URBAN DESIGN AND NOISE MANAGEMENT: ENVIRONMENTAL NOISE PROBLEMS AND SOLUTIONS SUGGESTIONS IN MARDIN CITY CENTRE

Mehmet Salih AYDIN [1], Zuhal ÖZÇETİN [2*]

[1] Siirt Üniversitesi, Güzel Sanatlar ve Tasarım Fakültesi, Mimarlık Bölümü, Siirt
ORCID No : https://orcid.org/0000-0001-9243-4014
[2] Uşak Üniversitesi, Mimarlık ve Tasarım Fakültesi, Mimarlık Bölümü, Uşak
ORCID No : https://orcid.org/0000-0003-4441-9471

Keywords

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Abstract

Noise pollution has become an increasingly important environmental issue, especially with the acceleration of urbanisation and population growth. In the literature, noise pollution is defined as unwanted or annoying sounds and its negative effects on human health, the environment and social life are emphasised. Traffic noise is the most common source of environmental noise in urban areas. Noise measurements and analyses are important in determining which areas are priority areas in combating this problem. Especially in historical and touristic cities, the effects of traffic noise on both people and structures have become an important research topic.

International organisations such as the World Health Organization (WHO) and the European Union have set limit values for noise levels. In Türkiye, the Regulation on the Assessment and Management of Environmental Noise is also accepted as an important reference in this regard.

In this context, noise measurements revealed that the main sources of traffic noise in the centre of Mardin were air horns used in motor vehicles, exhausts from blowers, and older vehicle models. The study's key finding was that equivalent noise levels exceeded the regulatory limit values at all nine measurement points in the evening (limit 65 dBA) and at night (limit 60 dBA). The maximum noise level measured, particularly in the evening, was 83.0 dBA, which exceeded the limit value by 18.0 dBA. The maximum level at night was determined to be 78.6 dBA. These findings demonstrate that noise levels have negative psychological and physiological effects on public health and quality of life. Based on these critical findings, detailed proposals for urban design solutions for Mardin city centre were presented at the end of the study.

KENTSEL TASARIM VE GÜRÜLTÜ YÖNETİMİ: MARDİN ŞEHİR MERKEZİNDE ÇEVRESEL GÜRÜLTÜ SORUNLARI VE ÇÖZÜM ÖNERİLERİ

Anahtar Kelimeler

Mardin
Gürültü kontrolü
Ses
Çevresel gürültü
Kentsel tasarım

Öz

Gürültü kirliliği, çevresel bir sorun olarak özellikle kentleşmenin ve nüfus artışının hızlanmasıyla daha belirgin hale gelmiştir. Literatürde gürültü kirliliği, istenmeyen ya da rahatsızlık veren sesler olarak tanımlanmakta; insan sağlığı, çevre ve toplumsal yaşam üzerindeki olumsuz etkileri vurgulanmaktadır. Trafik gürültüsü, kentsel alanlarda en yaygın çevresel gürültü kaynağıdır. Gürültü ölçümleri ve analizleri, bu sorunla mücadelede hangi bölgelerin öncelikli olduğunu belirlemek açısından önemlidir. Özellikle tarihi ve turistik şehirlerde, trafik kaynaklı gürültünün hem insanlar hem de yapılar üzerindeki etkileri önemli bir araştırma konusu olmuştur.

Dünya Sağlık Örgütü (WHO) ve Avrupa Birliği gibi uluslararası kuruluşlar tarafından gürültü seviyelerine ilişkin belirlenmiş sınır değerler bulunmaktadır. Türkiye'de de bu konuda Çevresel Gürültü Kontrol Yönetmeliği ve Binaların Gürültüye Karşı Korunması Hakkındaki Yönetmelik önemli referanslar olarak kabul edilmektedir.

Bu bağlamda yapılan gürültü ölçümleri sonucunda, Mardin kent merkezindeki trafik gürültüsünün ana kaynakları; motorlu araçlarda kullanılan havalı kornalar, üflemeli egzozlar ve eski model araçlar olarak belirlenmiştir. Çalışmanın temel bulgusu, 9 farklı ölçüm noktasının tamamında, akşam (limit 65 dBA) ve gece (limit 60 dBA) saatlerindeki eşdeğer gürültü seviyelerinin Yönetmelik sınır değerlerini aştığıdır. Özellikle akşam saatlerinde ölçülen maksimum gürültü seviyesi 83.0 dBA'ya ulaşarak, limit değeri 18.0

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dBA'ya kadar aşmıştır. Gece saatlerinde ise maksimum seviye 78.6 dBA olarak tespit edilmiştir. Bu bulgular, gürültü seviyelerinin halk sağlığı ve yaşam kalitesi üzerinde olumsuz psikolojik ve fizyolojik etkilere sahip olduğunu göstermektedir. Elde edilen bu kritik veriler doğrultusunda, çalışmanın sonunda Mardin şehir merkezi için kentsel tasarıma dayalı detaylı çözüm önerileri sunulmuştur.

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* Sorumlu yazar: zuhal.ozcetin@usak.edu.tr
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1. Introduction

Noise: although it is the general term for a group of sounds produced in an unharmonious and irregular manner, and although it is a situation that is rarely mentioned compared to other environmental pollution, it is a serious problem that reduces people's comfort. As people become more aware and prefer to live comfortably, the awareness of noise has been understood and in recent years there have been many studies carried out in this regard.

Urbanisation and population density are increasing due to the needs of today's conditions. With this urbanisation comes noise pollution. This pollution is now becoming a problem and has negative physiological and psychological effects on people. The main pollutants affecting all living things in nature can be defined as industrial and transport sources. Efforts should be made to create conscious faces, exposure times, noise maps and acoustic reports to minimise or eliminate noise.

