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Soundscape Evaluation of Mashhad Melat Park Sidewalk (Case Study: Emamat Boulevard)

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ABSTRACT: As cities become more and more crowded, urban environmental noise increases. This paper discusses the practical recognition of the Mashhad MELAT Park sidewalk's soundscape. The purpose of this study is to answer the question of the Mashhad MELAT Park sidewalk's soundscape in people's minds. On-site sound recordings have been collected from the 1st of November, December, and January of 2022 in consecutive places on Mashhad MELAT Park sidewalk and EMAMAT Boulevard. Sound and soundscape are sense stimulants that impact on quality of urban spaces. Sound, as one of the inseparable parts of the urban atmosphere, influences individual behavior, choosing the urban space, staying or passing by, perception of people from urban space, and overlay it influences the quality of urban spaces. Nowadays, variety and increasing sound sources from traffic, human activities, and disturbing sounds have created unpleasant soundscapes, leading to unclear sonic perception in citizens. The research is applicatory and descriptive-analytical. Data collection tools were done through sound walking (recordings for sound walking were up to 5 meters in dB by Calibrator St-8851 sound meter device for numerical analysis), photography, and questionnaires based on people's mental perception. The data analysis method was performed through SPSS Analysis, sound maps, and GIS maps for qualitative analysis. Surveys showed a lack of invigorating sound resources on this sidewalk, expressing the dominance of vehicle traffic horns over natural and people sounds. Concentrating on soundscape in urban spaces leads to achieving sustainable urban spaces.

Keywords: *Soundscape, Sound map, sound walking in silence, Mashhad MELAT Park sidewalk.*

INTRODUCTION

The street is a good place for people to walk and do their activities. Without activity, there is no sound. As the activities change, so does the acoustic landscape of the spaces. Research has shown that people prefer to sit where they hear natural sounds, such as birds and water fountain sounds, instead of cars and motorcycles horn. One of the few studies that have had both quantitative and qualitative evaluation of soundscape can be considered is the study of (Asdrubali et al., 2012), "Urban public open space redevelopment using the soundscape approach: a case study of Città di Castello, Italy." Which has paid attention to the physical characteristics of spaces, including the shape and manner of mass placement in the space or the type and variety of uses in the area, in this case, what effect it has on people's perception of a soundscape (Ghalenoei & Mohsen Haghighi, 2017). Water fountain sounds, birds sound, people's public conversation sounds, and children playing sounds were the identifying factors that made this sidewalk lively, but with the advent of vehicles, these features faded; this sidewalk does not have the desirable sound perspective and has affected its importance in people's satisfaction in this urban space (Shahabiyan & Larimian, 2017). During this research, to recount the importance of soundscape and its basic role in people's mental perception, the qualitative properties of sound have been identified. To introduce the soundscape survey tool, a questionnaire tool has been used to measure the soundscape of the MELAT Park sidewalk through sound walking and using sound map, representing the current situation of the MELAT Park sidewalk soundscape. Finally, according to the results obtained from the three methods, strategies have been developed to enhance the soundscape of this axis. In our country, no practical action has been taken to assess soundscape quality. The main aim of this paper is: Soundscape evaluation with a qualitative-quantitative approach, determining the sound map (noise level) in urban spaces, determining the degree of pleasantness and mental perception of people; in other

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words, perception of peoples' mental sound image from spaces (Ghalenoei & Mohsen Haghighi, 2017). Table 1 examines the paper's research question, the main target, and the hypothesis. This reveals the importance of considering soundscapes in urban spaces.

Literature Review

To conduct this research, the concept of sound, soundscape, and related concepts have been identified.

Concept of Sound

Sound is one of the non-physical factors that form the landscape of urban environments, which despite its very important role in the quality of the urban environment, sometimes appears in the form of bird song, leaf movement, river flow, etc., and provides sensory richness or sometimes in the form of passing traffic sound, riding, etc., it causes harassment of people. It even eliminates the opportunity for attendance of people in the environment (Sarlak Chivaei et al., 2016). Sound brings a sense of dynamism and helps to know the progress of time and dimensions of space and create a three-dimensional experience of place (Shahabiyan & Larimian, 2017). According to Figure 1, the question is, "Can sound be defined as a factor in the social reproduction of space"? (Karahan, 2020).

