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Unveiling iconic sounds as intangible cultural heritage of a tourist city

Abstract

Purpose

This study is part of a series aimed at improving the city's environment, as fully restoring the past soundscape is hardly feasible. The initial study aims to uncover the city's sound characteristics, including iconic sounds that have shaped the city's environment for decades, contributing to its status as Indonesia's second most popular tourist destination. This stage is critical for informing policy-making to carefully manage and enhance the urban acoustic environment in alignment with the preserved culture.

Design/methodology/approach

The city's sound profile was examined using standard urban sound taxonomies. The study used quantitative methods, including (1) sound pressure level measurements and sound recordings, (2) *in-situ* surveys, and (3) memory-based surveys. The first set of data were compared to current standards and standard urban sound taxonomies, while the second set was analysed to determine the median rating score for determining the soundscape dimensions. The third data set was used to identify the specific acoustic aspects inherent in Yogyakarta.

Findings

Yogyakarta's acoustic environment was bustling, with traffic noise and human activities dominating the soundscape, surpassing the standard levels. Many sounds not classified in standard urban sound taxonomies were present, showing the diverse nature of urban sound classification, particularly in a cultural and traditional city like Yogyakarta. The memory-based survey unveils Yogyakarta's two most remarkable soundmarks, 'gamelan' and 'andong', which support the findings of prior studies. The in-situ survey rated the city's acoustic environment as eventful, pleasurable, and generally appropriate, emphasising the presence of cultural sounds unique to Yogyakarta, even though they are not fully audible in the current environment.

Originality/value

The standard sound taxonomies used in urban areas need to be adjusted to include the unique sounds produced by cultural and traditional activities in developing countries. The ordinates and subordinates of the taxonomies also need to be updated. When cultural and daily activities are massively seen in a particular city, the sounds they produce can be recalled exclusively as the city's signature. It is urgent to

Commented [CEM1]: 1) The abstract is reworked to follow the structured abstract format.

implement policies to safeguard the few remaining soundmarks before they disappear entirely.

Keywords: iconic sound, sound taxonomy, soundmark, soundscape, culture, heritage, tourist

Commented [CEM2]: 2) A keyword is added to show the focus of the paper.

Introduction

Yogyakarta is the capital of Indonesia's only special province, Daerah Istimewa Yogyakarta. This special status arises from its historical formation as a kingdom, namely Mataram, established in the sixteenth century, whose King agreed to merge as a part of the Republic of Indonesia when Dutch colonialism ended in 1945. To honour the willingness to join as a nation, the Indonesian government bestowed the Yogyakarta government a unique form with the King as its governor. The kingdom was the centre of Islamic spread combined with Javanese culture and traditions (Rindrasih & Witte, 2021). Most tourists visit Yogyakarta to explore the town's remaining traditions and cultural heritage, which are strongly associated with the Sultanate's existence, making it unique and becoming Indonesia's second most visited tourist destination after Bali. Though the Sultan Palace currently serves as a cultural symbol only, it is the leading destination for tourists. People perceive 'gamelan', a substantial musical instrument of the Sultanate, as the most substantial part of Yogyakarta culture (- et al., 2023a). It was customary to hear this type of music in the palace and royal family residences. People also associate Yogyakarta with 'andong' (- et al., 2023a), a horse-drawn carriage used to transport humans and goods. The 'gamelan' and 'andong' each represented the cultural and traditional life of the locals, including the sound they produced.

Recently, visitors have noticed that Yogyakarta is different from what it used to be. They could not extend their arguments, but it seems mainly due to the change in local lifestyles, where modern activities gradually replaced cultural and traditional activities that affected the environment, including the sound environment. Human sounds that contribute to the sound environment are mainly by-products of people's activities, such as the sound from 'andong', and sounds that are intentionally generated to allow human society to function (Parker & Spennemann, 2022), such as the 'gamelan' sound. Since cultural and traditional values greatly influenced Yogyakarta people's lives, the sound environment was composed mainly of local activities related to cultural and traditional values. These should create an actual living museum that becomes the main tourist attraction. 'Actual' was used to differentiate it from living museums worldwide, commonly played by actors or museum staff.

When visitors notice that tourist attractions have changed from their expected conditions due to different environmental settings, it is crucial for the authorities to understand the cause. For the case in which sound is part of the city heritage and part of the

factors that visitors regard as degrading the quality of the tourist objects, a careful and comprehensive study is a critical stage before policies and actions for improvements. Pardoen and Guesney (2024) said this type of study requires numerous cross-checks to validate the information for the heritage sounds to be regained. The study is more challenging as it swings between tourism purposes and sustainable intangible heritage preservation of soundmarks that people strongly associate with Yogyakarta.

A series of studies to unveil the sound characteristics of Yogyakarta started with identifying the city regulations and policies regarding sound, which was conducted with nine other leading cities in Indonesia. The study found no specific code that applies to Yogyakarta (- et al., 2022c), given the city's unique characteristics. The Indonesian Government and Yogyakarta municipality use the general sound standard stipulated by the Ministry of the Environment of the Republic of Indonesia, dated 1996. The study reported here aims to unveil the characteristics composed partially of iconic sounds, which have contributed to the city environment for decades. The findings will allow policymakers to carefully manage and improve the acoustic environment to align with the preserved culture.

Phonic identity of a city

Cities can easily be distinguished from one another by their landmarks and their unique surrounding sounds to complement the visual ones. One can define the iconic sound or soundmark and describe the city's attributes by conducting a soundscape analysis. An iconic sound, others may call it a soundmark, is like a landmark, i.e. an object that is automatically heard when people are in a specific area to help them quickly identify the place. Through human activities, cultures are developed. Therefore, soundmarks have cultural and historical significance (Rehan, 2016), which are also essential for tourism purposes (Duffy et al., 2011; Yelmi, 2016; Liu et al., 2018; He et al., 2019).

Bilen and Can (2021) stated that soundscape changes depend on the complex interaction among multiple sound sources, properties of the environment, and society. Thus, changes in the city's physical composition, including landmarks, might change the soundscape of a city, including its soundmarks. In the case of Yogyakarta, where physical composition and social life are changed simultaneously along with modernity, there are significant cultural and traditional transformations related to its soundscape and soundmarks. Just like in nine cities under the earlier study, the phonic identity of Yogyakarta is hardly audible. Traffic noise creates low-fidelity sound that masks the nine cities' remaining soundmarks (- et al., 2022c).

Cultural sound and tourism

Commented [CEM3]: 3) The introduction has been revised to clarify the conditions in Yogyakarta further and better align with the objective.

Commented [CEM4]: 4) Narratives are included to elucidate the significance of specific policies related to sound for a cultural and tourist city.

Commented [CEM5]: 5) This part has been revised to incorporate reviewers' feedback by making normative explanations more engaging and emphasizing the importance of phonic identity.