In response to noise pollution, people need to create optimal mental and physical conditions. An ideal working environment should be created according to the measures required by ergonomic science. It is important to try to adapt noise pollution to people or people to noise pollution according to ergonomic conditions.

Depending on the current conditions, both the need for transport and the need for vehicles are increasing. Due to the increased noise generated by these long highways, it has a detrimental effect on the physical and mental health of residents. As a result, this situation reduces the effectiveness of our work and education. As a result of the studies and surveys, it has been observed that people are the most affected by the noise pollution caused by the motorway. In order to minimise this noise pollution, the Ministry of Environment, Urbanisation and Climate Change has issued the Environmental Noise Control Regulation. This regulation, which is stricter in the areas of education, culture and health, supports the creation of noise maps according to the distribution of noise and the number of people in the region. In this context, the study firstly includes a literature review on noise, then the current situation noise measurements were made at the identified points in the selected heavy traffic areas in the city of Mardin and analyses were carried out. The current situation assessment was carried out at 9 points in the densely functional areas identified based on the centre of Mardin and the study area was examined with environmental noise analyses. In order to determine the noise levels especially in the traffic areas in the city centre of Mardin, heavy traffic flow, high population, historical places, points with intensive vital activities were identified and evaluations were made based on standards and regulations.

2. Literature Review

In his study, Demir (2013) drew a noise map of the Beşiktaş district of Istanbul province and proposed solutions. It is believed that macro-level decision makers, especially local governments, should take precautions on this issue, create or expand recreational areas, and take precautions before the negative effects on human health occur, especially in large cities (Demir, 2013).

Akay (2015) determined the noise level in a certain area on Yeni İstanbul Street in Konya province to minimise the negative effects and investigated the relationship between plants and road noise. Measurements were taken 3 times a day for 14 days at 6 fixed points in the study area and the average sound level was determined. Sound was generated in the study area with a sound source corresponding to the average sound level in the area, and test measurements were made between 02:00 and 05:00 to determine how low the background noise of the selected groups was. Based on the test measurements, it was found that the maximum noise reduction between the test points was 2.8 dBA. As a result of the measurements made to determine the effect of distance on the degree of sound attenuation, it was determined that the degree of sound attenuation increased to 4.6 dBA due to the proximity of the sound source to the sound group (Akay, 2015).

Ögel (2015); tried to determine the sources of traffic noise pollution in the centre of Isparta province, measured the environmental noise, analysed, interpreted and evaluated by making maps. According to the results of the research; It was found that the most important source of noise in Isparta province is traffic noise, the noise level is high in the central parts of the

city and low in the outer neighbourhoods. Noise levels depend on weather conditions, vehicle speed and road conditions. It was found that the noise perception of Isparta village residents differed according to gender, age and the administrative unit in which they had lived for many years (Ögel, 2015).

Kahveci (2016) identified a study area of approximately 340 ha on Turgut Özal Boulevard, which extends 800 m north and south of the district in Çukurova district, Adana province, where traffic is heaviest. SoundPLAN software was used to determine and map noise levels in the study area. Based on the analysis of the current situation, satellite images, topographic maps and geodetic studies, the population affected by the noise level was identified and the data to be used by the programme, vehicle counts and noise measurements were carried out. Contaminated areas were determined within the scope of the district code of conduct, and noise prevention or reduction proposals were developed for these areas (Kahveci, 2016).

Özçetin (2016) conducted a road noise measurement and modelling programme, as well as a noise control analysis and noise mapping study. As a result of the comparison of the measurements repeated at different times and the simulation program data with each other, it was determined that the differences were within acceptable values (Özçetin, 2016).

In his study, Sezgin (2016) aimed to raise awareness of noise as an environmental issue. The study included the results of a survey conducted to measure the awareness of the residents of Şişli regarding noise pollution. Literature review and field research methods were used together. Evaluation of the research results; Noise is not considered as a form of environmental pollution by the residents of Şişli district (Sezgin, 2016).

Bilgen (2017); attempted to determine the noise levels at intersections and busy roads in the city centre of Nevşehir, determine the relevant factors, and create noise maps based on the obtained data. The noise measurements were transferred to the ArcGIS environment and morning, midday and evening noise maps of Nevşehir city centre were created. By evaluating the maps and the obtained data, necessary suggestions were presented to reduce and prevent noise pollution in the city centre (Bilgen, 2017).

Kaşağıcı (2017); aimed to determine the noise problem experienced by people living in the city centre of Kayseri, and to determine the measures that can help the central and local governments to solve this environmental problem. Based on the measurement results and survey evaluations, both preventive and noise-reducing solutions were proposed in the city and possible measures were evaluated (Kaşağıçı, 2017).

Taşkaya (2017) determined which noise sources were affected to what extent in Elâzığ from the noise measurements conducted by the Marmara Research Centre in 2015 and 2016 (Taşkaya, 2017).

The study conducted by Eren (2018) aimed to determine the noise levels in areas with high traffic and tourist density in the centre of Safranbolu, to investigate the noise-causing effects, and to prepare noise maps based on the data obtained. The noise measurements were transferred to the ArcGIS environment and a total of 16 noise maps were created for the Safranbolu district centre in the summer and winter seasons, including weekdays and weekends in the morning, afternoon and evening (Eren, 2018).

Katrancı (2018) investigated the levels of noise pollution and environmental impacts in a sample consisting of the central districts of Şanlıurfa. Noise levels were measured using a Rion sound level meter at measurement points in the morning, afternoon and evening hours. As a result of the data obtained, Eyyubi was identified as the district with the highest noise level among Haliliye Karaköprü and Eyyubi districts (Katrancı, 2018).