Concept of Soundscape

The soundscape is influenced by both acoustic and contextual factors (Oberman et al., 2021). The soundscape is the acoustic representation of place, giving people a sense of place and sound quality of place shaped by activities and treatment of people (Lotfi & Zamani, 2017). The soundscape is as good as any other phenomenon (Sarlak Chivaei et al., 2016). The soundscape is the sounds that are produced in an area (Ghalenoei & Mohsen Haghighi, 2017). The difference is that the soundscape includes all sources of sound, including wanted sounds (they are desirable to people) and unwanted sounds (people do not want to hear them) (Shahabiyan & Larimian, 2017). Soundscape refers to the acoustics of an environment, such as a residential area or park. It is perceived and understood by the public. Table 2 identifies the concepts of the city's soundscape from the perspective of various experts.

The main concern of the soundscape approach is the desirable sounds that people tend to hear. Also, the soundscape is one of the significant criteria for identifying and improving the quality of sense of place in urban space. The main focus of the soundscape is to create a mental image of the environment, including culture and personal experiences because different places have different soundscapes (Shobeyri Nezhad et al., 2010).

Table 1: Research question, target, and hypothesis

Question	Target	Hypothesis
What is the Mashhad MELAT Park sidewalk's soundscape from people's point of view?	In perception and perspective of On the sidewalk, users have an effective role in determining the soundscape of this area.	It seems that by evaluating the soundscape on Mashhad MELAT Park sidewalk, it is possible to achieve how people perceive this area.

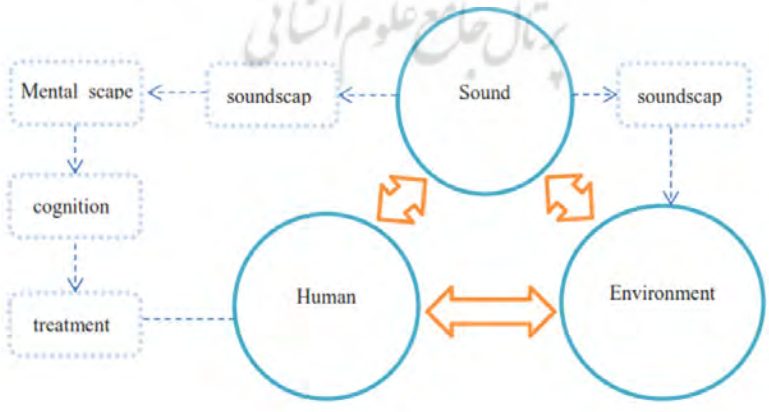

Fig. 1: Relationship between sound, human, and environment

Table 2: Soundscape of the city from the perspective of experts

Soundscape	(Krause, 2012)	Types of soundscapes classification: 1. Biophony: The sound of living things like birds and animals. 2. Geophony: Sounds from the earth and nature. 3. Anthrophony: Man-made artificial sounds like the sound of machines and sirens.
	(Cowan & Steward, 2007)	- Different meanings and values of sounds between different cultures and people. - Soundscape is the distinguishing factor of urban areas and ethnicity, gender, and social behaviors.
	(Roadway, 1994)	Sound is not just a feeling, it is information, and we do not just hear but actively listen.
	(Adams et al., 2008) (Corbin, 1988)	Types of sounds in the soundscape classification: 1. Background sounds: Sound of major space functions like talking and car horns 2. Foreground sounds: Sudden sound of siren or call to prayer.
	(Howard et al., 2013)	Sounds, signals, and signs of the place reflect a community's identity.

