

Article

Acquiescence of UNESCO Cultural Heritage and Acoustic Environments: Assessment of Hanlar District

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Abstract: Several natural and historical areas around the world are listed as UNESCO Cultural Heritage Sites. Hanlar District, located in Bursa, is the fourth biggest city in Turkey, its history includes the Ottoman, Roman, and Byzantine Empires, and it is an area with unique environmental features that represent various historical periods. Scholars at institutions worldwide have already recognized that such an environment has unique characteristics, and so local authorities should preserve the soundscape of the district as the sounds reflect the urban identity of the city. This study aims to evaluate the sounds of this unique district and recommends ways to preserve the historical and cultural heritage of the site in terms of its sounds. After collecting more than seven hundred pieces of data on sound pressure levels (SPLs) at twenty-one locations, the SPLs were statistically analyzed (an ANOVA was used for different time intervals, and a *t*-test was used for different days). Noon and weekend measurements varied among the sites, and these variations were statistically significant. Furthermore, the SPLs were above the WHO's suggested levels. The study findings show the importance of reducing sounds to create better acoustic environments. The local government should include all stakeholders, including residents, employees, and urban designers, in participatory approaches and action plans to preserve the sounds of cultural heritage sites.

Keywords: urban environment; UNESCO; cultural heritage; soundscape; history



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1. Introduction

Cultural heritage sites have become vital urban components of human-made structures in cities as they contribute to cities' cultural and historical identities. Various organizations, i.e., UNESCO, register such heritages to protect and manage them appropriately. Protection and management strategies may range from establishing regulations and using sustainable building materials to limiting visits, as cultural, social, and environmental factors threaten the intangible heritage of cities.

These strategies also affect air quality and sound levels, which affect historically registered sites. Although heritage sites have experienced various events and sustained their existence over centuries, their acoustic features, sound sources, and sound levels have changed. Soundscape assesses the impact of sounds on an area's identity [1]. Thus, sound environments contribute to the essence of areas, and UNESCO prioritizes the identity of these historical relics. Some researchers have examined the nexus between UNESCO World Cultural Heritage Sites and sounds in various ways, such as by exploring the types of sound sources [2], establishing a website for archiving purposes [3], identifying unique sounds [4], and using virtual reality [5,6]. We aimed to uncover the sound levels and historical sound features of the old bazaar and historical district of Hanlar District in Bursa, Turkey, to determine and preserve its historical acoustic heritage.

The city of Bursa, which was the first capital of the Ottoman Empire and has the characteristics of a historical town, includes six particular regions with prolonged histories, cultural values, and architectural features that reflect the history of the city; these include

Orhangazi Kulliye and its surroundings, Hüdavendigâr (I. Murad) Kulliye, the Yıldırım (Bayezid I) Complex, the Yeşil (Mehmed I) Complex, the Muradiye (Murad II) Complex, and Cumalıkızık Village, and these areas were classified as UNESCO World Heritage Sites in 2014. Hanlar District is located in the city center of Bursa. It reflects the city's image with its original historical features and embodies cultural heritage structures, meaning that preserving the district is desirable.

Although the architecture and history of Hanlar District have been evaluated, the soundscape elements of the district have not been assessed. Since the buildings are used and the site users' preferences change, exploring the soundscape of the district is highly important to provide a robust understanding of the association between sounds and historical sites and to unite history, urban studies, architecture, planning, and urban design disciplines.

This study aimed to contribute to the relationship between soundscape and historical sounds, since this nexus is missing in the literature. In line with this aim, sound pressure levels (SPLs) were measured on different days and at different time intervals to understand the acoustic environment of Hanlar District comprehensively. Thus, the study's research questions are as follows: How are the sounds in this area distributed? What are the sound levels in the region? Can the historic sounds in Hanlar District be preserved? We used a quantitative research design method to define and document the sound levels in Hanlar District and we provide some recommendations based on our results.