According to Demirel (2019), source-based and combined political noise maps were prepared and impact analysis was conducted in the areas within the service boundaries of Bolu Municipality. The SoundPLAN programme was used for this purpose. Noise measurements at 12 points were used to verify the modelling studies. In the joint assessment of the impact of roads, industrial and recreational facilities in the study area, it was determined that the most noise-sensitive settlements were the micro-districts passing through the main roads (Demirel, 2019).

Halaçlar (2019) in his study; In Adana city centre, the traffic was most intense at the intersections identified on Turgut Özal and Kenan Evren boulevards between 07:00-08:00, 19:00-20:00, 23:00-01:00 at night. In the study, a noise map was prepared according to the results of the calculation of the measures to be taken using the SoundPLAN program. As a result, the noise sources were identified and the levels of these environmental sources were measured and determined (Halaçlar, 2019).

In his research, Kulu (2019) investigated whether the sound generated by the Kabataş-Bağcılar tram systems in Istanbul province was assessed as noise within the scope of the current regulations. For this purpose, sound level measurements were carried out at the designated points, taking into account the types of vehicles, and the data obtained was analysed in detail to determine whether the values were within the limits. When the results were examined, the effects of noise in the measured areas were studied and the measures to be taken were determined in accordance with the data collected (Kulu, 2019).

In his study, Savaş (2019) focused on the efforts of the residents of Hisar Houses, located near the Beykoz Kavacık Mevkii Highway, to prevent noise pollution. 4-metre single-sided noise barrier was proposed as a solution to reduce the current noise level caused by noise from Hisar Houses. After the noise barrier was installed, SoundPlan 7.4 was used to map the noise in the new situation and calculate how much the noise level could be reduced from the current situation. As a result of the noise barrier modelling studies, noise levels in the residential area were determined using noise maps with limit values (Savaş, 2019).

In his study, Zengin (2019) examined the extent of noise in areas with heavy traffic in the city centre of Erzurum and tried to take precautionary measures. Noise pollution is one of the most important driving forces of unplanned and unhealthy urbanisation. He identified 4 heavy traffic points for noise modelling in Erzurum city centre. As a result, the existing noise sources in Erzurum city center were created and the environmental pollution levels were measured and the pollution parameters were determined using the mapping method (Zengin, 2019).

In the study conducted by Kaya (2020); The maximum noise levels were measured in important areas of Gaziantep city centre and evaluated together with the relevant noise regulations. As a result of this evaluation; it was found that winter months were less noisy, exit hours had more intense noise, and the morning time zone produced less noise compared to day and night measurements (Kaya, 2020).

In a study conducted by Sünnetci (2020), a noise map of Edirne was prepared and old noise measurements were compared with new noise measurements. The main problems causing noise in Edirne centre were recorded. In order to reduce noise, suggestions were made such as increasing noise control, creating a pedestrian zone in the city centre, giving importance to public transport and planning the city in a way that reduces noise (Sünnetci, 2020).

Teneler (2020) identified many health complaints due to auditory and visual discomfort in people living near wind turbines. The aim of this study is to determine the sleep quality of people living near wind turbines in Yaylaköy and Ovacık and in Küçükkaya and to investigate the relationship between sleep quality and socio-economic characteristics, risk perception, health status and noise. It was observed that groups with negative environmental, health and risk perceptions of wind turbines were more disturbed by the turbine. Considering the possible negative effects of power plants, it is recommended to implement practices that protect public health (Teneler, 2020).

Aktaş (2021) study; In the example of Kaleiçi district, the aim was to conduct noise analysis and modelling through remote sensing (RS) and geographic information systems (GIS) in parallel with the developing technology. As a result, the noise map of the Kaleiçi district, which is of national and international historical/cultural value, was prepared and applicable and effective proposals were developed within the framework of studying this noise with relevant standards (Aktaş, 2021).

In his study, Çoban (2021) found that the average value of the LAeq indicator, which is used for the equivalent sound level in the acoustic assessment of urban parks, was higher than the threshold recommended by the World Health Organisation (WHO) of 55 dBA for outdoor living spaces in all study areas. However, it was found that the L50 indicator, which has a statistically significant relationship with people's perception of quiet, was lower than 55 dBA in all but one of the study areas. It was also found that the L90 indicator, which is recommended to be used as a background noise indicator, remained below 55 dBA in all study areas (Çoban, 2021).

In his study, Kocaman (2021) tried to determine the level of awareness of the people of Turgutlu district against noise pollution. As a result, in this study he focused on the measures that can be taken to reduce the effects of noise pollution (Kocaman, 2021).

Onay (2021) tried to reveal the internal and external noise pollution in schoolyards using Isparta as an example. Based on the results of the study, he proposed the design of separate noise curtains for each schoolyard in order to continue education in schools in a healthier way (Onay, 2021).

Yalçındağ (2021), interested in the subjective side of noise, combined the soundscape method with virtual pedestrian environments and showed that noise perception and control can be evaluated numerically. To do this, he created a survey, which was conducted among 140 people of different age, gender and education at certain times between October 2018 and January 2020. In the implementation phase, it is planned to use virtual walks as an alternative to sound walks and noise control (Yalçındağ, 2021).

