euronoise 2021
25th to 27th of October
Madeira, Portugal - online

A Research on the Evaluation and Usability of Mosque Gardens as Quiet Areas

Gulsen Akin Guler[1], Asli Ozcevik Bilen[2]

[1]Department of Architecture, Eskisehir Technical University, Eskişehir, Turkey.
(gulsenakinguler@gmail.com)
[2] Department of Architecture, Eskisehir Technical University, Eskişehir, Turkey.
(asliozcevik@hotmail.com)

Abstract
Quiet areas within the urban settlements in Europe, as specified in the Directive 2002/49/EC, are areas where the city dwellers living at a fast pace and working hard could use to get away from the chaos and the noise of the city, to rest and relax by calmly spending time. However, urban green areas in Turkey cannot fulfil this need. Nevertheless, the gardens of mosques, which have had an important place in Turkish cities for centuries, are the areas that the city dwellers may use as quiet areas. In this study, the utilization and availability of mosque gardens as quiet areas have been analysed through acoustic measurements, spatial evaluations, and questionnaires through field studies conducted in 7 mosque gardens in the Historical Peninsula of Istanbul. According to the findings, it was concluded that the spatial arrangements, user profile, density, and other functions of mosque gardens have an effect on the potential of mosque gardens to be quiet areas and be used as quiet areas.

Keywords: quiet areas, urban green areas, mosque gardens.

1 Introduction

Today, people living in cities generally have intense work pressure/busy schedules, must spend a part of the day in traffic, and are exposed to different noise sources during working hours. So, they feel a need to get away from the chaos of the city during the day or on the weekends and to relax by spending time in a quiet area. Quiet areas in an agglomeration, which are also included in the European Directive No. 49, can be used to meet this need with their quietness [1]. In previous studies, the quiet areas were generally examined in terms of their restorative potential by being below a certain level along with their natural elements [2,3,4], and in this context, the quiet areas in agglomerations were generally examined over urban parks[5,6,7]. However, it is not always possible to find sufficient urban green spaces to be used by urban residents due to the dense construction in the current city centres. Especially when historical and touristic activities are added to commercial activities, city centres are exposed to denser housing and use by more crowded people. Therefore, especially in historical and touristic city centres, urban open spaces such as courtyards and gardens of buildings have been examined by researchers in terms of their potential to be quiet areas as an alternative to parks [8,9,10]. The green area per capita in the Historical Peninsula of Istanbul, the historical and touristic city centre that is the subject matter of this study, is 6.8m^2. In this study, the historical mosque gardens in the Historical Peninsula of Istanbul (Figure 1) were examined regarding their potential as quiet areas and their availability to the citizens and tourists as quiet areas.

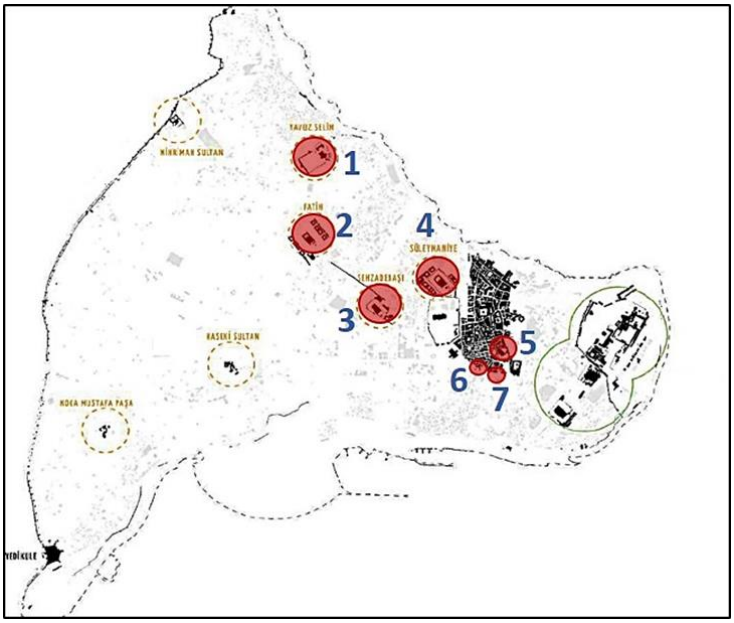

Figure 1 – 1.Yavuz Selim Mosque, 2. Fatih Mosque, 3.Şehzadebaşı Mosque, 4.Süleymaniye Mosque, 5.Nuruosmaniye Mosque, 6. Çorlulu Ali Paşa Mosque, 7.Atik Ali Paşa Mosque [11].