Concept of Soundscape Perception

There is a bilinear relationship between urban environment characteristics and human perception, cognition, evaluation, and behavior in the perceiving environment process. The soundscape is the product of human-environment interaction in outdoor spaces and a manifestation of the reality of human living space that the user perceives (Lotfi & Zamani, 2017). Ultimately, the perception of the soundscape is personal and influenced by people that are formed individually by their experiences and desires through listening. To better understand the soundscape and its impact on citizens' feelings, perceptions, and behavior, it is first necessary to determine the difference between visual and auditory perceptions. Although light and sound are wave phenomena, visual perception differs from auditory perception. Sound is everywhere. Unlike the segmented visual space, the auditory space is out of place, flowing everywhere and surrounding everywhere. The auditory space has no definite boundaries and tends to the space itself rather than its components. Auditory synchronization is temporal, while visual synchronization is spatial. Therefore, sensory hearing is indescribable and passive. Sound induces a sense of dynamism and helps man to understand the sequence of time and scale of space. Therefore, auditory perception is generally poor information and emotionally rich compared to vision (Sarlak Chivaei et al., 2016).

Concept of People's Mental Image of Soundscape

Studies show that three factors affect people's mental image from the city's soundscape: information contained in a voice, the context in which sound and sound level are perceived, and noise level. The acoustic environment is a resource that focuses on people's mental perception of sounds following the soundscape approach (Mancini et al., 2021). Of course, it should be considered that in this environment, the change of soundscape with the change of different seasons, days, and times should always be considered (Sarlak Chivaei et al., 2016).

MATERIALS AND METHOD

The research method in this paper is a quantitative-qualitative complementary approach that has been used to evaluate the acoustic soundscape of the Mashhad MELAT Park sidewalk. Library data collection and photography methods, questionnaires, and open-ended questions have been used about the quality of the environment, sound walking, and GIS maps (Lotfi & Zamani, 2017). In this section, the mental and visual perception of individuals was used by questionnaire, SPSS software analysis, and also the device Calibrator St-8851 sound meter (In dB) to collect sound information. Then, using GIS maps according to the sound files and sound points, sound maps were prepared for the sidewalk.

Methods of Discussion the Soundscape

Different Quantitative and Qualitative Methods have been Used

Sound Walk in Silence

A sound walk is a tool for collecting data on the acoustic environments of cities Includes data collection on people's mental perception that can be used to make sound maps (Oberman et al., 2021). Sound walking (active listening while walking) is a way to recognize the soundscape quality of places. And it shows that there are several sources of sound in space; a walk around an urban area makes the senses go to sounds heard

rather than ordinary scenery that is observed (Karahan, 2020). Sound walking methods include: sound walking in silence, focusing on what is heard, stopping at a few pre-identified places, listening for a minute in silence, and sound walking in silence in consecutive places (Shahabiyan & Larimian, 2017). The sampling strategy aims to obtain data from a typical user's perspective on a wide range of individual experiences in urban open spaces (Mitchel et al., 2021).

Sound Maps (Noise Map)

Environmental noise management is an important aspect of the EU's environmental policy (Moravec et al., 2021). A sound map represents the distribution of noise levels in a specific area, such as street noise and car traffic, defined for a period. After measuring noise levels and performing calculations with the GIS tool, the main indicator of a sound map is its spatial integration (Shahabiyan & Larimian, 2017).

Using the Questionnaire Technique

A combined questionnaire (including 40 standard questions in addition to 13 open questions, 5 Likert scale questions, nine spatial analysis questions, six multiple questions, and seven yes/no questions) has been used for qualitative assessment. Criteria obtained from the questionnaire results included: Sound potentials in space, keynotes, sound marks, and sound signals; for each criterion, some indicators, according to table 3 evaluated. Some frequently asked questions about achieving people's mental perception from the sound perspective of spaces have been compiled according to the standards of "Soundscape of European Cities and soundscapes" Cost TUD Action TD0804 (Kang et al., 2013) as shown in Table 3 (Ghalenoei & Mohsen Haghighi, 2017).

In Table 4 and Figure 2, the theoretical framework of the paper showed the process of Introduction and Methods.