Desarnaulds et al. conducted a numerical analysis of the noise reduction potential of road traffic management practices. According to their analysis, reducing the speed limit from 50 km/h to 30 km/h is one of the most effective measures, providing significant noise reduction of 2–4 dBA in passenger vehicles. Furthermore, coordinating traffic lights at intersections or using roundabouts can reduce local noise levels by 1–2 dBA. These international findings provide a scientific basis for urban design and traffic management interventions aimed at reducing noise in Mardin's narrow streets and dense traffic flows (Desarnauldsa, et al. 2004).

Table 1. Studies in the Literature

Author/Authors	Year	Place of construction	Name of the study	Method Used
Sami Demir	2013	İstanbul	Creation of Noise Map by Determining Noise Levels in Beşiktaş District Centre of Istanbul	Research Method
Ahmet Akay	2015	Konya	Control of Traffic Noise in Urban Areas with Plant Use: Konya- Istanbul Ring Road Example	Research Method
Cumali Ögel	2015	Isparta	Noise Pollution Caused by Traffic in Isparta City	Research Method
Barış Kahveci	2016	Adana	Mapping of Noise Pollution from Urban Roads in the Case of Adana / Turgut Ozal Boulevard	Research Method
Zuhal Özçetin	2016	Ankara	A Method Proposal on the Analysis of Traffic Noise on Celal Bayar Boulevard and Investigation of its Environmental Effects	Research Method
Sezgin Sezgin	2016	İstanbul	Noise and Noise Awareness as an Environmental Problem: Sisli Example	Quantitative Method
İsmail Bilgen	2017	Nevşehir	Measurement of Traffic Noise Levels in Nevşehir City Centre and Preparation of Noise Map	Research Method
Betül Kaşağıcı	2017	Kayseri	Detection of Noise Pollution in Streets and Sensitive Areas in Kayseri	Mixed Method
Selim Taşkaya	2017	Elâzığ	Analysing the Existing Strategic Noise Maps of Elâzığ Province with a Questionnaire Study	Quantitative Method
Sercan Eren	2018	Karabük	Assessment and Mapping of Noise Pollution in Safranbolu District of Karabük Province	Research Method
Harika Şima Katrancı	2018	Şanlıurfa	Noise Pollution and Environmental Effects in Şanlıurfa	Research Method
Adnan Demirel	2019	Bolu	Preparation of Noise Maps of Cities: Bolu Province Example	Research Method
Soner Halaçlar	2019	Adana	Study of Noise from Vehicles Adana City Centre Example	Research Method
Mücahit Kulu	2019	İstanbul	Environmental Noise Generated by Rail Systems (The Case of Istanbul- Kabataş- Bağcılar Tram Line)	Research Method
Süleyman Savaş	2019	İstanbul	Mapping of Noise from Tem Motorway in Kavacık District of Istanbul and Application of Noise Curtain Model	Research Method
Umut Zengin	2019	Erzurum	Environmental Noise Maps from Traffic and Erzurum City Centre Case Study	Research Method
Gizem Kansu Kaya	2020	Gaziantep	Determination of Noise Levels in High Traffic Areas of Gaziantep and Environmental Impacts	Research Method
Alper Sünnetci	2020	Edirne	Preparation of Edirne Central District Noise Map	Research Method
Aslı Ata Teneler	2020	İzmir	Determination of Sleep Quality of People Living in Yaylaköy, Ovacık and Küçükkaya Neighbourhoods of Izmir and Evaluation of the Relationship with Environmental Noise	Quantitative Method
Okan Aktaş	2021	Antalya	Geographical Information Systems Based Noise Analysis and Modelling Kaleiçi/Antalya Case	Research Method
Nilgün Akbulut Çoban vd.	2019	Türkiye	General overview to strategic noise maps and action plans in turkey: the case of quiet areas ıdentification process	Research Method
Emine Kocaman	2021	Manisa	Determination of Perceptions and Attitudes towards Noise Pollution in Turgutlu City	Research Method
Büşra Onay	2021	Isparta	Landscape Architecture Approaches in Preventing Noise Pollution in School Gardens and Surroundings: Isparta Example	Research Method
Nazlı Seda Yalçındağ	2021	Türkiye	Investigation of Perceptual Differences in Environmental Noise	Research Method

In their study, Lee et al. proposed a noise reduction strategy to address road and rail traffic noise in Panyu District, Guangzhou, China. Noise maps generated using commercial software predicted that implementing noise barriers would significantly reduce traffic noise levels. The results showed that, with an appropriate barrier strategy, the total area experiencing heavy noise pollution could be reduced by 24.5 km^2 during the day and 24.3 km^2 at night. Furthermore, it was predicted that the proportion of areas meeting legal noise standards would increase by 18.38% during the day and 12.62% at night. Psychoacoustic analyses revealed that installing noise barriers significantly reduced the number of people experiencing severe annoyance; however, the reduction in the number of people experiencing sleep disturbance was insignificant (Lee et al., 2022).

Current research in urban noise control examines the psychoacoustic effects of structural features and perceived annoyance rather than focusing solely on reducing decibel levels. In this context, Eggenschwiler et al. conducted laboratory experiments to analyse the effects of façade surface material (reflective, absorptive or diffusive) and building orientation (parallel or non-parallel walls) on perceived noise annoyance in residential areas. The study's key findings indicate that absorptive façades generally reduce noise annoyance due to lower sound pressure levels. However, surprisingly, absorptive façades are perceived as more annoying than reflective or diffusive façades at the same sound level, indicating a somewhat negative acoustic quality. Furthermore, building rotation resulting in non-parallel walls has been found to reduce noise annoyance compared to parallel walls, and this positive effect tends to persist even when sound levels are equal. These results highlight the importance of façade features and building alignment as architectural control tools for optimising the sound environment in residential areas such as inner courtyards (Eggenschwiler et al.. 2022).