2 Methodology

2.1 Selection of study areas

The Historical Peninsula can be divided into two main regions in terms of land use: a residential area and a historical and touristic area. In this research, field studies were carried out in 7 mosques, which are Yavuz Selim Mosque and Fatih Mosque from the residential area and Şehzadebaşı Mosque, Süleymaniye Mosque, Nuruosmaniye Mosque, Çorlulu Ali Paşa Mosque, Atik Ali Paşa Mosque from the historical and touristic area. Characteristics such as density of use, the potential of tourist attractions, and historical value were considered for in selecting the mosques. Mosques such as the Blue Mosque, Beyazıt Mosque, and Yeni Mosque, which are among the historical mosques that have intensive use, were not included in the scope of the study because they underwent restoration during the fieldwork.

2.2 Field study

In general, the results obtained from noise mapping and field studies are used to determine and evaluate quiet areas. In field studies, expert assessments, in-situ acoustic measurements, and evaluation of user/visitor experiences are mainly used [12]. While noise mapping is generally the preferred method in quiet area determination studies of EU member countries, academic studies are primarily carried out on field studies. In this research, in-situ expert assessments, sound recordings and sound-pressure level measurements, and questionnaires were carried out during the field study.

In-situ expert assessments: During the field study, the researchers noted the function outside the field, user profile, auxiliary functions in the field, other units in the field, garden size (m2), number of users in the field, tree and water elements, dominant sound outside the field, dominant sound in the field through in-situ observations.

In-situ acoustic measurement – (sound recordings with soundwalk method): Routes were created in the gardens of the selected mosques to centre the distance between the outer borders of the garden and the mosque. To avoid the effects of reflection and to move away from the sound environment outside the garden, the routes were plotted away from the mosque buildings and the outer borders of the garden to a feasible extent.
Sound recordings were taken on the plotted routes in the summer season and during the afternoon (16.00-19.00) when the mosque gardens were most heavily used, and the sound pressure levels in the area (Leq, L10, L50, L90) were determined by analysing these recordings in the Pulse Reflex 20.0.0 program.
Questionnaire: 30 questionnaires were made at the points determined on the soundwalk routes in the garden of each mosque (an example of the questionnaire conducted is given in Figure 2). The questions were prepared using a 5-point Likert scale about the participants according to the ISO/TS 12913-3 A method [13], including topics such as general information, sound source identification, perceived affective quality (pleasant, chaotic, vibrant, uneventful, calm, annoying, eventful, monotonous), assessment of surrounding sound environment, assessment of the appropriateness, and assessment of the quietness. The questionnaire data were evaluated through the SPSS 21 program by performing frequency analysis.

Figure 2 – The sound walk route determined in the garden of Fatih Mosque and the questionnaire points on the route [14].

3 Findings

3.1 In-situ expert assessments

Information on the function and user profile, size and number of users, vegetation and water, and sound environment in the study areas are compiled in Table 1.

Table 1 – Space usage and spatial features.

mosque name	function and user profile				size and number of users		vegetation and water	sound environment	
	function (outside)	user	other functions (inside)	other units (inside)	size (m2)	number of users (inside)	number of trees and type of water element	dominant sound (outside)	dominant sound (inside)
Yavuz Selim Mosque	residential	local-tourist	tourism-recreation	graves	9.000 m^2	40-50	a few trees, shadirvan	human beings	natural -human beings
Fatih Mosque	residential - commercial	local-tourist	tourism-recreation - child playing	graves cemetery - cultural activity units	35.000 m^2	200-250	a few trees, pool, shadirvan	traffic-human beings	human beings - other noise
Şehzadebaşı Mosque	residential - commercial	local-tourist	tourism-recreation	graves cemetery	10.000 m^2	50-60	lots of trees, fountain, shadirvan	traffic-human beings	natural – traffic - human beings
Süleymaniye Mosque	touristic-commercial	local-tourist	tourism-recreation	graves cemetery	22.000 m^2	100-150	lots of trees, fountain, shadirvan	traffic-human beings	human beings - natural
Nuruosmaniye Mosque	touristic-commercial	local-tourist	tourism-recreation	graves religious institution	4.000 m^2	20-100	a few trees, fountain	human beings - other noise	human beings - other noise
Çorlulu Ali Paşa Mosque	touristic-commercial	local-tourist	tourism - commerce	commercial units-cemetery	600 m^2	10-15	a few trees, shadirvan	human beings –other noise	human beings - other noise
Gazi Atik Ali Paşa Mosque	touristic-commercial	local-tourist	tourism - commerce	commercial units-cemetery	1000	10-15	a few trees	human beings - other noise	human beings - other noise