When tourists visit tourist places, they consider environmental quality, security, cleanliness, landscape quality, and health benefits (Romero et al., 2015). Soundscape quality is also considered but is not as significant as the other aspects. Even so, soundscape is integral to the whole visiting experience for tourists (Liu et al., 2013). Furthermore, Liu et al. (2018) extend their findings that a destination's soundscape is one of the core elements of tourists' experiences. This agrees with He et al. (2019), who observed that soundscape significantly influences tourists' perceptions. This is because the soundscape could be an integral aspect of tourist attractions or the main attraction itself (Briassoulis, 2002), for instance, music tourism (Gibson & Connell, 2005). Second, the soundscape could offer a backdrop upon which tourists create a sense of a place (Liu et al., 2018).

Although not literally mentioned as sound, oral traditions, expressions, and performing arts are part of intangible heritage, as the UNESCO Convention for the Safeguarding of Intangible Cultural Heritage acknowledged in 2003. This includes songs and music. The previous study indicated that 'gamelan' and 'andong' are distinct sounds that represent the intangible heritage of Yogyakarta. This heritage extends beyond the cultural heritage defined by UNESCO, as mentioned in Kirshenblatt-Gimblett (2004), as it includes both cultural ('gamelan') and occupational or transportation sounds ('andong'). Yogyakarta has 'gamelan' performances, which are a major draw for visitors, and the presence of 'andong' in the background contributes to a stronger sense of the place. Preserving cultural soundscapes is crucial for maintaining a place's cultural identity within the dynamic structure of intangible culture (Yelmi, 2016). Cultural and traditional sounds can represent social, spiritual, historical, national, and cultural memories of a specific place and society (Kato, 2009), just as in the case of Yogyakarta.

Soundscape method

Soundscape is a method to appraise the sound environment, defined by ISO 12913-1:2014 (ISO, 2014) as the "acoustic environment" as perceived or experienced and understood by a person or people, in context. Soundscape studies of a city are commonly interested in identifying the iconic sounds as a part of its intangible heritage (Yelmi, 2016; Parker & Spennemann, 2022), especially in a city that preserves historical values and famous landmarks as tourist objects, such as Yogyakarta. Questionnaire surveys and spatial audio-visual recordings of a soundscape are primarily based on Method A of ISO/TS 12913-2:2018 (ISO, 2018). This method is used for soundscape studies, including sound heritage.

Central to ISO 12913-2, an acoustic environment can be evaluated based on perceptual attributes (PA), standardised in English, which may be interpreted differently in non-English countries, resulting in a less valid soundscape evaluation. Aletta et al. (2020) attempted to validate the perceptual attributes in 15 different languages, including one in

Commented [CEM6]: 6) Narratives are included to describe the specific tourist attractions in Yogyakarta related to sound, which go beyond those defined by UNESCO in Kirshenblatt-Gimblett (2004).

Commented [CEM7]: 7) Narratives are added to justify the use of a soundscape approach in the initial stage of preserving historical values.

Commented [CEM8]: 8) Narratives are added to justify the use of general soundscape for sound heritage studies.

Bahasa Indonesia, which was reconfirmed by Sudarsono et al. (2021). Table 1 shows the eight soundscape perceptual attributes as of ISO/TS 12913-2:2018 in Bahasa Indonesia, which was used in this study.

Table 1 about here.

2. Methodology

The study was conducted as an initial investigation to unveil the city's unique sound characteristics and create a baseline for further research, policy formulation, and potential enhancements of the traditional-cultural yet tourist city's soundscape. As this stage was explorational, the study used a classificational approach as Parker and Spennemann (2022). Data was collected from three phases: (1) measurement of sound pressure levels (SPL) and sound recording at designated spots, (2) *in-situ* soundscape surveys and (3) memory-based soundscape surveys. The *in-situ* soundscape survey was conducted at the same spots as the SPL measurements and sound recording. The SPL was to be plotted against sound standard (Ministry of the Environment, 1996), and urban sound taxonomies shared by Salamon et al. (2014) and by ISO 12913-2 (2018) were used to study similarities or differences between typical and standardised urban soundscape and touristic urban soundscape collected from the recordings. The trend of participants' perceptions through soundscape data will be uncovered statistically to describe how the sound environment is classified. Participants of the survey, both *in-situ* and memory-based, were not differentiated between locals or visitors because, as Romero et al. (2015) noted, there are no differences in sound perception between residents and tourists.

Commented [CEM9]: 9) Narratives are added to explain that the study is designed as an initial stage for a reference to policy-makers. The study mentions the use of a classificational approach to study the sound characteristics of the city. This is to address reviewers' comments about the methodology.

Commented [CEM10]: 10) A comparison with the ISO taxonomy has been added to align with the study by Parker and Spennemann, as mentioned by reviewers.

SPL measurement, the area, and sound recording

In Indonesia, sound management and environmental noise policies primarily focus on reducing SPL. With stratified SPL based on area functions plotted, the study must confirm current environmental SPL against the standard as a reference for the later investigation. Previous research recommended the city's three most visited public places for soundscape studies amidst many cultural areas and tourist attractions (- et al., 2020b). This study agrees to use these areas: Malioboro, Tugu and Alun-alun Kidul (Figure 1). The three tourist attractions are located on the cosmological axis of Yogyakarta, which is the most substantial Yogyakarta's heritage, as well as culture-based tourism in the city (Wijayanti & Damanik, 2019). The cosmological axis and its historic landmarks consist of Mount Merapi, Tugu Monument, Sultanate Palace, Panggung Krapyak, and the Indian Ocean (Wipranata & Tjung, 2020), were inscribed as world heritage by UNESCO in 2023.

Commented [CEM11]: 11) Narratives are included to provide justification for site selections.

Malioboro is an iconic street with shopping arcades on both sides. Unique temporary food stalls, called 'lesehan', are spread out in the vicinity, which becomes very busy at night, especially on weekends. The name 'lesehan' represents customers sitting on floor linings,

namely, 'tikar' (Figure 2). The ambience rises further when street musicians, sketchers, and other artists display their works along the street, making it a must-visit place in Yogyakarta. Then, Tugu is the landmark of Yogyakarta, located at the starting point of the tourism corridor consisting of Tugu–Malioboro–Sultanate Palace. Tugu is also a must-visit place. Alun-alun Kidul (alun-alun means 'city square' and Kidul means 'South') is the southernmost part of the Sultanate Palace area. There are North and South squares, but the North Square has been closed to the public to maintain its sacredness. The South Square has lately become a favourite place. Locals and tourists mostly visit during weekends for sports and to enjoy local cuisine with friends and families. SPL measurements and sound recordings were carried out in these three selected areas, with more information on the measurements and equipment used listed in Table 2.

Figures 1 and 2 about here.

Table 2 about here.