RESULTS AND DISCUSSION

Acoustic Landscape Survey on Mashhad MELAT Park Sidewalk

Considering the current condition of the Mashhad MELAT Park sidewalk, water fountains sound, children playing sound

Table 3: Soundscape evaluating criteria obtained from the questionnaire results

Criterion	Indicator
Sound potentials in space	Birds sound, water fountain sound, children playing and activities sound, motorcycles and cars sound, mobile ringtones and music with mobile phones sound.
Keynotes	The traffic of vehicles and motor vehicles sound
Sound marks	Men talking in social hangouts as sound signs of sidewalk
Sound signals	Call to prayer in religious times sounds

Table 4: Theoretical framework of the article

All places sound, emphasizing the relationship between the individual or society perception and include all sound sources as many sounds as unwanted sounds.	
Sound is an integral part of the environment and should be considered at the same level of importance as visual aesthetics in the city.	
Questionnaire Semi-structured interview Recognition with sound walking	Based on people's perceptions and their mental perspective
Sound mapping by sound meter device	Measurements by a calibrated sound meter

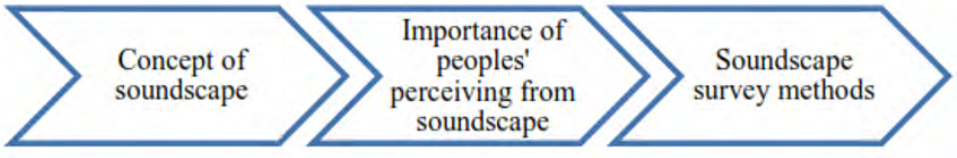

Fig. 2: Theoretical framework

Fig. 3: Case study area of Mashhad MELAT Park

and people talking sound, and birds sound are the identifying factors in this sidewalk that used to make this sidewalk lively. Still, with the passage of time and the arrival of vehicles, these characteristics faded. Now this sidewalk does not have the desired soundscape. In Figure 3, the study area is considered one of the noisiest places in Mashhad according to the latest studies in the three periods of November, December, and January 2021-2022 by the researchers. Its soundscape status is recounted using the methods mentioned.

Sound Walk on Mashhad MELAT Park Sidewalk

First, it should be noted that the key sound of the study area is the sound of riding and traffic. The range of sound sources in the study area is given in Table 5 when you walk in silence and focus on what is being heard.

Concerning artificial sounds in a sound walking period location of each sound in the study area is shown in Figure 4. Due to the high traffic of cars and motorcycles related to recreational and commercial use of 2nd-grade arterial streets, cars and motorcycles make noise from 80 to 90 dB, the most annoying among street sound sources, which is one of the other dominant sounds in the study area.

Regarding Table 6, people and natural sounds, walking and users running sounds in the Mashhad MELAT Park sidewalk, the public conversation of older men sounds in their hangouts and social camps in this area as a special background sound

Table 5: Classification of auditory potentials in the study area of Mashhad MELAT Park sidewalk

Sound sources of Mashhad MELAT Park sidewalk	
Natural sounds	Water sound, birds sound, wind sound, and The rustling of leaves in autumn.
People sound	People talking and walking sound, children playing sound, call to prayer sound and public conversation sound.
Artificial sounds	Traffic and the horn of cars, movement, and the horn of motorcycles, buses, taxis, police sirens, and advertisements of commercial units sound.

Fig. 4: Access to the Mashhad MELAT Park sidewalk and sound sources on EMAMAT Boulevard

Table 6: Images of natural, artificial, and people sound source

Artificial Sound Source	People Sound Source	Natural Sound Source
		
		

dominates other sounds of this sidewalk.

In many parts of this sidewalk, you can hear the voices of people talking while moving, and the voice of students and the call to prayer in religious times sometimes prevail in sound scenes. Birds and water sounds are natural sounds sometimes heard on the EMAMAT Boulevard axis. In Figure 5, Gis maps showed the sound sources of the area.

Using Sound Map Technique on Mashhad MELAT Park Sidewalk

According to Figure 6, using a sound meter device to achieve decibels of sounds on Mashhad MELAT Park sidewalk and EMAMAT Boulevard was used to prepare sound maps. The length of this sidewalk is about 800 meters; Points at distances of about 5 meters were considered, and only in 18 stations, where the intensity of difference in sound size was analyzed on the map. In general, it is on the verge of a crisis due to this sidewalk's average high noise level (in many cases above 80 decibels), and there is an urgent need to improve it.