Studies related to the subject are presented in Table 1.

3. Study of Noise Abatement in the Context of Urban Design Using Mardin as an Example

Within the scope of urban design, noise control analysis was carried out specifically for the city of Mardin.

1st Street is one of the busiest streets in Mardin. It is a historical and tourist street that connects old Mardin and new Mardin. The street passes through the foot of Mardin Castle and connects the upper part of the castle, the northern part, and the lower part of the castle, the southern part. Along the street there are boutique hotels, music venues, restaurants, cafeterias, tourist bazaars, historical sites (mosques, madrasahs, churches). In addition to being an important transport and pedestrian axis, the presence of educational, medical, commercial, tourist markets, cultural areas and some residential areas played an important role in the selection of the area as a study area (Figure 1).

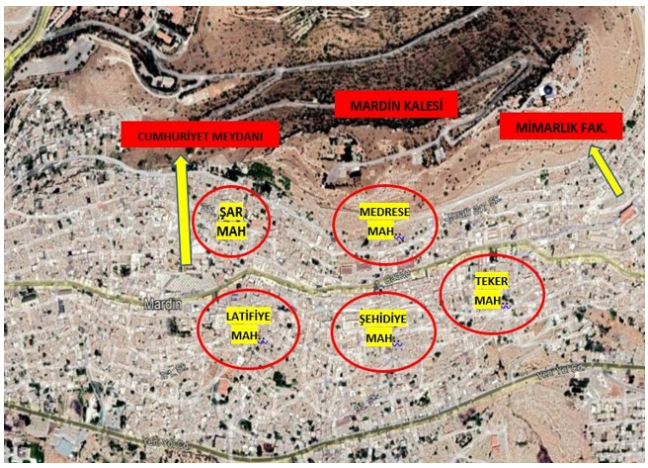


Figure 1. Mardin 1st Street (Google Earth)

A total of nine measurement points were identified on Mardin's 1st Street, which was the focus of the study. Rather than using the grid method commonly employed in noise mapping studies, a targeted and purposive sampling method was chosen to focus on the unique density and noise dynamics of the historical and tourist city centre. While the grid method typically seeks to generate strategic noise maps for extensive urban areas, this study aimed to pinpoint the areas of highest noise exposure on Mardin's narrow, rocky, and heavily trafficked main artery.

The following urban and functional criteria were used to select the measurement points:

- Intersections and axes with the highest concentration of heavy motor vehicle traffic, particularly along 1st Avenue.
- Areas of high population density, including residential areas, historical sites, tourist markets, food and beverage venues, and music entertainment venues in neighbourhoods such as Latifeye, Şar, Teker, Medrese and Şehidiye.
- Areas with the greatest echo and resonance effects caused by the historical urban fabric and narrow streets.

This objective selection aims to clearly identify areas that require urgent urban design intervention, by representing the 'worst-case scenario' in terms of the impact of traffic noise on public health.

3.1. Analysis of measurement results for Noise Control

The sound level meter used in the current situation assessment measurements is a calibrated Svantek

958/SV12L brand noise level meter. The sound measurement range of the device was selected as 30-130 dBA.

9 separate measurement points were identified to be taken in the 1st Street of Mardin Central District, especially in the areas of Latifeye neighbourhood, Şar neighbourhood, Teker neighbourhood, Medrese neighbourhood and Şehidiyle neighbourhood where there is heavy traffic, pedestrians and loud music (Figure 1 and Figure 2).

Figure 2. Display of Measurement Locations on the Map

Traffic noise measurements were conducted on Saturday 27 August 2022 under ideal meteorological conditions, in order to minimise the influence of environmental variables on noise propagation and avoid any negative impact. Data from the measurement day showed that the temperature remained at around 24°C throughout the day, with a relative humidity of approximately 28%. Most importantly, no precipitation was observed during the measurements. The wind speed was kept low at 4 mph (approximately 6.4 km/h), blowing from the southwest. These conditions confirm that the influence of wind on acoustic measurements is negligible, meaning that the equivalent noise levels obtained (L_{eq}) reflect the actual values resulting from environmental noise.

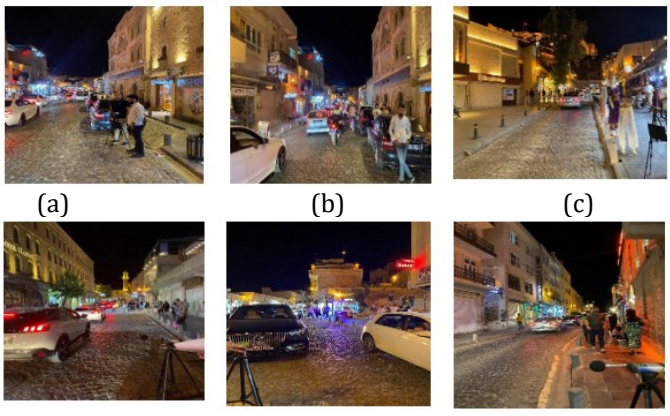
In order to determine the noise level in Latifeye, Şar, Teker, Medrese and Şehidiyle neighbourhoods of Mardin city centre and to take precautions against environmental effects and to ensure noise control, highways, intersections and connecting roads where there is heavy traffic were taken and the averages were calculated and the city noise was studied depending on the time of day at the 9 measuring points determined on Saturday during the day, evening and night hours.