In-situ soundscape survey

SPL indicators and sound recordings provide limited information on perceived acoustic comfort. Therefore, people perceptions of the acoustic environment through soundscape surveys were also carried out in these three selected areas. Three spots in each area were surveyed by nine participants, thus 81 data points were collected. The survey focused on temporary residents to collect perceptions from those familiar with the environment but with little memory of the past condition. Locals' perceptions might be biased by their positive memories of the past compared to the current significant change in the environment. Undergraduate students studying at a local university who have been residing for two to four years were invited to participate in the survey. They were six males and three females, aged 20–22 years. The surveys complied with ISO/TS 12913-2:2018 (ISO, 2018), and the questionnaire follows the questionnaire-based soundscape assessment (Method A) for typical soundscape survey as specific soundscaping for heritage fields has yet to be available. It was widely used for heritage and historic soundscapes. Jordan and Fiebig (2021) and Abd Jalil et al. (2023) are examples. Eight PA: pleasant, vibrant, eventful, chaotic, annoying, monotonous, uneventful, and calm were used. The PA in Bahasa Indonesia refers to Sudarsono et al. (2021), as listed in Table 1. The questionnaire was divided into three parts: (1) general information about the sound environment, soundmarks, and degree of pleasantness, (2) eight PA, and (3) reconfirmation of perception of the sound (Table 3). They were all collected using Likert scale responses, which are coded from 1 (strongly disagree) to 5 (strongly agree) as ordinal variables for the PA responses and from 1 (not at all) to 5 (dominate completely) and 1 (very bad) to 5 (very good) for other questions. ISO/TS 12913-3:2019 (ISO, 2019) was employed to analyse the PA collected based on the median rating score to determine the pleasantness and eventfulness

Commented [CEM12]: 12) Narratives are added to address reviewers' comments about the importance of specifying informants' selections.

Commented [CEM13]: 13) Narratives are added to address reviewers' feedback on the appropriateness of the typical soundscape approach for the historic soundscape.

dimensions commonly used in soundscape appraisal (Aletta et al., 2016). The pleasantness and eventfulness dimensions were calculated based on Equations (1) and (2).

Pleasantness = (pleasant − annoying) + cos 45°(calm − chaotic) + cos 45°(vibrant − monotonous) (1)

Eventfulness = (eventful − uneventful) + cos 45°(chaotic − calm) + cos 45°(vibrant − monotonous) (2)

Table 3 about here.

Memory-based survey

Memory-based survey was conducted online to collect data from broader respondents. The questionnaire was distributed randomly and borderless of domicile using a Google form with questions as listed in Table 4, shared through social media groups. Although it was random, only participants at certain ages were covered as it was only shared with adult social media groups (WhatsApp and Telegram). More than 100 responses were expected to be collected.

Table 4 about here.

3. Result and discussions

The sound environment

The measurement shows that SPLs at nine spots were high, ranging from Leq 68.3 dBA (Tugu) to 81.5 dBA (Malioboro). The high SPL of Malioboro is reasonable as it is bustled with passing vehicles, live music performances, and business activities. The narrow aisle between tenants amplified all those sounds. The SPLs at Tugu and Alun-alun are generally lower as human activities and traffic in those areas were lesser than in Malioboro. Repetitive and monotonous sounds were found here instead of dynamic sounds, as they were at Malioboro. Generally, the SPLs exceeded the noise level standard for public facilities (60 dB) or recreational areas (70 dB) stipulated in the Ministry of the Environment Decree. The three areas are all categorised as public facilities, but Tugu and Malioboro can also be classified as recreational and trading areas. The high noise level, which strengthens earlier findings of noisy Indonesian cities (Colombijn, 2007), was dominated by sounds of non-cultural activities and traffic. This created a low-fidelity soundscape that made the remaining iconic sounds less audible. Though Indonesians like to engage in social activities that create noise (—et al., 2023b), the high noise level remains homework for the authorities concerning public health.

Besides SPLs, all sound types that emerged at the three locations were listed and recorded. The sound listing was intended to confirm sound taxonomies used worldwide. The taxonomy stipulated in ISO (ISO, 2018) includes urban sound taxonomy but is less detailed than the taxonomy plotted by Salamon et al. (2014). Figure 3, modified from Salamon, shows that some of Salamon's sounds did not emerge at the recording time. The four primary sound sources, i.e., human, nature, mechanical, and music, emerged, but some sounds of the subordinates (the rounded and firm boxes) were inaudible. By the ISO's

Commented [CEM14]: 14) Narratives are included to outline the participant recruitment process.

Commented [CEM15]: 15) A comparison with the ISO taxonomy has been added to align with the study by Parker and Spennemann, as mentioned by reviewers.

taxonomy, human, mechanical, and music are subordinates of sounds generated by human activity, and nature is subordinate to sounds not generated by human activity (Figure 4).

Figures 3 and 4 show that these taxonomies could only accommodate sound sources at the ordinate levels (those in yellow or yellow shade), and many of the subordinates were absent (those in orange or orange shade). Some sounds were absent simply because they were not emerging during the recording, such as crying and coughing, or the activity did not exist in the city. Similar activities might exist, but local communities use different tools, resulting in other sounds. This suggests that a comprehensive classification system for urban areas in developed countries only partly encompasses the various sounds of urban areas of developing countries. It is due to different activities, social dynamics, types of vehicles, and tools, as exemplified in Yogyakarta. The terms 'developed' and 'developing' focus on the two groups' dissimilar vehicle and traffic characteristics (Dargay, 2002).In developing countries, traditional and old vehicles are easy to spot. They mix with modern cars to create heavy traffic.

Figures 3 and 4 about here.

In Yogyakarta, train sound is quite prominent as the train station is located in the city centre, between Tugu and Malioboro. The half-coloured rounded box of the skateboard in Figure 3 reflects the use of different roller objects. Children and teenagers prefer roller skating to skateboarding. The sound of bike spokes is absent although people riding bicycles are spotted in the city. However, their sounds are too faint to be audible and recorded masked by other sounds. For Indonesians, bicycles are primarily for sport, fun, and showing the riders' level in the community rather than for transportation—a similar case for skateboards that are primarily for sport and fun rather than for transportation. Riding bicycles is also unsafe concerning streets and pavement conditions in Indonesia (- et al., 2021).

Some sounds not mentioned in the ISO's and Salamon et al.'s taxonomies emerge in the area: horse-drawn carriages, hand claps, whistling and cutlery. The sound of cutlery is audible and went into the recording input because open-air dining (Figure 2) is massive in Malioboro. The sound of bells does not solely emerge from bicycles but also street vendors to attract prospective buyers. Various traditional economic activities are easily found in cities in developing countries, for instance, street vendors offering their products by shouting or using noisy tools, bus conductors shouting the carriage routes along the way, and the whistle and shout of parking attendants directing drivers to enter or exit parking slots. In contrast, these traditional economic activities are hardly found in developed countries. All these indicate that an urban sound taxonomy is specific to each area, especially when it is also a traditional, cultural, and tourist area. The many differences suggest that the urban sound taxonomy of developed countries, where social lives are modern, more regular and homogeneous, and developing countries, where communities live more traditionally, creating

Commented [CEM16]: 16) Narratives are included to discuss specific findings concerning sound classification based on standard taxonomies, which will later propose modifications to the taxonomy for urban areas in developing countries, particularly for heritage, cultural, and traditional cities.

Commented [CEM17]: 17) A figure has been included to compare the findings to the ISO taxonomy.

various and irregular activities, should be plotted differently. When linked to the SPL, a more detailed taxonomy can be created by highlighting dominant, less dominant, and barely heard sounds. Additionally, separate taxonomies may be needed for tourist and non-tourist cities.