Function and user profile

In the mosques located in the residential area, the users mainly (more than 50%) consist of people living in the surrounding area, while the users of the mosques in the tourist and commercial areas were workers and tourists. Local users usually come to the mosque gardens to worship and rest/relax (more than 80%) while tourists come to visit/sightsee.
While there are graves or a cemetery in all mosque gardens, there are religious institutions in the garden of Nuruosmaniye Mosque, cultural activity units in the garden of Fatih Mosque, and commercial units in the gardens of Çorlulu Ali Paşa and Atik Ali Paşa Mosques.

Size and number of users

The walkable areas in the gardens of mosques such as Fatih, Süleymaniye and Şehzadebaşı have a larger garden area compared to other mosques. The mosques with the highest user density (number) are Fatih, Süleymaniye and Nuruosmaniye Mosques. While the crowd in the Süleymaniye and Nuruosmaniye mosques is mostly tourists, the community in Fatih Mosque consists of people from the local environment.

Vegetation and water elements

The richest gardens in terms of perennial trees grown in mosque gardens are the gardens of Şehzadebaşı Mosque and Süleymaniye Mosque. There are sparsely grown trees in the gardens of other mosques (Figure 3-4). Except for Gazi Atik Ali Paşa Mosque, there is a shadirvan (water-tank with a fountain) or fountain in the garden of all mosques.

Information about the sound environment

Although traffic noise or human sounds can be heard around the areas in the residential area, the related sounds are not dominantly heard inside the areas, but human voices are heard more than traffic sounds. If there is road traffic in the commercial and touristic areas, traffic and human voices are heard, and if there is no road traffic, other commercial and tourism sounds (sounds of transportation and loading/unloading of goods, commercial calls, etc.), as well as human sounds and sirens, are dominantly heard. Inside the areas (mosque gardens), the dominant sound types are usually natural and human sounds. While human sounds are more dominant in mosques where the number of users is high, the dominance of natural sounds in mosque gardens increases as the number of users decreases, and the green element expands. In the mosques located in the commercial area, other sounds such as sirens and horns are also heard more frequently than inside the mosques.

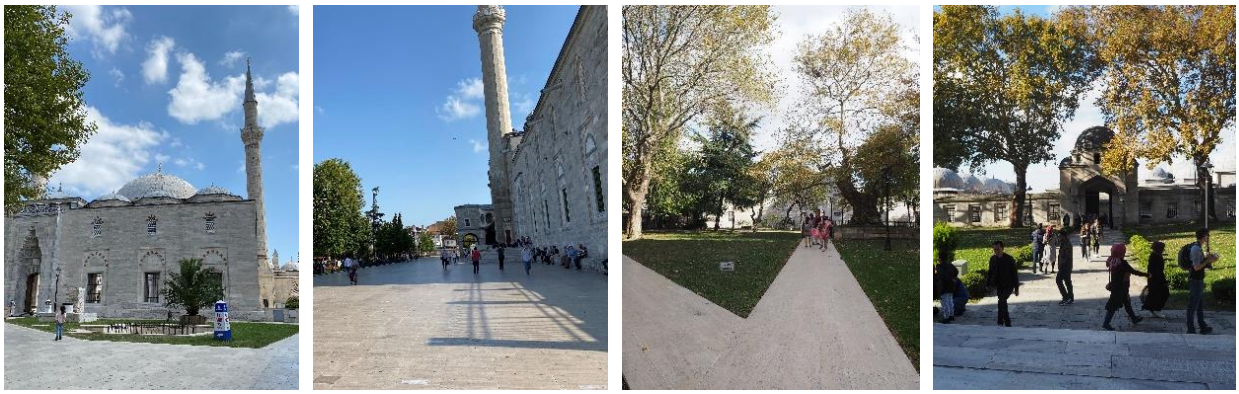

Figure 3 – Photos from the mosque gardens (from left to right, 1. Yavuz Selim Mosque, 2. Fatih Mosque, 3. Şehzadebaşı Mosque, 4. Süleymaniye Mosque)