At first, the recorded sound decibels while walking on Mashhad MELAT Park sidewalk and EMAMAT Boulevard are given in colored zones at intervals of 5 meters, shown on map Figure 7.

- The highest volume is recorded at the beginning of EMAMAT Boulevard and the end of this sidewalk on MOALEM Boulevard. The distance decreases by getting away from the intersections.
- With the passage of motorcycles and car horns in traffics sound level suddenly rises to 80 to 93 decibels.
- Due to traffic lights at the intersection of the two-way EMAMAT and MOALEM Boulevard, the volume increases as the light turns green, and the range becomes quieter when the light is red.
- On holidays, due to the close time of commercial uses in the middle of the day, traffic is less, and consequently, the study area is calmer.
- Lack of live music, suitable space, and water sound is one of the area's weaknesses.
- Traffic of motorcycles, taxis, and cars, and parking along the sidewalk on weekdays and holidays are the main sources of noise pollution.

Using Questionnaire Technique on Mashhad MELAT Park

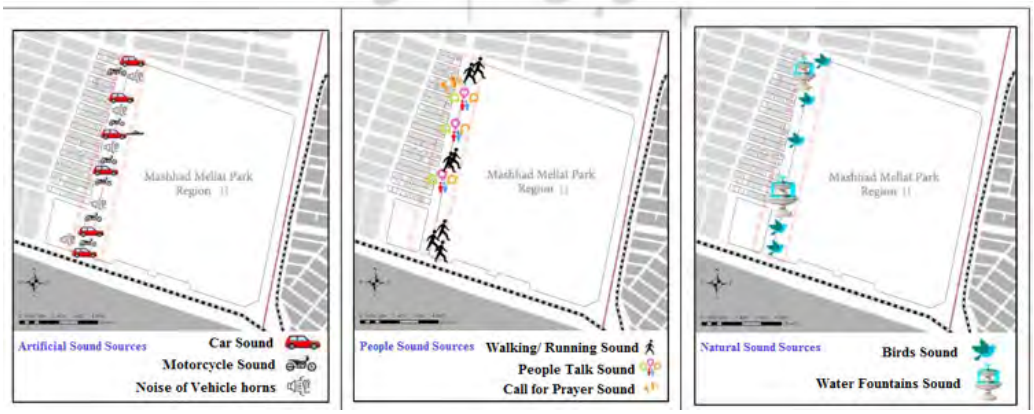

Fig. 5: Sound sources Mashhad MELAT Park sidewalk and EMAMAT Street

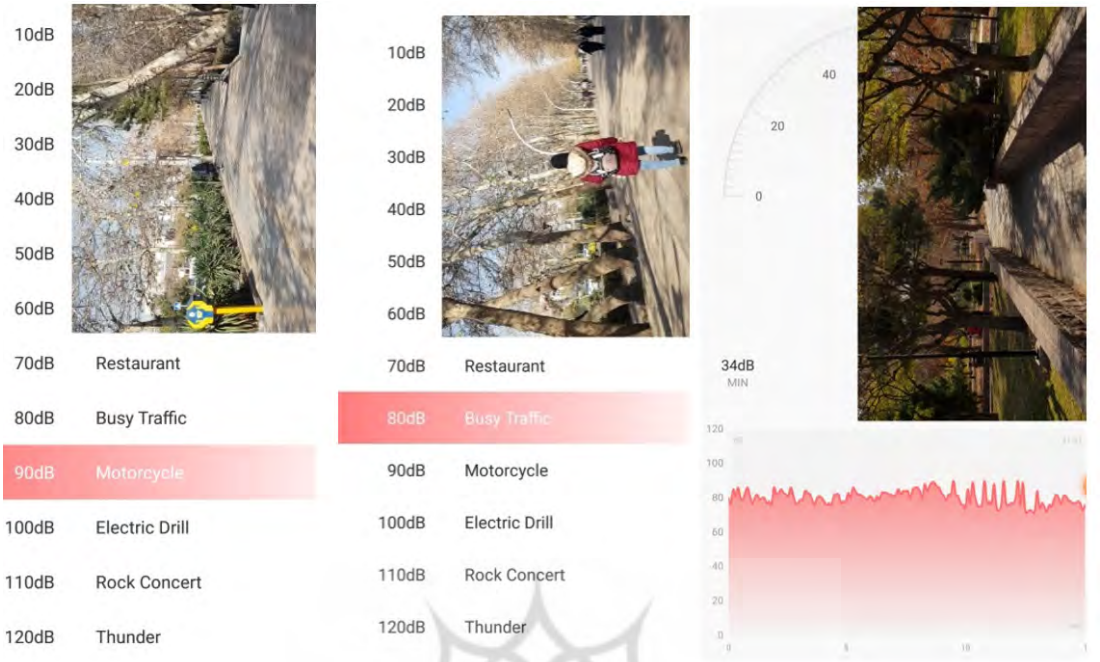

Fig. 6: Sound meter device to measure decibels of sound sources of Mashhad MELAT Park sidewalk

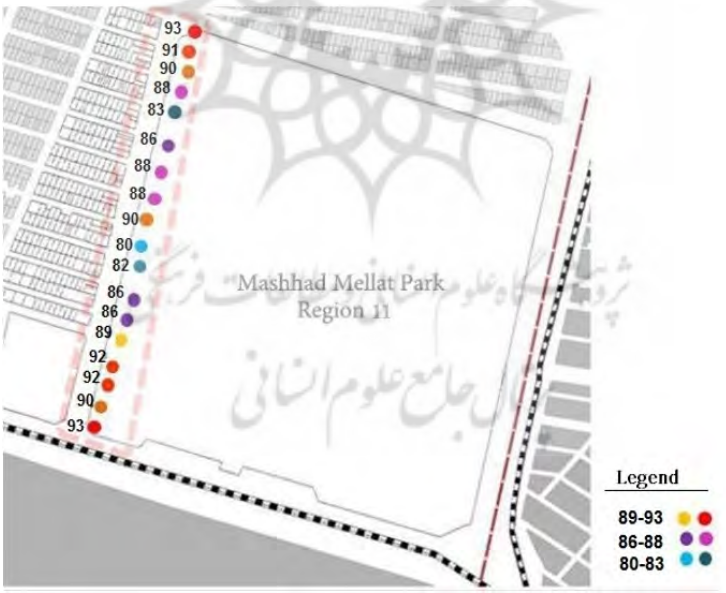

Fig. 7: Sound map (Noise Map) study area

Sidewalk