In-situ soundscape survey

The soundscape data were processed for analysis and visualisation using a Python package, Soundscapy, developed by Mitchell et al. (2022), as in Figures 5a and 5b. The sound environment, measured as 'noisy' in terms of SPL and needs a more details taxonomy, is perceived as eventful but pleasurable, in general (Figure 5b). The soundscape spreads over four quadrants means that perceptions are scattered almost evenly. The spread of responses in four quadrants is evident, especially in the Tugu area (Figure 5a). Nonetheless, the figure shows that most participants simultaneously perceived an eventful and pleasant sound environment (Figure 5b). These results correlate to earlier studies that Indonesians spend their time in public places to engage in communal activities (- et al., 2020a). They create noise and enjoy the noise at the same time. When the sounds are grouped into five categories—traffic, human, nature, music, and other noise (such as from constructions and machines)—traffic sounds, sounds from human activities and music were dominant. Nature sounds could only be heard mildly in Alun-alun Kidul. In association with Figures 3 and 4, the nature sound is only the sound of the wind, not animals or vegetation, since natural areas are very minimal in the city. Nevertheless, amidst the heavy traffic, Yogyakarta still offers a comfortable public space with gentle natural sounds, as natural sounds can enhance acoustic comfort (Hong & Jeon, 2013). Although Hong and Jeon (2013) did not explicitly mention wind, the sound of wind offered acoustic comfort for some visitors of Alun-alun Kidul, who found it pleasant and eventful because wind-based relaxation seemed effective for them (Ito et al., 2023).

Figures 5a and 5b about here.

The scattered response of Tugu indicates that participants do not have place attachments to the surveyed areas. Axelsson et al. (2010) said familiarity was also found in soundscape surveys, accounting for 8% of the variance, which is typically disregarded. However, this differs in Yogyakarta, where place familiarity may bias participant responses. This can be less beneficial for a tourist area because place attachment affects soundscape perception to impact tourist satisfaction (Kankhuni & Ngwira, 2022). Despite the eventful and pleasurable environment, participants were also aware that the noise is high with the domination of traffic noise, thus simultaneously creating a low-quality acoustic environment.

Memory-based soundscape survey and the iconic sounds

Commented [CEM18]: 18) Narratives have been included to illustrate the unique finding that the working environment is considered pleasant due to the presence of natural sounds.

The memory-based survey had two objectives: to evaluate the soundscape and capture the city's iconic sounds. These objectives need broader participants than the *in-situ* survey, and the difference between the two is tabulated in Table 5. The memory-based survey was completed by 110 participants, with demographic composition compiled in Figure 6. It shows that residents dominated over visitors. Participants agreed that the sound in Yogyakarta evoked their memory because it had and still has iconic sounds that represent the culture and tradition of the city. However, for the current situation, approximately half of the participants perceived Yogyakarta's sound environment as inappropriate. The questionnaire did not extend inquiries about what caused the appropriateness and inappropriateness. However, when connected to the high SPL and the *in-situ* survey, the inappropriateness is likely due to the dominance of sound from human activities and traffic rather than iconic cultural sounds.

Table 5 about here.

Figure 6 about here.

ISO 12913-3 mentioned several approaches to analysing data collected from the questionnaires (ISO, 2019). Since this study used Method A of ISO/TS 12913-2:2018 (ISO, 2018), the data was analysed using Method A, where sound source identification, perceived affective quality, and assessment of surrounding sound environment and evaluation of the appropriateness should be evaluated using median as central tendency since the data is not normally distributed. Furthermore, the data of this study were obtained from a questionnaire that might have had a different data distribution, which led to the selection of a non-parametric approach. For small sample sizes, as in the study, a hypothesis test known as the Shapiro–Wilk test is used to determine whether or not the data fits a normal distribution.

The Shapiro–Wilk normality test shows a low p-value, suggesting a normality assumption violation (González-Estrada et al., 2022). Therefore, to test more than 2 dependent variables, a non-parametric approach, the Kruskall–Wallis, was used. It was found that only statement 2 correlates to participants' age, whereas no significant differences were found between other demographic factors and the other statements (Table 6). Although there was a significant difference in the number of local and visitor participants, no significant difference related to their responses to the 6 statements was found. This relates to Romero et al. (2015), who note no sound perception differences between residents and tourists.

Table 6 about here.

The results show that age variations significantly affect the perception of pleasantness and annoyance. Those below 60 perceive the sound environment as less annoying than those over 60 (Figure 7). This aligns with earlier studies by Champelovier et al. (2021), Gozalo et al. (2018), and Dökmeci et al. (2008), which mention that older adults tend to be

Commented [CEM19]: 19) Narratives are included to justify the type of sampling used to select informants for both the online and on-site questionnaires. A list of the sampling variances used for each data collection technique is presented in Table 5.

Commented [CEM20]: 20) Narratives are included to justify the terminology used (Shapiro-Wilk) about standard soundscape data processing, including soundscape for the heritage field.

more sensitive. In contrast, different study layouts found that with the same noise exposure, relatively older adults feel less annoyed (Beaman, 2005; Michaud et al., 2008; Nang Li et al., 2012; Okokon et al., 2015) than intermediate ages due to the impairment of the senses of the elders (Miedema & Vos, 1999).

Figure 7 about here.

Through an open question about the sound that is identical to Yogyakarta at the end of the questionnaire, the study collected 48% entries of 'gamelan' (Figure 8), followed by the sound of 'andongs' (horse-drawn carriages) and drum bands, accordingly. Drum bands, a name given by locals, are small marching bands that parade using several types of drums, heard by locals or visitors either early morning or late at night. Until today, no one can explain who plays the drums and where they come from. Although it is less audible, it remains the unique sound associated with Yogyakarta. Scientifically, strange sounds heard during quiet time are most likely sounds of nature, such as sounds of soil (Rillig et al., 2019), sounds of earth or moving ground (Kahn, 2013), or sounds of cloud and cloud droplets (Colgate & McKee, 1969; Qiu et al., 2021), which is almost inaudible in noisy environments.

Commented [CEM21]: 21) Discussions have been initiated to identify the source of the unusual sound.

Figures 8 and 9 about here.

For the ease of exploring the past soundmark, the data were clustered as words depicted in different sizes, known as 'word clouds'. Some local terminologies were used in the word cloud tool as they could not be translated into English. The iconic sounds are composed mainly of economic activities, such as 'andong', 'becak's bell, 'pengamen' (English: buskers) and the sound from local markets (Figure 9). 'Andongs' and 'becaks' (three-wheeled traditional vehicles) were once the primary means of transportation for people and their products from the production houses to markets and vice versa, but they are now used more for tourist purposes. On these transport modes and in markets, local conversations using the Javanese language or Bahasa Indonesia with a Javanese accent, namely, 'logat Jawa' (Figure 9), were also perceived as one of the iconic sounds of Yogyakarta.