2. Related Studies

2.1. UNESCO World Cultural Heritage and Urban Design

Scholars have assessed the attractiveness and urban identity of World Heritage Sites. Wesener initially aimed to understand the experience of visiting a site and what makes a place authentic by examining the Jewellery Quarter in Birmingham (UK) [7]. The author surveyed the surrounding business owners to determine the site's authenticity based on its urban design characteristics. In another study, Długozima and Rybak-Niedziółka assessed the Royal Route, which includes forty landmarks in Poland [8]. The authors first identified the critical attractiveness criteria, i.e., accessibility, architecture uniqueness, sense of place, etc., as have been determined by various scholars, and they applied such standards to explore the selected study areas. They offered some suggestions on enhancing the site's attractiveness by providing lighting designs, enhanced way-finding features, a sense of belonging, etc.

Li et al. assessed the nexus between urban morphology characteristics and a UNESCO World Heritage Site in the old town of Lijiang, China [9]. After performing some spatial analyses, the authors found that although the structures were relatively stable, the neighborhood connections were about to disappear. Ashrafi et al. conducted a heritage impact assessment and incorporated visual integrity to obtain and examine anthropology-based ramifications on cultural heritage [10]. They compared two cases, the Meidan Emam and Cologne Cathedral, and proposed more cooperation and enhancement in the capacity-building of the sites.

Other scholars have concentrated on the buildings and structural pressures surrounding UNESCO Cultural Sites. Khalaf (2017) discussed the reconstruction conflicts surrounding UNESCO World Heritage Sites, whereby the changing urban fabric was causing irreversible problems [11]. The author mainly focused on the guidelines that should be changed or modified. Anelli and Tajani (2022) defined a novel approach toward exploring land pressures on cultural heritage sites [12]. The authors remodeled the city of Alberobello in Italy as if it were being reconstructed, and removed irrelevant structures from the site; the scenario results showed that the new model resulted in more financial and environmentally friendly benefits for the local government and site users.

2.2. UNESCO World Cultural Heritage and Sound

A few scholars have assessed noise pressures at UNESCO sites. Morillas et al. (2013) evaluated the noise levels at a historic square of a World Heritage Site in Cáceres in Spain by identifying the noise sources that masked the historical sounds of the site [2]. The authors determined that car-related noise and passing people were the primary noise sources at the site.

Several other researchers have used the soundscape approach to highlight the unique sound sources. Regarding cultural heritage specifics, Yelmi (2016) examined cultural sounds to help to preserve and archive the intangible cultural heritage of Istanbul [3]. Specifically, the author created a website to collect the acoustic features of the city. Lee et al. (2018) collected sound samples using a phone application at the Miyajima and Itsukushima Shrine in Japan [4]. They reported that the site offered unique sounds, i.e., the sounds of cross-channel ferries and individuals walking around the mountain. Belkayali and Kaymaz (2021) studied three historical places to understand the cultural heritage sounds [13]. The authors also created several noise maps using a phone application and found that building use and temporal attributes played essential roles in defining the sound characteristics of the city. In another study, Pietroni (2021) experimented to determine cultural heritage sounds using virtual reality and mixed reality tools [5]. The author proposed the importance of simulations to preserve cultural heritage sites and several directions for future museums, galleries, and games. Similarly, Diaz Rubio et al. (2022) extended the approach of using virtual reality to record sounds by using virtual reality in a cultural heritage building—The Water Tribunal of the Plain of Valencia—in Spain [6]. They aimed to help to preserve the important cultural heritage sounds.