9 measurement points were selected according to traffic density in August. The environmental noise measurements were carried out in Latifeye, Şar, Teker, Medrese and Şehidiyle neighbourhoods on Mardin city centre's 1st Avenue, taking into account the hours of highest motor vehicle traffic and Saturday. Leq measurements were taken between 16:00-18:00 during the day, 19:00-21:00 in the evening and 23:00-00:30 at night (Figure 3(a,b,c,d,e,f) and 4(a,b,c,d,f)).

(a) (b) (c)

(d) (e) (f)

Figure 3. (a,b,c,d,e,f) Photographs from daytime measurements made on Mardin 1st Street in August (Mehmet Salih Aydın archive - Aydın, 2020)



(a) (b) (c)

(d) (e) (f)

Figure 4. (a,b,c,d,e,f) Photographs from evening and night measurements made on Mardin 1st Street in August (Mehmet Salih Aydın archive - Aydın, 2020)

4. Findings and Discussion

Noise levels were measured in dBA, which gives priority to sounds to which the ear is sensitive. Measurements were analysed by grouping equivalent noise levels (L_{eq}) as day, evening and night on Saturday and averaging them. In addition, general noise levels during the day were determined from measurements taken at monitoring points. In total, 9 monitoring points were measured and averaged during the day, evening and night.

As a result of the measurements made at the 9 determined points, a comparison was made with the limit values (Figure 5-Table 2). It is seen that the evening and night noise levels exceed the limit values for each point, while the daytime noise levels are close to the limit values.

Table 2. Day – Evening – Night Comparisons

		1. point	2. point	3. point	4. point	5. point	6. point	7. point	8. point	9. point
Day (dBA)	**70**	68,6	70,5	68,8	68,2	70,0	69,0	69,6	68,9	70,6
Evening (dBA)	**65**	78,3	80,6	83,0	78,8	76,7	76,6	80,8	75,1	77,2
Night (dBA)	**60**	74,0	74,2	73,7	73,0	73,2	72,0	78,6	70,8	72,5

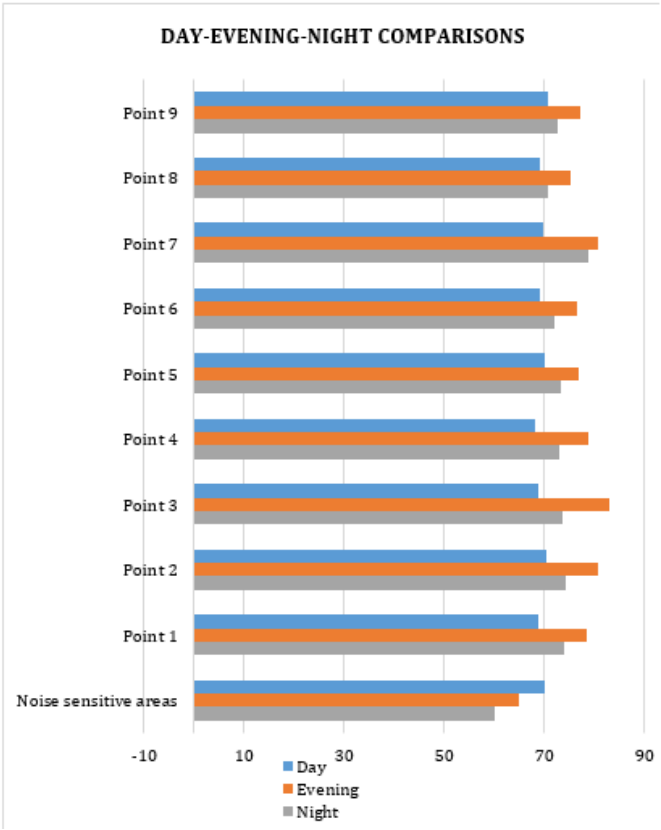


Figure 5. Day-Evening-Night Comparisons

If we look at the noise levels at 9 measurement points in the city centre, the noise levels at the weekend range from 68.2 dBA - 70.6 dBA during the day, 75.1 dBA - 83.0 dBA in the evening and 70.8 dBA - 78.6 dBA at night (Table 3-4-5-6). The most obvious common feature of these locations is that they are places with heavy vehicle traffic, so the noise sources include exhaust noise, horn noise, tyre noise on tarmac or when the brakes are applied. In these areas; pedestrian noise is relatively low and traffic noise is the most obvious feature. According to the results obtained; it can be said that the noise levels at different points of the city centre of Mardin province are at the limit values for daytime evaluation, but higher than the limit values for evening and night evaluation, and that these noise levels negatively affect and will affect people both psychologically and physiologically.

According to the Environmental Noise Control Regulation, the Leq limit values for the study area in central Mardin were set at 70 dBA for daytime, 65 dBA for evening and 60 dBA for night-time. Measurements show that exceedances of these limits are particularly high and persistent during the evening and night-time periods (Table 3).

Table 3. Day – Evening – Night Comparisons

Time Zone	Limit Value (dBA)	Maximum Measured Value (dBA)	Measurement Point	Limit Excess Amount (dBA)
Day	70	70,6	9.point	0,6
Evening	65	83,0	3.point	18,0
Night	60	78,6	7.point	18,6

Daytime (16:00 – 18:00): The limit exceedance during this period was lower than during other periods. The maximum value of 70.6 dBA, measured at measurement point 9, exceeded the 70 dBA limit by only 0.6 dBA and remained within it. This is due to the higher limit set for daytime periods in the regulations and the more controlled distribution of traffic flow. However, the average daytime levels at all measurement points, ranging from 68.2 dBA to 70.6 dBA, confirm that the area experiences constant high noise exposure.