Figure 9 shows that 'gamelan' was the top-notch. 'Gamelan' does not exclusively belong to Yogyakarta; it is also a name used by other regions in Indonesia, such as Solo and Bali, but with different instrument details and styles of playing. Even so, this study notes that the connection between 'gamelan' and Yogyakarta is more substantial than 'gamelan' and other regions. There are three sultanates on Java Island: Yogyakarta, Surakarta, and Cirebon. Each has the same traditional event, namely 'sekaten' and 'grebeg' to commemorate the birthday of Prophet Muhammad (Hananto, 2020). In this event, the Sultanate's 'gamelan' is transferred from the Sultanate Palace to the Grand Mosques. The 'sekaten' as part of the event was greater and livelier in Yogyakarta (Mulyana, 2017; Sapphira, 2019; Priyatiningsih & Rahayu, 2021), which likely to put 'gamelan' and

Yogyakarta in people's mind than it was in Surakarta and Cirebon. In the past, when buildings were rare and the air was purer, the actual sound of 'gamelan' played in several locations was audible from a distance. Nowadays, this traditional sound is mild and locally audible through playback in shops, small local events, or radio broadcasts.

The second soundmark of Yogyakarta is the sound of 'andong', an orchestra of the knock of horse's shoes on pavements, the jiggling horse's attire, the horse's and driver's voices, and the cart's bell. This type of transportation is also found elsewhere in Indonesia, such as 'delman', 'bendi', 'sado' or 'cidomo' (Wendi & Suasti, 2018; Gultom, 2020; Tirtasari & Atma, 2021; Thalib, 2022; Dewi & Saputra, 2022), but the different types of horse-drawn carriages result in different sound combinations. In Yogyakarta, 'andong' is also known as 'dokar', but the latter is used less often. Like 'gamelan', 'andong' is significantly associated with Yogyakarta than other places (Hutami & Effendi, 2015; Purnamasari, 2018; Prasetyo & Marzuki, 2019; Hijriyanto, 2020; Huda, 2022; Hanifah, 2021; Tontowi et al., 2021; Ciptosari et al., 2021). The 'andong' orchestra sound has gradually diminished with the shifting in transportation modes.

Comprehensive findings

The in-situ survey captures the domination of sound from human activities, traffic noise, and music to comprise Yogyakarta's current soundscape. The music heard during the in-situ survey was not the 'gamelan' sound but more of playback music turned on by youngsters hanging out in Malioboro and the sound of buskers with their mini loudspeakers. These differ from the 'gamelan' music as the most notable soundmark collected from the memory-based survey. Significant population growth, lifestyle changes, and revolutions in the use of machinery tools are the main contributors to the change of soundscape from a high-fidelity to a low-fidelity uniform soundscape (Kyvelou et al., 2021). This happens in Yogyakarta and many cities worldwide (Kyvelou et al., 2021; Parker & Spennemann, 2022). Although in Naples, tourists were less concerned about soundscape quality amidst cleanliness, security, and maintenance aspects (Romero et al., 2015), it might not be the case in Yogyakarta, where visitors began to notice that Yogyakarta is different from what it used to be.

Conversely, Duffy et al. (2011) and Liu et al. (2018) stated that sound influences tourists' experience as it is integral to the entire visitation process. This aligns with Qiu et al. (2018), who identified the importance of soundscape in promoting sustainable development in tourist destinations. Liu et al. (2013) said soundscape expectation strongly influences tourist satisfaction. Expectation differs from preference; a person might not prefer a particular sound, but when they visit a specific place known for its uniqueness, they might expect to hear certain sounds related to its uniqueness.

After all, participants perceived Yogyakarta's soundscape as evoking their memory of the city, which used to be unique and represented the culture and tradition of the city (Figure 10). Even with a less distinctive and low-quality acoustic environment, they rated the city's soundscape quite appropriate (Figure 10). This correlates with the perception of pleasantness, selected by 59% of participants, and the perception of annoyance by only 15% (Figure 11), indicating that when iconic sounds still faintly exist, the city soundscape is generally appropriate. Once the remaining soundmarks are inaudible, people may feel Yogyakarta's sound environment is inappropriate. This aligns with Yelmi (2016) and Rehan (2016), who said preserving iconic sounds is vital in creating the appropriate sound environment for a cultural and tourist city. Given the current acoustic environment, where traffic noise dominates the city soundscape and the iconic sounds, especially the 'gamelan' music, preserving the remaining iconic sounds becomes a matter of urgency (Jucu, 2021). Learning from Yogyakarta, where the sounds of 'gamelan' and 'andong' were once widespread throughout the city and now are only scattered, a policy to protect and manage the areas where these activities still exist is urgent before they disappear eentirely.

Figures 10 and 11 about here.

4. Conclusion

A series of quantitative modes was conducted to investigate the past and current acoustic environment of a city known as a cultural and tourist city based on sound classification (Parker & Spennemann, 2022). Even though it had many specific sounds that participants recall as the city's soundmarks, it is now changing to a more uniform sound dominated by humans, traffic, and musical sounds other than the cultural ones. The current sound characteristics of Yogyakarta have altered from past cultural and traditional activities, though tourism activities are still held. The high SPL covers the remaining soundmarks, even though the city's soundscape is reasonably pleasant.

The detailed sound composition of this urban area is different from the standard urban sound taxonomies, which indicates that a given urban sound taxonomy might only be partially applicable worldwide. The social characteristics of developing countries, where social lifestyles affect urban activities, result in different sound taxonomies. By plotting the sound sources and types in Yogyakarta on to Salamon's sound taxonomy (the more detailed urban taxonomy compared to the ISO's; Salamon et al. 2014), we learn that the ordinate levels of classification consist of sound generated by humans and not generated by humans (as of ISO), and human, nature, mechanical, music sounds (as of Salamon et al.) is matched. However, variations occur at the subordinate levels. Some sounds were absent in Yogyakarta because the source did not exist or other sources masked them within the high SPLs. Some sounds at the lower subordinate were audible but should be shifted to another

Commented [CEM22]: 22) Narratives are included to address the specific state of the city's remaining soundmarks and the necessity for particular policies.

Commented [CEM23]: 23) The conclusion has been revised to address reviewers' comments. The study focuses on classifying urban sound environments, highlighting that sound taxonomies vary from one country and city to another, especially in cultural and tourist cities. It is suggested that a modified taxonomy is required to provide a more detailed sound classification. The study also identifies that the remaining soundmarks of a cultural city may be scattered across specific areas, requiring government support to establish policies for the protection of these soundmark sources before they disappear completely. Soundmarks from daily local activities are challenging to replicate, particularly as local lifestyles evolve. However, sounds from cultural activities may be more readily reproduced as long as the cultural events continue to take place. These narrations are added to the paper.

ordinate to match their function, such as bicycles and skateboards. Ordinates of sports and entertainment should be included in the taxonomy.

The referred taxonomies need to be broadened and detailed to match the taxonomy of developing countries with various traditional activities using traditional tools. For instance, the use of whistles instead of sirens, the presence of shouts, and conventional tools used by vendors need to be included. The sounds of cutlery from outdoor dining also need to be added to the taxonomy. Cutlery sounds are inclusive because outdoor dining is worldwide, particularly during summertime. When the taxonomy is linked to the SPL, a more detailed taxonomy may be created, highlighting the dominant, less dominant, and faintly audible sounds. Further, we may also need different taxonomies for tourist and non-tourist cities.