The questionnaires included 40 questions, such as personal information and other questions, as mentioned in Methods, about the soundscape of the study area. Three hundred eighty-five active people in the space answered them for more than 1 hour (who came to the area for walking, passing, training, and work, etc.) and were analyzed and evaluated. (Number of sample volume according to the uncertainty volume of a statistical population in Equation 1 used of qualitative Cochran formula that Z-score to 1.96, p and q are the standard deviations which usually considered 0.5 and d is the margin error by 0.05 considered reliable) (Abbaszadeh et al., 2022).

$$N = \frac{z^2 * p * q}{d^2} = \frac{(1,96)^2 * 0,5 * 0,5}{(0,05)^2} = 384,16 \sim 385$$

Equation 1: Uncertainty volume of statistical population

As can be seen from the results extracted from the SPSS software questionnaire, most respondents were under 40 years old. This area is high universality which is adjacent to the Ferdowsi University of Mashhad and the commercial and residential axis of EMAMAT boulevard and with the largest public park in the city, which provides services to users such as recreation and transit with the highest percentage and educational jobs and equal services for residents.

According to Figure 8, sound sources of the area, people were asked to give each source a quality degree of intensity. About 95% of respondents described the soundscape as noisy. Voices mostly heard in the area also included motorcycles, vehicle traffic, car horns, and men talking in their social hangouts. The children, birds, and water fountain sounds were hard to hear. The call to prayer sound and public conversation sound was in the middle range, cars and taxis could be heard a lot, and motorcycles sound was the most dominant sound in the area in people's minds.