Evening (19:00 – 21:00): The highest equivalent noise level, 83.0 dBA, was measured at measurement point 3. This value exceeds the relevant regulatory limit of 65 dBA by a significant amount: 18.0 dBA. The main reasons for this were increased evening tourist and recreational pedestrian traffic, heavy motor vehicle use and uncontrolled air horn/exhaust noise. Even the lowest evening level, measured at 75.1 dB(A) at measurement point 8, indicates an exceedance of the limit by at least 10.1 dB(A).

Night-time (23:00 –00:30): The most critical exceedance was recorded at Measurement Point 7, reaching 78.6 dBA. This level exceeds the night-time limit of 60 dBA by 18.6 dBA, indicating that the highest level of excess occurred during the night-time period. This can be attributed to commercial and recreational activities continuing into the late hours, coupled with engine and exhaust noises from older vehicles becoming more pronounced in the quiet of the night.

Table 4. Day measurement

Frequency (Hz)	1.point	2. point	3. point	4. point	5. point	6. point	7. point	8. point	9. point
100	65,1	65,9	67,5	67,0	64,2	65,2	67,5	68,3	63,8
125	65,3	65,9	68,3	65,4	62,1	63,1	64,7	62,4	61,2
160	64,3	66,3	64,3	61,6	63,8	62,1	63,7	61,9	60,7
200	61,8	62,1	62,6	60,5	61	61,7	61,4	60,6	61,0
250	60,4	62,9	59,2	58,7	60,7	60,8	61,5	60,3	60,4
315	60,7	66,5	60,7	59,5	61,6	62,4	60,9	62,1	61,8
400	62,2	62,8	60,8	60,2	63,7	62,3	62,2	61,3	65,1
500	62,8	63,5	59,9	61,0	62,8	62,3	62,0	61,2	65,7
630	64,5	64,9	60,6	61	63,7	62,1	63,0	61,4	65,8
800	60,2	62,5	59,1	58,7	60,5	62,1	61,5	60,2	62,4
1000	58,9	58,8	58,4	57,1	59,7	58,1	59,1	59,3	61,0
1250	56,3	60,3	58,5	58,8	59,3	57,8	58,9	58,5	59,0
1600	54,7	57,6	58,2	59,1	58,5	57,9	59,5	57,7	58,6
2000	52,3	55,0	57,2	55,9	57,7	55,6	57,3	56,2	54,7
2500	51,7	55,7	55,9	54,4	56,1	54,8	55,2	55,1	55,2
3150	51,1	55,7	55,6	54,0	55,6	52,8	53,7	54,9	54,8
4000	49,6	54,0	53,2	50,5	54,7	50,7	51,5	53,4	52,6
5000	45,8	49,4	49,9	47,8	51,7	49,0	49,9	50,7	46,2

Table 5. Evening measurement

Frequency (Hz)	1.point	2. point	3. point	4. point	5. point	6. point	7. point	8. point	9. point
100	70,1	69,0	69,9	66,0	65,5	65,6	76,2	70,1	67,7
125	68,4	74,8	71,5	63,7	64,0	65,5	68,4	70,8	65,8
160	65,5	71,2	70,3	61,0	65,2	60,9	67,1	67,6	64,0
200	63,4	66,8	63,2	58,8	66,4	58,9	71,0	66,5	64,5
250	64,7	68,9	66,1	58,2	68,7	58,3	69,3	64,8	60,2
315	63,8	66,4	64,9	61,9	63,7	59,6	69,8	64,2	59,8
400	63,0	70,6	63,6	60,3	63,1	60,1	72,3	67,7	63,2
500	64,4	76,2	62,7	59,9	64,7	59,8	75,5	64,4	68,6
630	65,8	74,2	62,6	60,3	70,9	60,6	77,1	64,2	64,0
800	70,1	74,4	64,3	60,1	69,4	60,3	73,0	62,8	63,3
1000	72,1	70,0	66,2	60,3	67,5	61,6	69,5	61,6	63,4
1250	71,3	68,8	70,6	65,9	64,6	64,9	69,4	62,4	65,4
1600	70,0	67,8	76,3	68,7	67,4	67,8	68,5	67,4	68,0
2000	64,3	68,6	75,6	72,5	66	70,3	67,0	65,5	70,2
2500	64,4	65,0	73,1	70,0	63,2	66,3	65,0	63,8	66,9
3150	61,3	62,4	68,6	66,9	60,6	64,6	64,3	60,2	62,8
4000	57,8	67,1	67,9	64,6	59,6	62,0	63,7	58,0	62,1
5000	54,2	62,2	69,6	64,7	59,1	61,8	60,8	61,1	61,5

Table 6. Night measurement

Frequency (Hz)	1.point	2. point	3. point	4. point	5. point	6. point	7. point	8. point	9. point
100	69,3	52,6	53,7	51,3	51,9	53,4	54,8	54,5	55,1
125	65,5	51,8	56,1	53,1	52,0	53,3	54,5	56,0	55
160	62,8	50,3	56,5	51,1	50,4	51,4	55,2	55,1	54,3
200	62,9	50,2	65,6	52,2	49,7	53,7	55,4	53,6	51,6
250	60,6	52,1	58,7	56,0	51,5	52,7	56,2	56,6	53,5
315	61,3	53,2	55,0	53,5	49,8	53,3	58,0	56,7	51,4
400	61,4	55,4	67,0	60,3	55,8	55,3	59,9	57,8	57,5
500	60,6	55,7	63,5	64,4	59,5	58,2	62,9	62,1	61,4
630	61,0	59,4	67,0	66,3	63,3	61,4	65,7	64,9	65,8
800	59,4	61,9	65,9	66,5	65,3	60,8	65,8	63,7	66,8
1000	58,4	61,1	63,3	62,9	62,8	58,7	63,8	61,1	63,1
1250	62,6	63,1	66,3	64,1	64,0	61,2	67,4	61,4	64,4
1600	67,2	63,9	63,6	64,2	65,0	63,0	69,8	61,7	63,3
2000	67	64,5	62,3	60,6	63,4	62,7	70,7	60,4	61,1
2500	62,2	63,3	60,2	59,6	61,6	62,1	69,3	56,8	58,4
3150	60,2	66,1	56,6	58,5	57,0	58,1	63,3	54,3	54,1
4000	56,8	64,4	55,5	55,4	56,7	56,9	60,1	51,9	51,5
5000	58,9	62,7	49,4	48,4	57,4	55,0	65,1	45,2	44,2