Figure 4 – Photos from the mosque gardens (from left to right, 1. Nuruosmaniye Mosque, 2. Çorlulu Ali Paşa Mosque, 3. Atik Ali Paşa Mosque)

3.2 Results of actual in situ measurements of sound-pressure levels

According to the results of the analysis of the sound recordings in the study areas using the soundwalk method, the A-weighted equivalent sound pressure level (LAeq) ranges from 42 dB to 63 dB (Table 2).
The reason for the high noise level in the Nuruosmaniye Mosque, which is the mosque with the highest level (LAeq), is that the mosque is in an area with intense commercial and touristic activities in terms of outside function, and the user density is high due to touristic activities in the area. In Fatih Mosque, along with the traffic sounds coming from outside the area, the high number of local users in the area are effective in

increasing the noise level. Şehzadebaşı Mosque, on the other hand, is exposed to traffic noise from outside the area. Yavuz Selim Mosque, which has the lowest noise level and is quieter than other areas, is in a residential area. In addition, the traffic around the mosque is lighter. Çorlulu Ali Paşa and Atik Ali Paşa Mosques are in an area closed to road traffic. Although the tourist density is less than the other mosques, the commercial units in the garden of these two mosques cause an increase in the density, and thus, the sound level.
Various studies in the literature show that the perception of quietness is closely related to background sounds [15,16], and the background sound (L90) measured in all mosques is below 55 dB (between 43 and 55 dB). Ambient sound level (L50) varies between 48 and 58 dB. Foreground sounds (L10) ranging from 53 to 66 dB are usually sounds caused by humans. Yavuz Selim Mosque is in a high and breezy location, so wind sound is also effective on the high level of foreground sounds.

Table 2 – Acoustic measurement results.

Mosque name	LAeq (dB)	LA10(dB)	LA50(dB)	LA90(dB)
Yavuz Selim Mosque	42.09	63.56	50.23	43.07
Fatih Mosque	62.32	66.36	58.95	51.22
Şehzadebaşı Mosque	59.78	64.36	56.78	53.74
Süleymaniye Mosque	47.63	65.19	56.10	49.37
Nuruosmaniye Mosque	63.97	61.57	57.79	55.43
Çorlulu Ali Paşa Mosque	49.43	53.85	48.69	46.25
Gazi Atik Ali Paşa Mosque	51.63	60.07	51.37	48.81

3.3 Evaluation of user/visitor experiences

In each selected area, 30 people of different age groups ranging from 18 to 75 years who did not have any hearing problem as per their own statements and who were selected randomly were surveyed, and 210 citizens (78 female and 132 male subjects) were surveyed in total.
As a result of the questionnaire, based on the user perception, possible to suggest that the following sounds are heard

- in Yavuz Selim Mosque, natural sounds (1% moderate, 11% high, 18% completely dominating), followed by human sounds (10% moderate, 6% high) and other sounds (such as sounds of sirens, construction, industry, loading of goods) (16% moderate);
- in Fatih Mosque, mostly human sounds (6% moderate, 16% high, 7% completely dominating) followed by natural sounds (12% moderate, 9% high, 7% completely dominating) and other sounds (sounds of sirens, construction, industry, loading of goods) (3% moderate);
- in Süleymaniye Mosque, mostly human sounds (14% moderate, 9% high) followed by natural sounds (9% moderate, 15% high, 6% completely dominating) and other sounds (sounds of sirens, construction, industry, loading of goods) (9% low);
- in Şehzadebaşı Mosque, mostly the natural sounds (20% moderate, 50% high, 30% completely dominating) followed by human sounds (33% moderate) and traffic sounds (10% moderate);
- in Nuruosmaniye Mosque, mostly human sounds (13% moderate, 43% high, 33% completely dominating) followed by natural sounds (23% moderate, 40% high, 10% completely dominating) and other sounds (sounds of sirens, construction, industry, loading of goods) (23% moderate, 3% high);
- in Atik Ali Paşa Mosque, mostly human sounds (50% moderate, 30% high, 13% completely dominating) followed by natural sounds (33% moderate, 26% high, 6% completely dominating) and other sounds (sounds of sirens, construction, industry, loading of goods) (16% moderate, 3% high);

- in Çorlulu Ali Paşa Mosque, mostly human sounds (43% moderate, 23% high, 10% completely dominating) followed by natural sounds (43% moderate, 20% high) and other sounds (sounds of sirens, construction, industry, loading of goods) (20% moderate, 13% high).