2.3. Site-Specific Studies

Several studies have examined the current study area from various aspects. Polat et al. (2018) argued that the site is losing its identity and needs to be integrated with urban-design-related guidelines or tools [14]. The authors developed guidelines for users' needs and preferences to preserve the unique identity of the heritage site. Other researchers have highlighted the importance of enhancing the site. Koprulu Bagbanlı (2007) conducted the most comprehensive historical evaluation of the site [15]. The author mentioned that the site had been a part of the city center since the 14th century, and it fulfilled several needs of individuals in terms of culture and environment. Polat et al. (2019) aimed to establish a participatory design guideline for urban design aspects to improve site management [16]. Shakur et al. (2012) compared the attributes of Dakka Chawk Bazaar in Bangladesh and Hanlar District and how they influence their economy, social life, and culture [17]. Although these scholars identified some cultural and environmental concerns with the site, the sound was not considered to be part of the site's identity, and this study aims to contribute from this aspect.

3. Materials and Methods

We used a quantitative approach for the research design, including soundwalking, sound pressure level measurements, and spatial representation to digitize and determine the sound-level characteristics of the UNESCO World Heritage Site for archival and preservation purposes.

3.1. Study Area

Hanlar District was the study area, which is a UNESCO World Heritage Site, with its cultural, historical, and architectural features (Figure 1). Although over a thousand sites are on the World Cultural Heritage Site list, only eighteen of them are in Turkey, and the study area is in the core area of Bursa [16]. The site was on the caravan routes around the Uludağ skirts hundreds of years ago and was built between the 14th and 16th centuries to meet religious practice, shopping, trading, and socializing needs at the time. Although

over three thousand stores and twenty-seven inns existed, only 21 registered buildings currently exist, and 7 of them are inns with square or rectangular footprints [16].

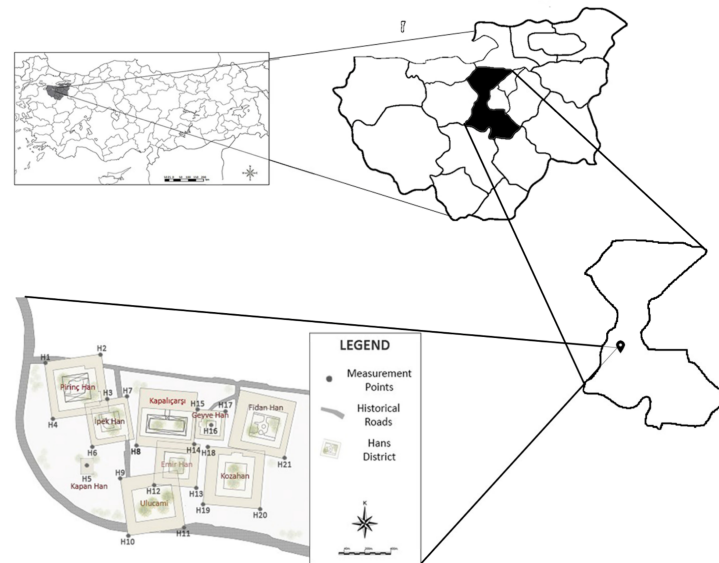


Figure 1. Study area.

3.2. Soundwalking and Sound-Level Measurements

The researchers initially carried out soundwalking to identify the existing sounds and potential dimensions of the sound environments in the study area. Soundwalking is a method whereby one walks and concentrates on the acoustic environment as a listening practice to develop a first impression of the sounds in an area [18–20]. Thus, the key aim of this method is to detect sound elements and to identify sound-level measurement locations along with routes. The soundwalking was concluded after determining twenty-one sampling points.

Next, the sound sampling process was performed at the twenty-one pre-defined points (Figure 2), including various sounds, i.e., site users' chats, footsteps, business owners' shouts, surrounding traffic, birdsongs, water, etc. (Figure 3 shows photos of these areas.) The sound pressure levels (SPLs) were collected at different time intervals, i.e., mornings, afternoons, and evenings of weekdays and weekends, to understand the temporal variations in the sounds. Following the literature, the SPLs were collected at three time points to holistically understand the sound attributes [21–23]. Thus, we collected SPLs between 8 and 10 a.m. (morning representation), 12 and 2 p.m. (noon representation), and 5 and 7 p.m. (evening representation).