In Figure 9, people mostly recognized the entrance of the swimming pool complex, located on the Mashhad MELAT Park sidewalk, as the most desirable part with a favorable soundscape. Next, the beginning of EMAMAT Blvd., the entrance of the GOL-GHASHT pass, the park, amusement Park, and ping pong complexes were considered urban spaces with a favorable soundscape. In the last point, they preferred the soundscape in front of the MEHR center, coffee shop, and the culture and art passage entrance.

Also, in Figure 10, the criteria affecting the sound source of study according to a survey question to measure people's attitudes towards the subject of the research topic by answering a series of statements and grading the feeling of each of them is displayed. Given their perceived mastery, interviewees are asked to rank several sound sources on a five-point Likert scale, from 1 to 5, with propositions: 1. sounds are completely dominant, 2. heard a lot, 3. middle, 4. Hard to hear, 5. Not audible are coded. Sound sources are categorized into six, including people talking sound, children playing sound, the rustling of leaves sound, water fountain sound and car traffic sound and each is ranked separately (Michel et al., 2021); According to Figure 10, desired criteria from users' point of view are in category three means middle.

As shown in Figure 11, in a situation where many people considered the amount of noise pollution in the area high, many

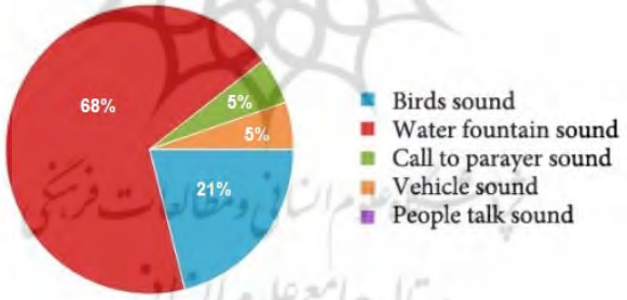

Fig. 8: Lack of visible sounds in the soundscape of the area from people's point of view

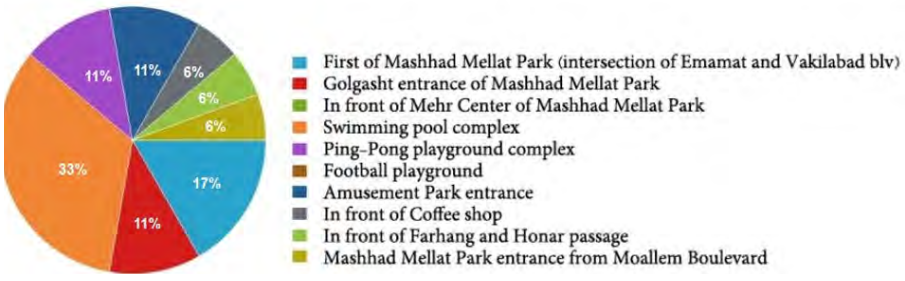

Fig. 9: People's place preference from the soundscape of Mashhad MELAT Park sidewalk

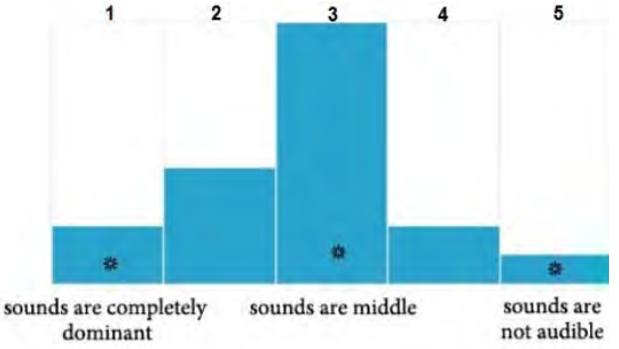

Fig. 10: Criteria affecting the sound source of the area in people's minds due to the Likert scale (1- 5)

people did not consider the current situation unfavorable. This goes back to habits and acceptance of people from the current state of the soundscape. From people's point of view, vehicle sound is most people's soundscape of EMAMAT Blvd. Many people had no opinion on improving the street soundscape, which could be due to their lack of knowledge about the desired soundscape. Some pointed to the removal of motorcycle noise and the addition of water and music. Figure 4 shows the activities and methods people consider necessary to improve the soundscape of the Mashhad MELAT Park sidewalk.