Accordingly, while natural sounds are dominant in Yavuz Selim and Şehzadebaşı Mosques, human sounds are dominant in other mosques, but traffic and other sounds are also heard in mosques. These results are in line with the in-situ expert assessments.
Yavuz Selim, Şehzadebaşı, and Süleymaniye Mosques, respectively, are perceived as "calm and pleasant" areas in terms of the perceived affective quality compared to other mosques (Figure 5). While the perception of "annoyance and chaos" is low in all mosques, the perception of being "vibrant and eventfulness" is higher in Fatih and Nuruosmaniye Mosques than in other mosques. Yavuz Selim, Atik Ali Paşa, and Çorlulu Ali Paşa Mosques were perceived as more "monotonous and uneventful" than other mosques. So, it is possible to state that mosques with a low noise level, few people, and a high number of trees are perceived as calmer. The perception of being "vibrant and eventfulness" can be associated with the high number of people in mosques. The high perception of "monotonous and eventful" in some mosques can be explained by the low number of tourists.

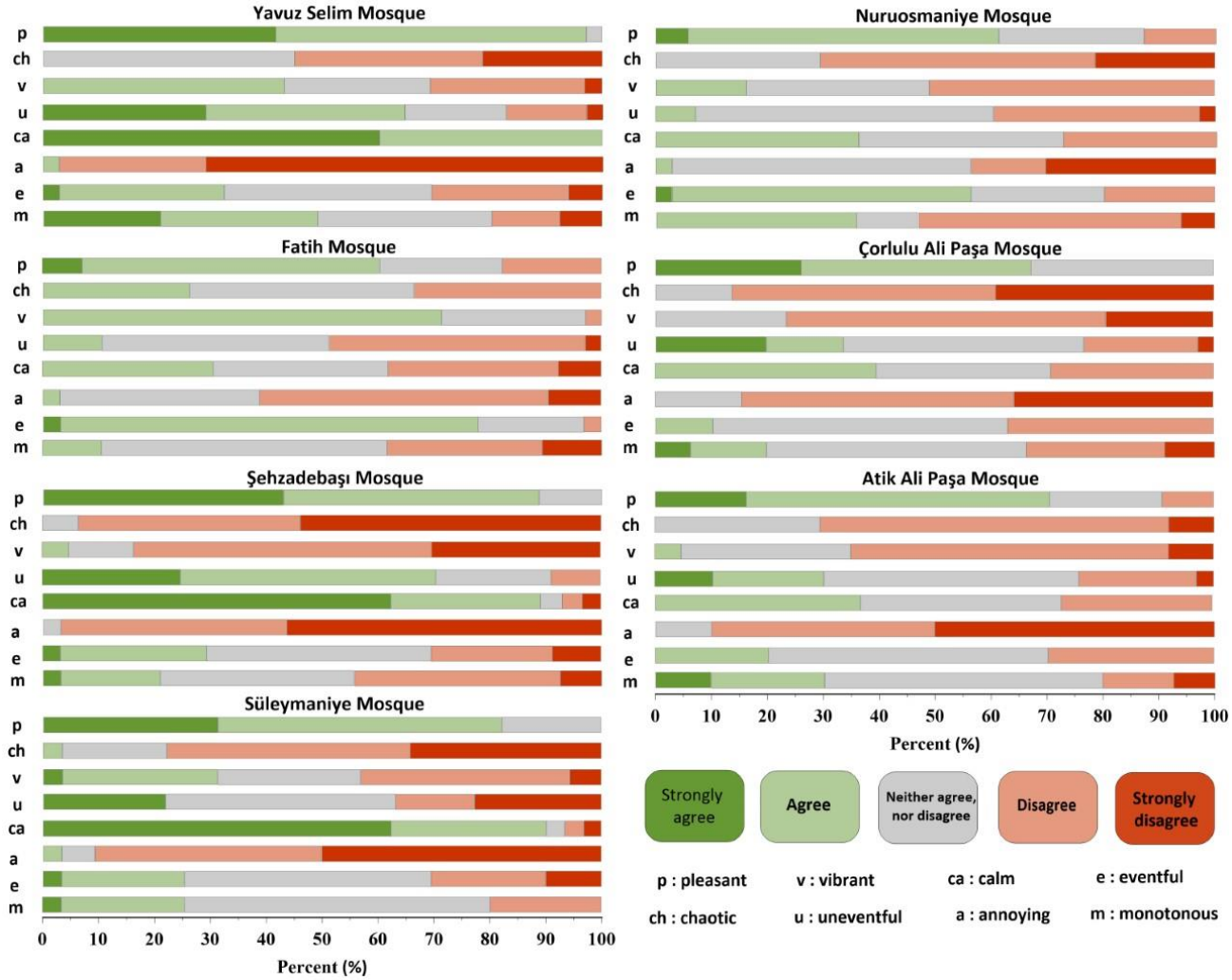

Figure 5 – Perceived affective quality in mosque gardens.

The results of the assessment of the surrounding sound environment and assessment of the quietness are similar in all mosques. All of those who evaluated the sound environment in the area as quiet or very quiet evaluated the overall sound environment as good or very good. The results of the general quietness assessment in all mosques show parallelism with the results of the assessment of the appropriateness of the sound environment for the area. Most users (more than 90%) who found the areas quiet or very quiet found the sound environment very appropriate or perfectly appropriate for the area. The majority (more than 90%) of users who rated the areas as noisy or very noisy rated it as slightly appropriate or not appropriate at all. This indicates that the appropriate sound environment is expected to be quiet or very quiet in mosque gardens. In general, it can be suggested that "*areas where the sound level is low, natural sounds are dominant, and areas that are considered calm, pleasant, and still are considered quieter; and sound environments that are considered quieter are appropriate for the area*".

4 Evaluation and Conclusions

The gardens of mosques, which have existed in Turkish cities for centuries, are areas that have the potential to be evaluated and used as quiet spaces. In addition, the mosque gardens, which also have a religious function, are expected to offer a calm and peaceful environment to the users. As a result of the study, it is determined that the outside and inside features of a mosque are effective on the quietness/calmness of the areas, and some features specific to mosque gardens contributed positively to the perception of quietness.