Figure 2. Detailed map of SPL measurement locations (adapted from Bursa Site Management Unit, 2013) [24].



Figure 3. Photo collage from the SPL measurement locations.

Based on the ISO standards and the procedures used for other studies, the SPL measurements were conducted using a PBX LXTI Class I Professional SPL meter by recording fifteen-minute sampling (L_{eq} 15 min) in each location in dB(A) parameters. Following the ISO standards and the literature, the sounds at each location were measured during three time intervals and on weekends and weekdays (which resulted in a total of six measurements for each measurement point); the measurements were recorded at a 1.5 m height from the ground and away from the facades and curbs to prevent the sounds from reflecting off the ground and wall [22,25,26]. The measurements included some parameters, including LA_{eq} , LA_{min} , and LA_{max} , and a total of 756 measurements were eventually performed.

4. Findings and Results

The study findings revealed some specific patterns. Considering all of the sound-level parameters, the mean LA_{eq} was 67.3 dBA, with a range of 31.6 dBA, and the min. and max. values were 51.7 and 83.3 dBA, respectively. Additionally, the L_{min} and L_{max} values were 48.2 and 85.5 dBA, respectively, whereby the min. values were between 40.9 and 78.6 dBA and the max. values were between 60.9 and 89.5 dBA, respectively. The range between these parameters was 20.0 and 10.9 dBA, respectively.

Considering the temporal variations, the noise measurements at different times of the day differed by about 8 dBA (Table 1). The highest mean noise levels were measured at noon (72.3 dBA), followed by the morning (65.2 dBA) and the evening (64.6 dBA). After conducting an ANOVA, we determined that these differences were statistically significant (ANOVA ($F(2,753) = 297.260$, $p = 0.000$)). It was somehow expected that the noon measurements would include the highest noise levels. Furthermore, the weekend measurements were approximately 2 dBA higher than the weekday measurements at 68.2 and 66.5 dBA, respectively. The t -test results also showed that the difference was significant, $t(754) = -4.454$, $p = 0.00$.

Table 1. SPLs of time and day.

		Mean	Std. D.	Std. E.	Min.	Max.
Time	Morning	65.2	5.96	0.65	45.2	88.1
	Noon	72.3	2.89	0.31	43.0	89.2
	Evening	64.6	1.50	0.16	40.9	81.9
Day	Weekday	66.5	5.39	0.48	43.2	88.1
	Weekend	68.2	4.93	0.43	45.2	89.2

The SPLs of the sites showed variations in the sound-level sampling points (Figure 4). The lowest mean (L_{eq}) was captured at the Geyve Han (P15–17) at 65.5 dBA, and the

highest mean SPLs were measured at the Ulucami (P9–12) at 69.8 dBA, followed by the Kapan Han B (P5), Emir Han (P12–14), Pirinc Han (P1–4), Ipek Han (P3,6–8), and Kiza Han (P18–20) at 68.6, 68.3, 67.5, 67.2, and 67.2 dBA, respectively (Table 2). Overall, the sites near transportation facilities, i.e., roads, bus stations, etc., had higher noise levels, whereas those without transportation and human interaction locations had lower noise levels. Furthermore, after performing an ANOVA, it was found that a significant difference did not exist between the sites with and without transportation (ANOVA ($F(8753) = 1.349$, $p = 0.219$)).