CONCLUSION

This study was conducted with the aim of qualitative evaluation of sidewalks in Mashhad MELAT Park. In comparison with similar studies, the findings of this paper show that the soundscape components in order to evaluate the quality of places in previous studies have been paid only to the one-dimensional study of urban design studies. For example, some researchers demonstrate the significance of intentional soundscape design in urban squares by investigating people's general perceptions of urban soundscape and sound preferences and the effects of demographic factors. In some other studies, according to the ability of certain settings, termed "restorative environments," to facilitate recovery from everyday cognitive fatigue, negative mood, and stress by acoustic environmental properties of the soundscape. Moreover, other researchers providing an overview of people consciously perceiving their environment through noise measurements and interviews of people by questionnaires have been used to investigate the sonic environment and its influence on the recognition and quality of an urban site by the users in the lab. The results show that the individual sound walking method has advantages for measuring various mental responses and obtaining perceived elements from urban soundscape that can help design sustainable urban spaces. In response to the main question of the research, it can be stated that the highest amount of annoyance and the highest volume of noise measured by the device was expressed by people at intersections. The results obtained by public perception bring us closer to providing more solutions to improve the soundscape of the sidewalk. First, the work surveyed indicates that sounds of bird songs and wind broadly characterize nature and water fountains. These sounds can enhance positive perceptions of natural environments presented through visual means. Second, isolated from other sensory modalities, these sounds are often, although not always, positively effectively appraised and perceived as vital. Third, after stress and fatigue, nature sounds and soundscapes can lead to subjectively and objectively improved mood and cognitive performance, as well as reduced arousal. However, some inconsistencies in findings are observed. The components of sensory soundscape underlie the formation of qualities such as presence, universality, vitality, identity, and sense of

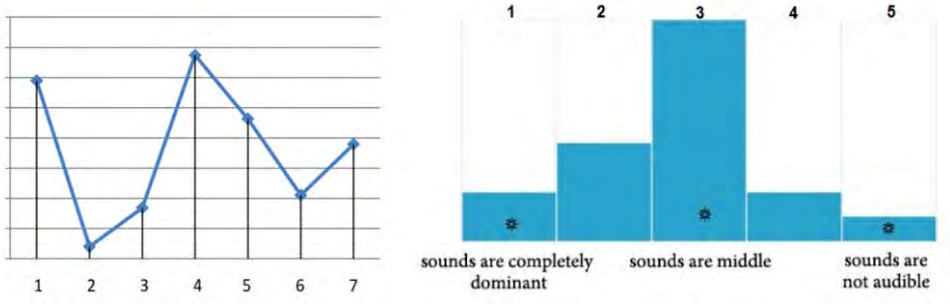

Fig. 11: Ways to improve the acoustic soundscape from the people's point of view

place in the space. For example, soundscape creates diverse natural and ambient sounds and a unique background identity, increasing readability and a sense of place in the environment. In general, the current study of Mashhad MELAT Park sidewalk soundscape shows that the most detrimental factor in the soundscape of urban space is motor traffic which causes a breach in the formation of environmental identity. Also, using natural and artificial elements and paying attention to culture are effective factors in forming desired sound landscapes in cities. Figure 12 shows the main factors performing the soundscape of a place both in peoples' perceptions and sound sources.

AUTHOR CONTRIBUTIONS

B. Khalesi performed the literature review and experimental design, analyzed and interpreted the data, and prepared the manuscript text and edition. M. Daneshvar helped with the experiments and literature review, compiled the data, and manuscript preparation.

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CONFLICT OF INTERESt

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication or falsification, double publication and, or submission, and redundancy, have been completely witnessed by the authors.

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