As a city of culture and tourism, people strongly linked Yogyakarta to the traditional 'gamelan' music and the sound of conventional transportation known as 'andong'. Even though 'gamelan' and 'andong' are not unique to Yogyakarta, they are closely linked to the city. Its attribute as a cultural city contributes to the acquisition of these two features by Yogyakarta only. The two notable soundmarks corroborate the findings of previous studies in the same series (- et al., 2023a). The perception of pleasantness and annoyance associated with the soundscape is influenced more by age than by residents' or visitors' settings. These initial findings will serve as a reference for preserving and managing the intangible heritage, contributing to sustainable tourism development and the well-being of local people associated with sound.

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Disclosure statement

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Commented [CEM24]: 24) The revised narratives include several additional references for alignment.

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Word count: 9,066

Figure 1. Snapshots of Tugu, Malioboro, and Alun-Alun Kidul vicinity.

4218x791mm (72 x 72 DPI)

Figure 2. Informal culinary activities in the Malioboro vicinity, namely 'lesehan', get livelier while entering the night phase.

1151x647mm (72 x 72 DPI)

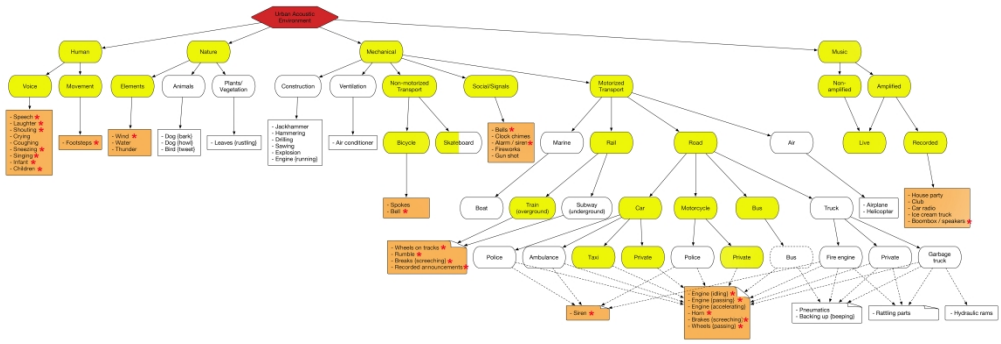

Figure 3. Sound taxonomy of Yogyakarta based on Salamon et al. (2014). Only sounds in the coloured forms and those marked with red asterisks (*) are found in Yogyakarta's tourist areas—Zoom in for clarity.

800x272mm (300 x 300 DPI)

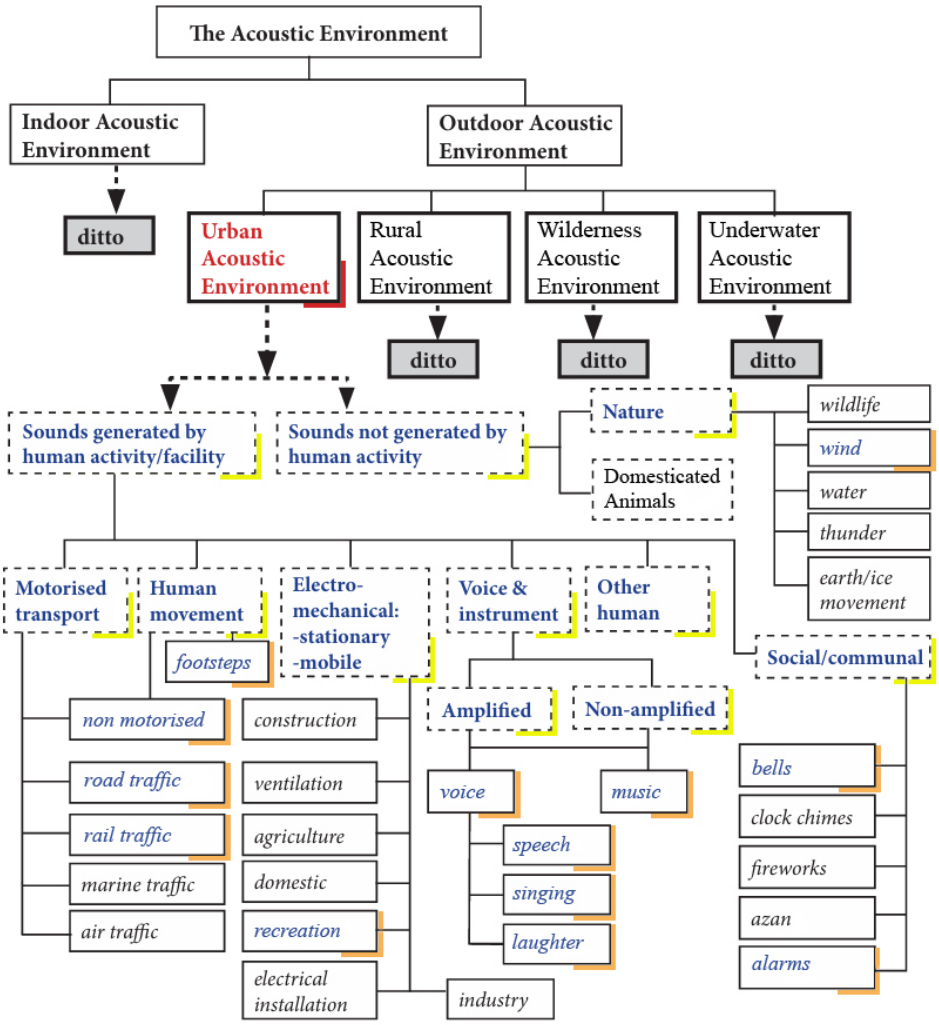

Figure 4. Sound taxonomy of Yogyakarta based on ISO (2018). Only sounds in the coloured shades are found in Yogyakarta's tourist areas.

300x318mm (72 x 72 DPI)

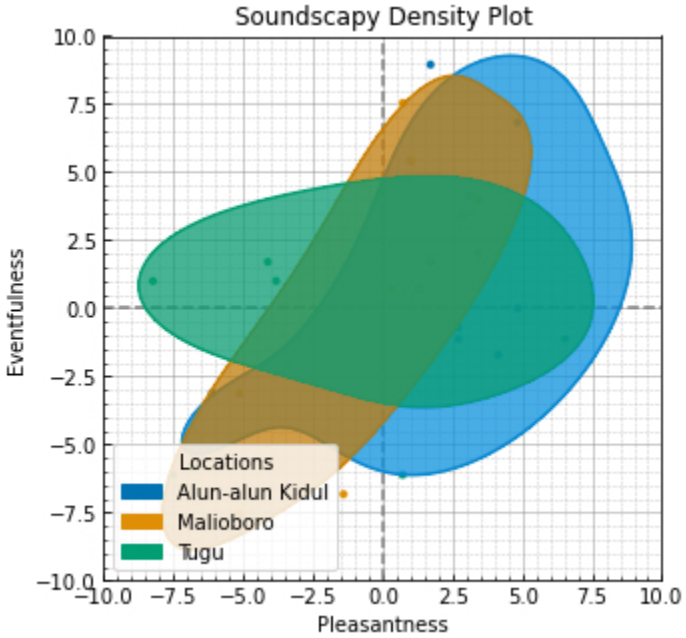

Figure 5a. Responses collected from the soundscape survey at three tourist areas.