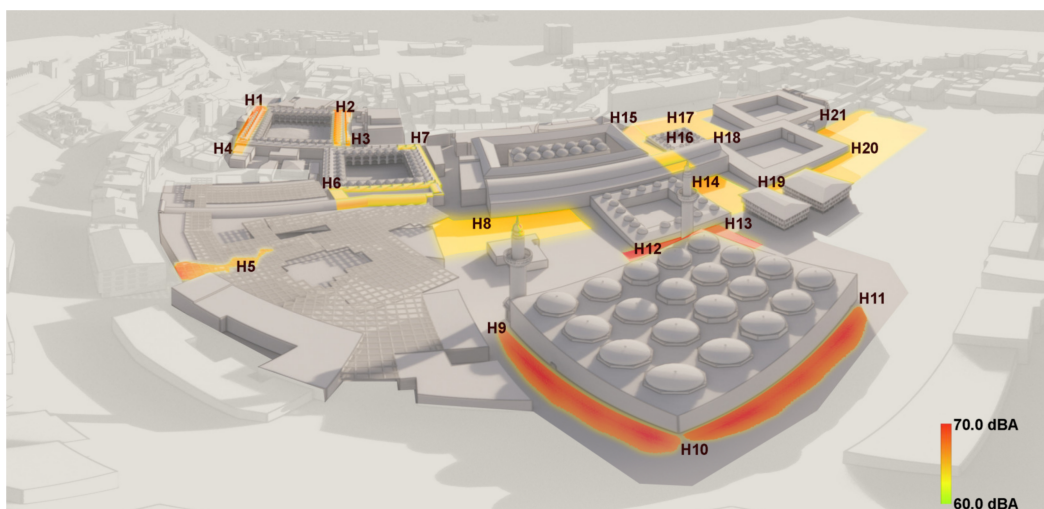


Figure 4. Sound-level representation of each building.

Table 2. SPLs of the site buildings.

Sampling Points	Mean	Std. D.	Std. E.	Min.	Max.
P1–4 (Pirinc Han)	67.5	5.19	0.74	40.0	88.2
P5 (Kapan Han)	68.6	3.92	1.13	43.0	88.0
P3,6–8 (Ipek Han)	67.2	4.54	0.65	40.9	88.1
P9–12 (Ulucami)	69.8	4.81	0.69	46.6	89.5
P12–14 (Emir Han)	68.3	5.79	0.96	46.6	89.5
P8,14–15 (Kapali Carsi)	66.5	5.14	0.85	43.0	89.1
P15–17 (Geyve Han)	65.5	6.32	1.05	43.0	89.5
P18–20 (Koza Han)	67.2	5.38	0.89	43.8	89.4
P21 (Fidan Han)	67.0	4.87	1.40	43.6	89.0

A Specific Glance at Heritage Buildings

One of our core aims was to understand the levels and potential sources of the sounds present at the cultural heritage sites, and we found some sound patterns at each site (Figure 4).

Emerging Patterns

Highlighting some patterns at each site from west to east, Pirinc Han was used for fur trading and has a hexadecagon-shaped water fountain and a two-story building with 38 units on the first floor and 48 units on the second floor. Since the site includes several coffee and hookah shops on the first floor and very few offices on the second floor, the site users are generally younger. Hence, the primary sounds were generated at the coffee and hookah shops, including loud music, chatting, eating and drinking activities, and indoor games, such as foosball table and other video games. Ipek Han is located south of Pirinc Han and has a similar layout, including various clothing stores, tailors, and wedding dress shops. The SPL measurement points (P1–2) near the tram and heavy pedestrian-

use routes of Pirinc Han were noisier than the other points (P3–4) by almost 4 dBA. In a more inner location than Pirinc Han, Ipek Han had more steady sound levels at all of the measurement points (P3,6–8) at around 65.9 and 66.9 dBA. This might be explained by the fewer interactions between users and the fewer transportation components.

Another site (Kapan Han) is the only site nearly disappearing and is surrounded by high-rise buildings, mainly warehouses or manufacturing retailers. So, this site only generates machine-related sounds, and the sound level remained at around 68.6 dBA.

Ulucami is the most important mosque in the city. It was built in the late 13th century, includes two minarets and twenty domes, and is near a busy road. It also includes a shadirvan, a type of water-tank-style water fountain, next to the structure. These features attract several visitors, and they cause various anthropogenic sounds. This may be why the site had the highest sound levels, between 68.1 and 69.9 dBA, among all of the study areas.