Outside Features of a Mosque
The main outside features of a mosque that cause an increase in the sound level in the area, are the excessive crowd due to commercial-touristic activities outside the area and the heavy road traffic noise outside the area. The mosque gardens in areas where the outside of the area is not crowded, and the traffic density is low are areas with a high potential to be quiet areas compared to other areas.

Inside Features of a Mosque
The high number of users in the area and other auxiliary functions increase the sound level in the mosque gardens and negatively affect the perception of quietness. For this reason, it is recommended not to add other auxiliary functions such as trade, eating, and drinking, which cause an increase in the number of users in the mosque gardens and to limit the number of visitors to the touristic mosque gardens at the same time.

Specific Features of a Mosque
Mosque gardens are usually surrounded by walls. These walls act as barriers and are important in terms of protecting the sound environment in the mosque gardens from the noise outside the area. So, it is recommended that the wall between the outside of the area and the garden should be considered as a noise barrier, and there should not be any openings on the garden walls.
There are usually elements such as trees, fountains, and shadirvans in the mosque gardens. It has also been revealed in previous studies that the presence of natural elements such as plants and water in an environment and the predominance of natural sounds contribute positively to the perception of quietness/calmness [17, 18, 19]. In this context, reducing concrete floors in mosque gardens, planting more trees, and keeping water elements will contribute positively to the perception of quietness.
Worshipping makes people feel more peaceful and calmer. In this respect, mosque gardens are expected to have a sound environment suitable for staying calm and peaceful. Besides, as an expression of respect to the graves and cemeteries in the historical mosque gardens, it would be appropriate to be sensitive about not disturbing the peace and tranquillity of the activities and added functions in such areas.

Arrangements in line with the above recommendations according to the in-situ expert assessments, acoustic measurements, and questionnaire results in the field will contribute to the usability of mosque gardens as quiet open spaces that offer rest and relaxation along with their worship function, especially in urban areas where green areas are insufficient.