319x298mm (28 x 28 DPI)

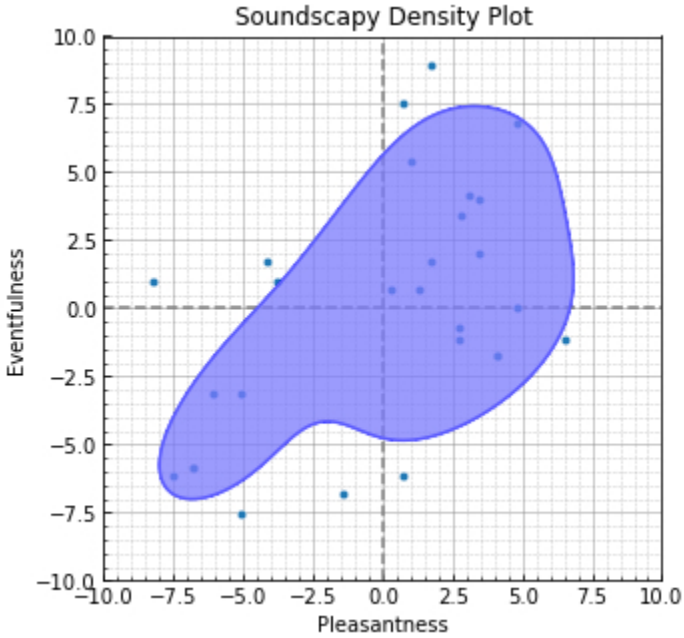

Figure 5b. Combined responses collected from the soundscape survey.

319x298mm (28 x 28 DPI)

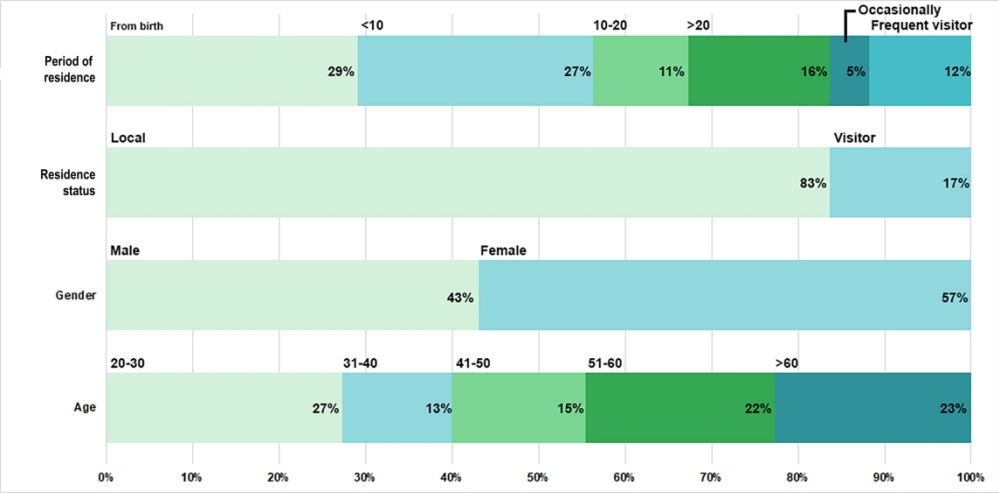

Figure 6. Demographic data of the memory-based survey participants.

366x180mm (200 x 200 DPI)

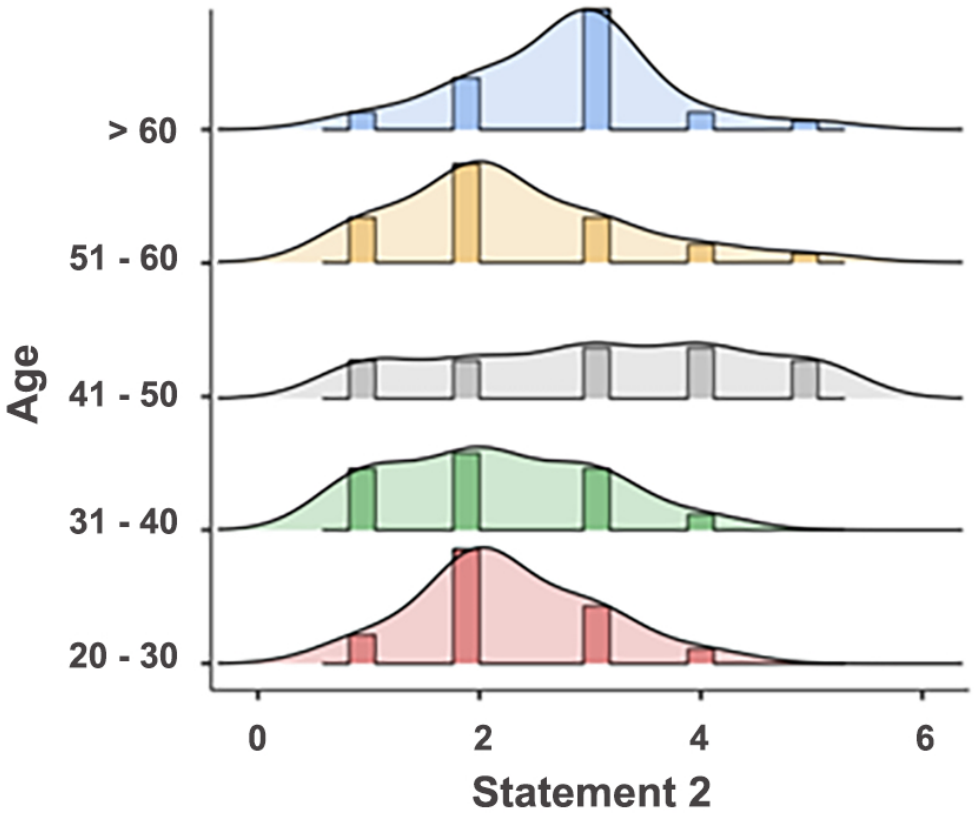

Figure 7. Age variants related to statement 2: annoyance.

299x244mm (72 x 72 DPI)

Figure 8. A set of gamelans played by a group of musicians (https://travelinkmagz.com/2018/10/gamelan-jawa/).

363x204mm (72 x 72 DPI)

Figure 9. Responses related to Yogyakarta iconic sounds.