Emir Han has a two-story 46×50 m layout. The first floor comprises thirty-six units without windows, and the second floor contains thirty-eight units. The site is currently used to sell books and clothes, and the sounds were caused by users who visited the building, passed other buildings, or purchased books; the sound level at the inner point was about 67.0 dBA, whereas the sound level at the outside corners was 69.1 dBA.

Kapalicarsi (Grand Bazaar) used to be the center of the city's banking systems and stock markets, and the structure is in the east–west direction with two rows and fourteen domes to enclose the units. The site is somehow semi-closed, and, currently, it includes several jewelry stores. So, the site's primary users include pedestrians that are passing by and individuals shopping at jewelry stores. Since the site meets the users' general shopping needs, the sound level remained constant at around 65.7–66.8 dBA.

Geyve Han is also a two-story building with 26 units on the first floor and 30 on the second floor. It has an almost square layout, and textile manufacturers currently use the facility. Since it is in a very inner location that is not close to any transportation or individual activities, the site had the lowest sound levels at 64.7 and 65.6 dBA.

Koza Han was built in the late 14th century to finance the Istanbul economy. The layout is close to a square but somewhat rectangular, and includes 45 units on the first floor and 50 units on the second floor. The most remarkable detail of this complex is that it has an octagon-shaped shadirvan and a mosque above it at the center of the site. Currently, many tea houses and coffee shops are on the site. Since the site is actively used to purchase tea and coffee, the site had mainly anthropogenic sounds, and the sound levels differed between 66.0 and 69.0 dBA.

The last building was Fidan Han, which has a similar layout to Koza Han; it has 48 units on the first floor and 50 units on the second floor, and a shadirvan and mosque above it. The site currently has small local restaurants for surrounding business people and coffee and textile shops. So, various individuals visit the site, and it has sound levels of about 67.0 dBA.

5. Discussion

How are the sounds in the UNESCO Cultural Heritage Sites distributed? Additionally, how does the sound of this site differ from that of other UNESCO sites? After collecting over seven hundred and fifty sound-level measurements, we found that the site showed some variations in sound patterns.

5.1. Transportation Features

The sound levels close to the transportation features mainly remained higher at almost 90 dBA. Since the cultural heritage site is a “peninsula” shaped by heavily used roads, trams, and some tiny roads, the transportation facilities affected the sound measurements adjacent to these features. Although transportation characteristics and noise associations have been studied well enough [27–30], we also confirmed that the noise levels increased near transportation facilities.

Perhaps as Ruiz et al. (2017) suggested [31], a specific route based on both the site users' frequency of visiting the site and multi-modal transportation should be implemented, and this should exclude vehicles and other options, i.e., underground passes [32]. This may assist the area in two aspects: way-finding and site branding may comprehensively enhance familiarity with the buildings of the cultural site and offer higher-quality local and regional tourism opportunities, resulting in lower noise levels and higher air quality in the area. This may also direct additional local policies, including emission reduction and quiet zones [33].

5.2. Site Specifics and User Habits

Another spatial sound pattern emerged regarding the specific buildings and individuals' use of the sites. Users heavily use some routes (Emir Han to Koza Han) or landmarks (e.g., the entrance of Ulucami) in the cultural heritage site. The buildings in the cultural heritage site have been transformed to be used for other functions, or they have ceased their operation entirely or completely disappeared. Such transformations have also altered the sound levels, as some buildings include coffee and hookah shops, which generate noise specific to the site activities. Moreover, some other facilities are "specialized" in selling textiles, and other manufacturers and individuals visit such areas as customers. Furthermore, individuals use specific routes between these historical buildings. Whereas some buildings' second floor and south entrance or exit are primarily used (i.e., Koza Han), other buildings are used for their ground floor and west or east entrance or exit (i.e., Pirinc Han and Ipek Han). So, all of these buildings affect the sound levels of the cultural heritage sites.