Acknowledgements

The study was supported by research the Eskişehir Technical University Scientific Research Projects Commission under the grant no: 20DRP008.

References

[1] Directive, E.U. *Directive 2002/49/EC relating to the assessment and management of environmental noise*. Off. J. Eur. Commun. 2002, 189, 12-25.

[2] Watts G. Tranquillity in the city - building resilience through identifying, designing, promoting and linking restorative outdoor environments, *173rd Meeting of Acoustical Society of America and 8th Forum Acusticum*, Boston, Massachusetts 25-29 June 2017.

[3] Zhang, Y.; Kang, J.; Kang, J. Effects of Soundscape on the Environmental Restoration in Urban Natural Environments. Noise and Health, 19 (87). pp. 65-72. ISSN 1463-1741

[4] Weber, A.M.; Trojan, J. The Restorative Value of the Urban Environment: A Systematic Review of the Existing Literature. *Environ. Health Insights*, 2018, 12, 1–13.

[5] Payne, S. R.; Bruce, N. DeStress: Soundscapes, quiet areas and restorative environments. *In Proceedings of the Institute of Acoustics*, 2019, pp39-46.

[6] Liu, Q.; Wu, Y.; Xiao, Y.; Fu, W.; Zhuo, Z.; van den Bosch, C.C.K.; Huang, Q.; Lan, S. More meaningful, more restorative? Linking local landscape characteristics and place attachment to restorative perceptions of urban park visitors, *Landsc. Urban Plan.*, 197 2020, Article 103763.

[7] Shu, S; Ma, H. Restorative effects of urban park soundscapes on children's psychophysiological stress, *Applied Acoustics*, Volume 164, July 2020, 107293

[8] Maffei, L.; Toma, R.A.; Masullo, M. Objective and subjective assessment of pockets of quiet inside historical urban areas. *In Proceedings of the INTER-NOISE 2018 Impact of Noise Control Engineering*, Chicago, IL, USA, 26-29 August 2018.

[9] Akin Guler, G.; Ozcevik Bilen, A.; Masullo, M.; Maffei, L. The potential of being the quiet plans of the Khans Courtyards in Istanbul Historic Peninsula. *In Proceedings of the 23rd International Congress on Acoustics*, Aachen, Germany, 9–13 September 2019.

[10] Masullo, M.; Castanò, F.; Toma, R.A.; Maffei, L. Historical Cloisters and Courtyards as Quiet Areas *Sustainability*; Basel Vol. 12, Iss. 7, 2020: 2887.

[11] Tarihi Yarımada Kentsel Sit Alanında Dönüşüm Yaklaşımı Geliştirilmesine Yönelik Fikir Projesi, İstanbul Büyükşehir Belediyesi, 2017, p 15.

[12] Good practice guide on quiet areas, European Environment Agency, EEA Technical report No 4/2014

[13] ISO (International Organization for Standardization). ISO/TS12913-2. Acoustics–Soundscape–Part 2: *Data Collection and Reporting Requirements*; International Organization for Standardization: Geneva, Switzerland, 2018; Available online: https://www.iso.org/standard/75267.html (accessed on 4 January 2019).

[14] https://sehirharitasi.ibb.gov.tr/

[15] Botteldooren, D.; Decloedt, S.; Bruyneel, J.; Pottie. S. Characterisation of quiet areas: subjective evaluatjion and sound level indices, *In proceedings of the 137th Meeting of the ASA and the 2nd Forum Acusticum, integrating the 25th DAGA Conference*, Berlin, Germany, Mar. 1999.

[16] Botteldooren, D.; De Coensel, B. Quality Assessment Of Quiet Areas: A Multicriteria Approach, *Euronoise 2006*, Tampere, Finland, 30May-1June, 2006.

[17] De Coensel, B.; Vanwetswinkel, S.; Botteldooren, D. Effects of natural sounds on the perception of road traffic noise. *J. Acoust. Soc. Am.* 2011, 129, pp 148–153.

[18] Watts, G.; Pheasant, R.; Horoshenkov, K.; Ragonesi, L. Measurement and subjective assessment of water generated sounds. *Acta Acust. United Acust.* 2009, 95, pp 1032–1039.

[19] Watts, G.R. The effects of greening urban areas on the perceptions of tranquility. *Urban For. Urban Green.* 2017, 26, pp 11–17.