283x134mm (200 x 200 DPI)

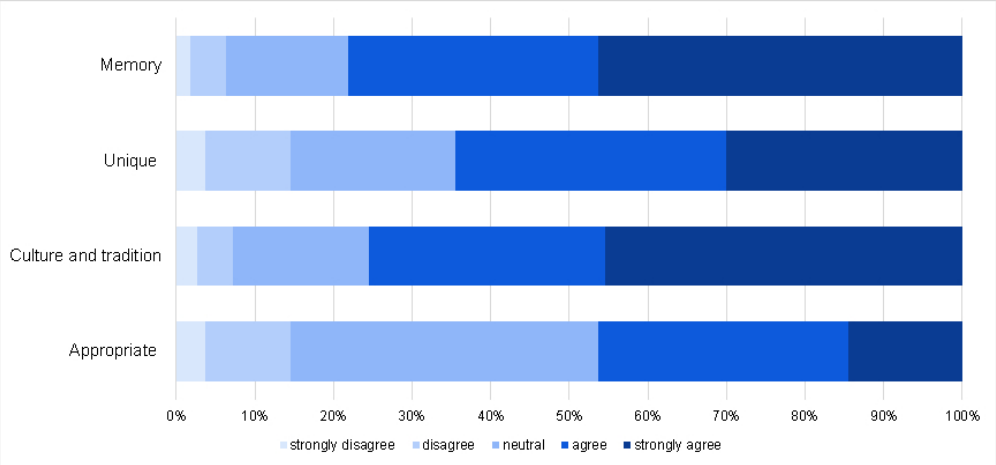

Figure 10. Responses related to sound characteristics of Yogyakarta.

305x142mm (72 x 72 DPI)

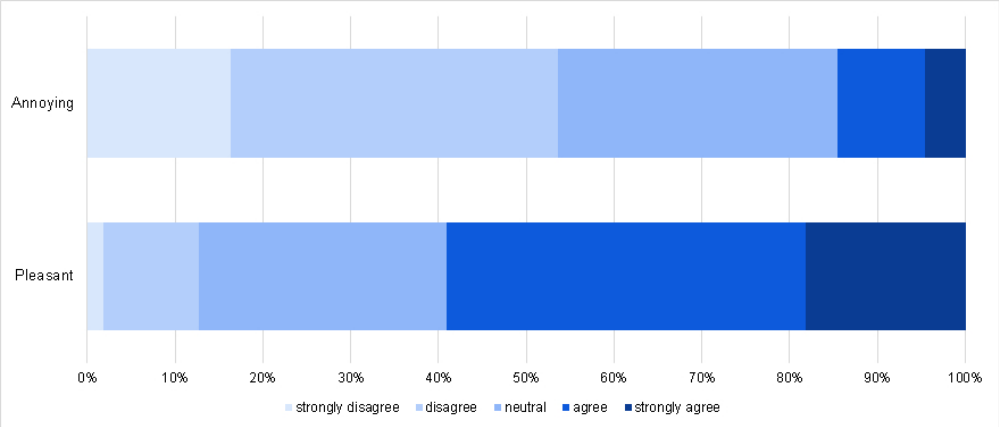

Figure 11. Responses related to the general perception of Yogyakarta's sound environment.

310x133mm (72 x 72 DPI)

Table 1. The translation of eight soundscape attributes into Bahasa Indonesia (Sudarsono et al, 2021).

English	Bahasa Indonesia
Pleasant	Menyenangkan
Chaotic	Ribut
Vibrant	Bersemangat
Uneventful	Sepi
Calm	Tenang
Annoying	Mengganggu
Eventful	Ramai
Monotonous	Menjemukan

Table 2. Equipment used for recording and SPL measurements.

Equipme	Specification	Factors collected	Duration
SLM	Class 2 with omnidirectional pattern measurement microphone and connected to Soundlab software	Acoustic data: (a) 1-second logging period (b) L_{Aeq}, L_{AFmax}, 1/3rd Octave Band L_{Aeq}, Octave Band L_{Aeq}, Full statistics, and Full Spectral Statistics	Three sub-points for each public area, each sub-point measured 3 times, each of 10 min.
Recorder	H2N Zoom Handy Recorder	(a) .wav audio recordings (b) 44.1 kHz, 24-bit resolution	5 min 3 times repeated for each point

Table 3. The *in-situ* soundscape survey questionnaire.

Questions	**Responses: Likert scales of 1-5**
Do you hear traffic?	Not at all – completely dominate
Do you hear sound from human beings (activity)?	Not at all – completely dominate
Do you hear natural sound?	Not at all – completely dominate
Do you hear music?	Not at all – completely dominate
Do you hear other sound (construction, workshop/ industry)?	Not at all – completely dominate
Pleasant feeling (Bahasa Indonesia: *menyenangkan*)	Strongly disagree – strongly agree
Chaotic feeling (Bahasa Indonesia: *ribut/semrawut*)	Strongly disagree – strongly agree
Vibrant feeling (Bahasa Indonesia: *bersemangat*)	Strongly disagree – strongly agree
Uneventful feeling (Bahasa Indonesia: *sepi*)	Strongly disagree – strongly agree
Calm feeling (Bahasa Indonesia: *tenang*)	Strongly disagree – strongly agree
Annoying feeling (Bahasa Indonesia: *mengganggu*)	Strongly disagree – strongly agree
Eventful feeling (Bahasa Indonesia: *ramai*)	Strongly disagree – strongly agree
Monotonous feeling (Bahasa Indonesia: *membosankan*)	Strongly disagree – strongly agree
How noisy is the environment?	Not at all – completely dominate
How is the acoustic environment?	Very bad – very good

Table 4. The memory-based soundscape survey questionnaire.

Questionnaires	Questions (statements number)	Responses
Demographic data	Age	20 to 30; 31 to 40; 41 to 50; 51 to 60; > 60
	Gender	Male – female
	Residence status	Local - Visitor
	Period of residence	From birth; < 10 years; 10 to 20; >20 years; occasional visitor; frequent visitor
Soundscape (Likert scale 1 to 5)	Sound environment is pleasant (1)	Strongly disagree – strongly agree
	Sound environment is annoying (2)	Strongly disagree – strongly agree
	Sound environment is unique (3)	Strongly disagree – strongly agree
	Sound environment evokes memories (4)	Strongly disagree – strongly agree
	Sound environment reflects rich culture and traditions (5)	Strongly disagree – strongly agree
	Sound environment is appropriate (6)	Strongly disagree – strongly agree
Open question	Name unique sounds that represent Yogyakarta as a city of culture, tradition, & tourism	One response or more

Table 5. Participant differences between *in-situ* and memory-based soundscape surveys.

	***In-situ* participants**	**Memory-based participants**
Objective	- To rate the current soundscape	- To appraise general soundscape - To collect soundmarks of the city by recalling memories
Number of entries	81	110
Distribution	Purposive --> temporary resident	Random --> various
Age range	20-22	20 to > 60
Sex composition (male: female)	67: 33	43: 57
Resident status composition	Temporary resident (100%)	Various: local, temporary resident, regular visitor, occasional visitor
Occupations	Undergraduate students	Various: unknown

Table 6. Significance of statements.

Statement	χ^2	df	p
Statement 1	4.64	4	0.326
Statement 2	**10.08**	**4**	**0.039**
Statement 3	1.6	4	0.809
Statement 4	3.83	4	0.43
Statement 5	6.5	4	0.165
Statement 6	3.17	4	0.529