According to the Regulation on the Protection of Buildings against Noise, the study area in Mardin is within the high noise level.

However, it was noted that the daytime measurements were close to the limit values, while the evening and night measurements were above the limit values (Figure 6).

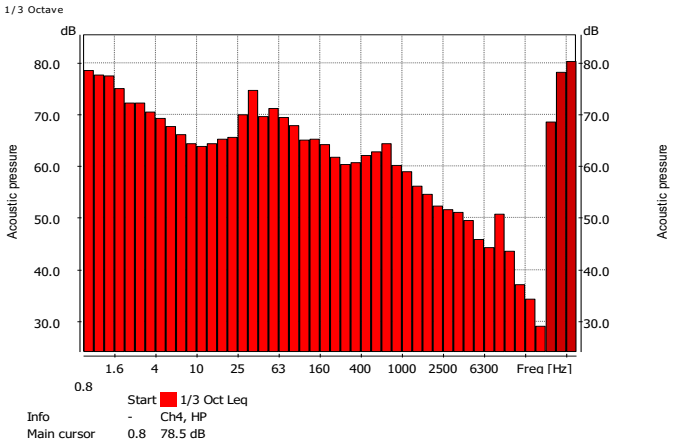


Figure 6. Evaluation of Day-Evening-Night Averages of the First Measurement Point

The World Health Organisation (WHO) has set a noise limit of 55 dBA for outdoor living areas. For a person to feel completely healthy and comfortable, it is essential to be in a state of complete physical and mental well-being. Measurements taken in the city centre show that noise levels exceed the WHO limits at all times of the day. Therefore, people cannot be in a state of complete well-being.

5. Conclusions and Recommendation

The analyses show that the noise levels at the nine selected points are above the limit values. The evening and night measurements at these points are above the limit values, while the daytime measurements are within the limit values. The values are lower due to the absence of traffic in the morning hours, and the increase in traffic density due to people leaving work in the evening makes the noise levels at these points different. It has been found that the noise level at weekends is 3-4 dBA lower than on weekdays. This is because the weekend is a holiday and the traffic density is low. However, the readings are still above the limit values. Noise levels are always high at all points except the specified points. Noise levels are highest in the evening hours and lowest in the morning hours.

As a result of the measurements and assessments carried out in general, it has been found that the noise levels at many points exceed the limits set by the Noise Ordinance and the WHO in the noise assessment carried out at weekends. Even the lowest noise level measured is above the 55 dBA accepted as the limit by the WHO. It can be said that Mardin city centre is generally noisy and disturbs people both psychologically and physiologically.

The main sources as a source of noise in the central district of Mardin; It has been determined that these are air horns used in motor vehicles, blower exhausts used in engines and old model vehicles. As a result, noise today has a negative impact on human health and performance. In our country, where urbanisation is increasing rapidly, road traffic noise is also a major health hazard. For this reason, it has been observed that traffic noise, which has the greatest impact on noise, varies according to vehicle differences.

Considering the study,

- Reducing vehicle speed limits,
- Increasing the use of public transport,
- Limiting heavy vehicles,
- Using porous asphalt instead of dense asphalt for road surfacing,
- Designing natural or artificial barriers in the designated areas within the study area (particularly at points 2, 3 and 7 where limit values are exceeded),
- It is predicted that the use of soundproofing in buildings to reduce noise will greatly reduce the discomfort caused by traffic noise to people living and working by the side of the motorway.

It is suggested that porous asphalt should be used instead of cobblestones, which are known to make a lot of noise when vehicles pass. This will ensure that sound and vibration are absorbed by the porous asphalt, reducing the noise generated by vehicles passing by.

Another suggestion is to close 1st Street completely to traffic and open it to traffic when necessary (service, ambulance, fire brigade, etc.). A solution to noise pollution can be developed in cooperation with the relevant institutions regarding 1st Street. As the entertainment venues on 1st Street are a major environmental nuisance, it is necessary to carry out a soundproofing analysis and control of these buildings and to take soundproofing measures. In areas where an action plan is required and where noise levels are above threshold values, it is expected that noise will be significantly reduced by applying one or more of the above methods.

This study was carried out to investigate the extent to which people living in tourism-oriented settlements, especially where highways and entertainment venues are dense, are affected by noise in terms of environmental noise levels, to develop proposals to reduce noise levels, and to determine the existing noise

levels for new settlements. In addition, it is proposed that town planning and noise levels in new buildings should be planned below the limit values.

In the context of urban design, this study has examined road traffic noise and entertainment-oriented spaces, and it can be recommended that different sources of environmental noise be examined in subsequent studies.

Author Contribution Statement

A.	*Idea and Fiction*	***B.***	*Literature Review*	***C.***	*Writing*
D.	*Data Collection*	***E.***	*Analysis*	***F.***	*Critical Review*
Author 1: B, D, *Author 2: A, C, E, F*					

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