Establishing more pedestrian-oriented policies, i.e., pedestrianized sites [34], may enhance the sites in various ways. Such efforts cause a more sustainable environment, and they also create a quieter environment as well. These efforts may cause nature-related features, i.e., wildlife and birds, to be introduced to the cultural heritage site, which will balance the dominant anthropogenic and transportation-related sounds.

Regarding the other research concerning sound levels, the sound levels of the cultural heritage sites differed with time. The site had the highest sound levels at noon and on the weekend, whereby an almost 8 dBA difference existed between the sound levels obtained at daytime and noon, and a 2 dBA difference existed between the sound levels obtained on the weekdays and weekends, which are considerable variations. Although the WHO suggests a 50 dBA SPL for outdoor areas, cultural sites excessively produce noisy environments with more remarkable variations in sound levels [35]. So, keeping this area at the recommended sound level is another concern for this UNESCO Heritage Site.

5.3. Other UNESCO Site Comparisons

Comparing the sound levels of the study area with those of other UNESCO sites exemplifies the overall status of the acoustic environment of Hanlar District. Some scholars have determined that 65 dBA should be the sound-level threshold for vehicles, people, animals, and other features of UNESCO sites, and have accordingly conducted various analyses [2]. In comparison, Lee et al. found that the mean sound level of a UNESCO site was 64.1 dBA, which was below that of other Japanese sites [4]. Another researcher measured the sound levels at three UNESCO sites and found a higher range for the mean L_{eq} between 60 and 81 dBA [13]. Our study results showed that all measurements of the L_{eq} parameters somehow exceeded 65 dBA. So, Hanlar District is also exposed to noise levels that should be reduced with some design and policy guidelines.

6. Conclusions

Various policies, regulations, and actions have been undertaken to sustain the historical values of UNESCO World Cultural Heritage Sites. Although several policies and regulations allow the site's conservation to be successfully managed, some concerns occur for these areas, and sound is one of them. This study aimed to highlight the sounds in Hanlar District by assessing them in several ways, such as measuring how the sounds vary

according to time and building use, along with potential transportation noise threats to the site's existing buildings.

Since the study notably identified that the sound levels were above 65 dBA, these sounds need to be reduced via some mitigating and masking policies and design solutions. Since the site is a local and foreign tourist attraction, the acoustic environment has noisy features, and the sound levels should be reduced accordingly. A survey could be conducted to understand what the site users prefer to hear in this location, as people and transportation are the main reasons for the noise. Even though the municipality operates restoration projects that remove non-historical buildings, the same effort should be applied to acoustic environments to introduce pleasant sounds to the site. The historical site includes some quiet areas that can promote tranquility by creating more natural sounds, i.e., water, monumental trees, birds, etc., to preserve the site's unique identity, since changing building uses and transforming their functions also alter acoustic environments. Furthermore, transportation noise should be eliminated by establishing a "quiet zone" or forbidding heavy trucks and buses; this would reduce noise levels as heavily used roads surround the site.

The sound levels of the site are affected by several factors, including the characteristics, functions, and uses of the buildings, the implementation of transportation and other built-environment factors, the site users' preferences and their habits, the temporal conditions, and the transportation attributes, i.e., roads, vehicles, bus stops, higher speed limits, number of vehicles, multi-modal types, etc. Therefore, creating noise-related solutions considering these characteristics is necessary, and perhaps UNESCO should also develop environmental exposure guidelines that incorporate noise and emphasize instructions and regulations in conjunction with built- and nature-related features.

UNESCO Cultural Heritage Sites were established centuries ago and have experienced many man-made and natural events, and they need to be maintained for future generations. To ensure this, the historical values along with other cultural, societal, and environmental attributes of the sites, including site-related sounds, should be preserved to sustain and generate the sound identity of these sites, and multi-disciplinary approaches, including planning, urban design, history, etc., can be used to establish a more compelling platform for such purposes.

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