace.2010.12.011

Glazier, R. H., Creatore, M. I., Weyman, J. T., Fazli, G., Matheson, F. I., Gozdyra, P., ... Booth, G. L. (2014). Density, Destinations or Both? A Comparison of Measures of Walkability in Relation to Transportation Behaviors, Obesity and Diabetes in Toronto, Canada. PLoS ONE, 9(1), e85295. doi:https://doi.org/10.1371/journal.pone.0085295

Grasser, G., Van Dyck, D., Titze, S., & Stronegger, W. (2013). Objectively measured walkability and active transport and weight-related outcomes in adults: a systematic review. International Journal of Public Health, 58(4), 615–625. https://doi.org/10.1007/s00038-012-0435-0

Hajna, S., Dasgupta, K., Halparin, M., & Ross, N. A. (2013). Neighborhood Walkability. American Journal of Preventive Medicine, 44(6), e55–e59. doi:https://doi.org/10.1016/j.amepre.2013.01.033

Handy, S. L., Boarnet, M. G., Ewing, R., & Killingsworth, R. E. (2002). How the built environment affects physical activity. American Journal of Preventive Medicine, 23(2), 64–73. doi: https://doi.org/10.1016/S0749-3797(02)00475-0

King, K. E., & Clarke, P. J. (2015). A Disadvantaged Advantage in Walkability: Findings From Socioeconomic and Geographical Analysis of National Built Environment Data in the United States. American Journal of Epidemiology, 181(1), 17–25. https://doi.org/10.1093/aje/kwu310

Lee, C., & Moudon, A. V. (2006). Correlates of Walking for Transportation or Recreation Purposes. Journal of Physical Activity and Health, 3(s1), S77–S98. doi:https://doi.org/10.1123/jpah.3.s1.s77

Lee, I.-M., & Buchner, D. M. (2008). The Importance of Walking to Public Health: Medicine & Science in Sports & Exercise, 40(Supplement), S512–S518. doi:https://doi.org/10.1249/MSS.0b013e31817c65d0

Leslie, E., Coffee, N., Frank, L., Owen, N., Bauman, A., & Hugo, G. (2007). Walkability of local communities: Using geographic information systems to objectively assess relevant environmental attributes. Health & Place, 13(1), 111–122. doi:https://doi.org/10.1016/j.healthplace.2005.11.001

Leyden, K. M. (2003). Social Capital and the Built Environment: The Importance of Walkable Neighborhoods. American Journal of Public Health, 93(9), 1546–1551. doi:https://doi.org/10.2105/AJPH.93.9.1546

Litman, T. (2003). Economic Value of Walkability. Transportation Research Record: Journal of the Transportation Research Board, 1828, 3–11. doi:https://doi.org/10.3141/1828-01

Millington, C., Ward Thompson, C., Rowe, D., Aspinall, P., Fitzsimons, C., Nelson, N., & Mutrie, N. (2009). Development of the Scottish Walkability Assessment Tool (SWAT). Health & Place, 15(2), 474–481. doi:https://doi.org/10.1016/j.healthplace.2008.09.007

Moudon, A. V., & Lee, C. (2003). Walking and Bicycling: An Evaluation of Environmental Audit Instruments. American Journal of Health Promotion, 18(1), 21–37. doi:https://doi.org/10.4278/0890-1171-18.1.21

Panter, J. R., Jones, A. P., Van Sluijs, E. M. F., Griffin, S. J., & Wareham, N. J. (2011). Environmental and Psychological Correlates of Older Adult's Active Commuting: Medicine & Science in Sports & Exercise, 43(7), 1235–1243. doi:https://doi.org/10.1249/MSS.0b013e3182078532

Park, S., Deakin, E., & Lee, J. (2014). Perception-Based Walkability Index to Test Impact of Microlevel Walkability on Sustainable Mode Choice Decisions. Transportation Research Record: Journal of the Transportation Research Board, 2464, 126–134. doi:https://doi.org/10.3141/2464-1

Pikora, T. J., Bull, F. C. ., Jamrozik, K., Knuiman, M., Giles-Corti, B., & Donovan, R. J. (2002). Developing a reliable audit instrument to measure the physical environment for physical activity. American Journal of Preventive Medicine, 23(3), 187–194. doi:https://doi.org/10.1016/S0749-3797(02)00498-1

Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003a). Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. Annals of Behavioral Medicine, 25(2), 80–91. doi:https://doi.org/10.1207/S15324796ABM2502_03

Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003b). Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. Annals of Behavioral Medicine, 25(2), 80–91. doi:https://doi.org/10.1207/S15324796ABM2502_03

Sallis, J. F., Saelens, B. E., Frank, L. D., Conway, T. L., Slymen, D. J., Cain, K. L., ... Kerr, J. (2009). Neighborhood built environment and income: Examining multiple health outcomes. Social Science & Medicine, 68(7), 1285–1293. doi:https://doi.org/10.1016/j.socscimed.2009.01.017

Schlossberg, M., Greene, J., Phillips, P. P., Johnson, B., & Parker, B. (2006). School Trips: Effects of Urban Form and Distance on Travel Mode. Journal of the American Planning Association, 72(3), 337–346. doi:https://doi.org/10.1080/01944360608976755

Shbeeb, L., & Awad, W. (2013). Walkability of School Surroundings and its Impact on Pedestrian Behaviour. *Tema. Journal of Land Use, Mobility and Environment*. doi:https://doi.org/10.6092/1970-9870/1608

Soltani, A., & Allan, A. (2006). Analyzing the Impacts of Microscale Urban Attributes on Travel: Evidence from Suburban Adelaide, Australia. Journal of Urban Planning and Development, 132(3), 132–137. doi:https://doi.org/10.1061/(ASCE)0733-9488(2006)132:3(132)

Soltani, A., & Hoseini, S. H. (2014). An analysis of the connection between built environment, physical activity and health: comparing three urban neighbourhoods from Shiraz, Iran. *International Journal of Urban Sciences*, 18(1), 19–30. doi:https://doi.org/10.1080/12265934.2013.874546

Southworth, M. (2005). Designing the Walkable City. Journal of Urban Planning and Development, 131, 246–257. doi:https://doi.org/10.1061/(ASCE)0733-9488(2005)131:4(246)

Talen, E., & Koschinsky, J. (2013). The Walkable Neighborhood: A Literature Review. *International Journal of Sustainable Land Use and Urban Planning*, 1(1). doi:https://doi.org/10.24102/ijslup.v1i1.211

Tibbalds, F. (2003). Making people-friendly towns improving the public environment in towns and cities. Taylor & Francis.

Witten, K., Blakely, T., Bagheri, N., Badland, H., Ivory, V., Pearce, J., ... Schofield, G. (2012). Neighborhood Built Environment and Transport and Leisure Physical Activity: Findings Using Objective Exposure and Outcome Measures in New Zealand. Environmental Health Perspectives, 120(7), 971–977. doi:https://doi.org/10.1289/ehp.1104584

IMAGE SOURCES

Fig. 1 – Fig. 2: Authors.

AUTHOR'S PROFILE

Ali Soltani is professor of Urban Design/ Planning Faculty of Art and Architecture, University of Shiraz, Shiraz, IRA

Mohammad Hosseinpour is Assistant Professor of Urban Design/ Planning Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN

Mahsa Sholeh is assistant Professor of Urban Design/ Planning Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN

Parisa Zare is M.A. Student of Urban Design, Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN